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Strategies and Partnerships for Biotech Regions

The Regional Innovation and Partnership Project

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Foreword

In this report ITPS has taken on the challenge of analyzing new developments around innovation systems and partnerships by focusing on strategies in biotech regions. The report is a contribution to informed policy-making that may enable ideas, products and processes to be effectively transformed into business opportunities and sustained economic development.

The report reveals that strategies and regional partnership formation is becoming increasingly relevant for policymakers due to the complexity of the many relations crucial for promotion of innovations and their commercialization. Policymakers at all levels need to determine how to attract, retain and nurture a critical mass of biotech assets. Only a small number of biotech regions are likely to compete successfully in fierce competition for capital, companies, research facilities, talent, tax revenues, and publicity.

It is evident that biotech regions are actively involved in partnership formation and strategic biotech development in order to position themselves in the current situation. The results are highly relevant for any type of cluster, but particularly knowledge-intensive industrial sectors, in Sweden as well, due to general tendencies in terms of geographical distribution and concentration. The report is co-authored by Anders Östhol (Project Director) and Johan Lembke.

Stockholm, April 2003

Sture Öberg,
Director General, Swedish Institute for Growth Policy Studies

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We are thankful to all the individuals who enabled this entire undertaking by generously setting off their time, completing our regional opinion survey, submitting to interviews, and offering their views and insights about local circumstances. While this report intends to reflect the consensus of those interviewed and surveyed, it cannot do justice to all their contributions and views. Any errors, omissions, or inconsistencies are the responsibility of the report writers.

The regional opinion survey is partly informed by the work by Professor Michael E. Porter, the Monitor Group, and the Council on Competitiveness and its Cluster of Innovation Initiative. We are especially thankful to Chad Evans and Michelle Lennihan at the Council on Competitiveness for their encouragement and assistance.

We would also like to extend our gratitude to those in the Swedish biotech community who provided comments on our findings.

For additional information on this research initiative, contact Anders Östhol or Johan Lembke at the Swedish Institute for Growth Policy Studies/Institutet för Tillväxtpolitiska Studier, ITPS (email: anders.osthol@itps.se, lembke@gwu.edu)

Strategies and Partnerships for Biotech Regions

Executive Summary

The purpose of the Regional Innovation and Partnership Project (RIPP) is to support informed public policymaking concerning technology-based economic development. In this study, we analyze innovation (from research to commercialization into marketable products) in biotechnology and life sciences by examining the role and activities of partnerships and strategies, identifying and analyzing critical factors for innovation, and assessing the role of the institutional environment in which innovation-oriented organizations operate. This study explores debates and activities in North Carolina about how to capitalize on existing biotech assets and bolster additional growth. The focus of the regional analysis is on a number of areas that are deemed to be central for nurturing and enhancing competitiveness and the capacity for innovation.

IN EACH REGION, WE EXAMINE:

Regional performance and innovation capacity

Strategies on competitiveness and positioning

Regional partnerships

Regions and metropolitan areas are aggressively investing in biotechnology to stimulate job creation, corporate growth, manufacturing, research, venture capital, and tax revenues. Most major urban regions of the world are developing a strategy around the biotech industry. Some have suggested that there are today probably around two hundred metropolitan areas in the world that are staking their claim to being a significant participant in the biotech sector. However, there may eventually be no more than twenty-five worldwide biotech centers of excellence. Partly due to history, the strength of the Research Triangle region and the flexible biotech approach and cluster enhancement model advanced by the North Carolina Biotechnology Center, North Carolina is likely to be one of these centers of excellence.

In North Carolina, a statewide strategy plan for the biotech sector is emerging that will identify the competencies and capabilities of each region in the state. Currently, there is no single coherent and comprehensive statewide strategic plan, or coordinating institutional arrangement, to position the state for biotech. This strategic effort raises a number of issues that are discussed in this report:

- Whether to concentrate biotech assets
- Whether to diffuse them throughout a larger geographical area
- How to capitalize on existing assets and stimulate future growth and by what institutional arrangements
- How to respond to a highly competitive environment
- How to balance broad and niche-oriented biotech strategies in order to stay ahead of the competition and reduce vulnerability in economic downturns
- Whether to create new models of regional collaboration and public-private partnerships for the promotion of the biotech sector

- Whether new strategic efforts and partnership models should be established at the local, regional or state level
- Role of the government, the private sector and other partners
- How to support and benefit from the learning processes involved in such developments.

The report states that conditions for success in science-based and technology-based economic development and innovation are concentrated in a few geographical urban and regional areas. It stresses, among other issues, the need to support the conditions for early-stage economic development and innovation, the ability to capture new ideas resulting from investments in basic research and human capital; encouraging a culture of entrepreneurship that adapts to changes in the market place in an effective and timely manner, a culture of leadership among business leaders that supports an active approach to economic development; balancing competitive models of academic entrepreneurship and supportive approaches to smaller growth companies with a collaborative model among universities and other institutions to reduce conflicts of interest that could hamper the creation of economic value and sustained growth; identifying how public investments in science and technology-driven efforts for economic development relate to private investments, and delegating some of the assessment of the connection between public and private investments to a body that is independent of specific industries and state-sponsored organizations.

FINDINGS INCLUDE:

- Biotech economic development is concentrated in specific geographical areas. Regions are aggressively investing in the biotech sector and are competing for capital, companies, talent and tax revenues. The result is intense competition between regions that adds an important level of competition to that between companies and institutions.
- The regional level and regional partnerships – and the aggregation of biotech assets at the regional level – are gaining increasing legitimacy as true references for economic development and support for the biotech sector, partly as a result of limited pools of available resources and capital.
- The biotech sector realizes the need for concerted state and regional efforts and strong public commitment in biotech economic development. The private sector is working in tandem with various public-private partnerships to mobilize resources.
- Responsibility for developing strategies for the biotech sector is based on and implemented through decentralized and flexible institutional arrangements of cluster enhancement and market-oriented incentive structures.
- Biotech economic development is encouraged as a way to diversify state and regional economies and to reduce vulnerability.
- The biotech community is supporting statewide strategic plans and is engaged in a process of identifying all available capabilities and competencies in different regions as a way to build on the existing strengths and the uniqueness of each region.
- Emerging biotech regions are striving to leverage the proximity to more established biotech regions and to develop niche capabilities that complement existing strengths. There is a need to recognize the distinct features of each region and to play to their particular strengths by tailoring approaches to maximize impact.
- The importance of nurturing smaller, high-growth businesses is recognized as a crucial strategy for technology-based economic development in combination with recruiting external investments, companies, and talent from outside the region that complement the existing cluster throughout the value chain.

- Competitiveness and regional advantages are reflected in the innovative capacity to attract venture capital to the region, to mobilize business angels through various types of network organizations, and identify complementarities between venture capital, private equity investment and public investment, all of which are important for early-stage technology-based economic development.
- Governmental agencies fulfill a role in the diffusion of knowledge and technology transfer. Such efforts counterbalance the high degree of concentration in the biotech area, but only to a limited extent. The forces of concentration are strong in terms of capital endowment and start-up capability. Regional strategies are in the process of becoming increasingly important for further dispersion.

The institutions of higher education, particularly in the established Research Triangle biotech region, reveal great capacity in commercializing ideas and inventions and play an important role in contributing to entrepreneurship and economic growth. In the emerging Piedmont Triad region, a number of actions remain to be implemented in order to build a durable platform for a vital and comprehensive regional partnership. Its larger biotech community is still at the stage of creating an identity and greater internal coherence and consensus about priorities. In addition, with some individual exceptions, this emerging biotech region has been relatively less successful in attracting government grants and contracts. In times of economic downturn and intense competition, this makes such a region vulnerable. The Piedmont Triad regional economic strategy for the biotech sector is intended to promote the high-tech image of the region and to attract public money that could provide greater potential for future investments in the region. The emerging region needs to attract more public grants and contracts. Since the emerging region does not have the same critical mass in biotech assets and infrastructure as more established biotech regions, it is not able to embark on a true challenger's strategy. Rather, it is more likely to rely on a complementary strategy that strives to leverage proximity to more established regions. It intends to build on its existing strengths and manufacturing heritage by focusing on a niche strategy of promoting and supporting capabilities in biomanufacturing and bioprocessing, which are relatively less sensitive to a research-oriented development and workforce and prestigious research grants.

In the more established Research Triangle biotech region, which is one of the leading regions in the world, the focus is on capitalizing on its excellence and success by coordinating the capacity of partnerships. Biotech firms are increasingly being targeted and invited to become active members in various types of partnerships. Data on technology transfer, the number of start-up businesses, and entrepreneurial development are encouraging. The Research Triangle, due to its high level of critical mass in biotech assets, is relatively less vulnerable to economic downturn and more able to raise capital and create potential for homegrown companies. The character of cluster relationships in the region's biotech sector, and their connections with related sectors, is highly interactive and increases the opportunities to remain at the cutting-edge of technology-based economic development. Specialization and higher concentration seems unavoidable in both established and emerging biotech regions. The region's innovation capacity and strengths in active capital accumulating institutions is higher than in the emerging Piedmont Triad region. The Research Triangle, due to its relatively more

dense institutional landscape for capital accumulation appears less vulnerable to intense competition for capital investment, lower levels of capital available and awarded to the biotech sector, and a possible trend among venture capitalists to put greater emphasis on commercial product potential and later-stage manufacturing.

Furthermore, there is growing legitimacy of regional strategies and partnership models, partly as a result of continuing regional competition on capital and workforce and corporate recruitment. Both the established and emerging biotech regions show signs of institutional pluralism, even though the former region has a longer history of learning and greater resources and the latter region has fewer resources available to regional partnerships as is reflected in its relatively more peripheral character and position. Despite the dominant market-oriented dynamics and relationships, the private biotech sector recognizes the need for some degree of coordination in order to mobilize biotech assets and resources and thereby to strengthen the region as a reference and actor in the race for regional, national and global competitiveness. High performance, depth in quality and concentration of institutions of higher education, as well as effective policies and instruments for academic entrepreneurship and technology transfer of university ideas through decentralized and competitive incentive structures, may encourage further partnership building. This, in turn, could provide additional legitimacy for the regional perspective in technology-based economic development.

A closer look at the overall biotech industry suggests that the tendency to form partnerships based on the sector is diminishing. The involvement of broader partnerships with authority to mobilize resources more effectively, and the development and implementation of strategies aimed at promoting stronger innovation systems, may thus gain broader support in the biotech community, particularly in emerging regions where the demand for coordination and pooling of common resources appears greater. The biotech community in the emerging Piedmont Triad biotech region particularly needs to promote entrepreneurs and deepen the entrepreneurial spirit, whereas the Research Triangle region, which enjoys the advantages of scale, particularly needs to promote further capital utilization in order to gain ground compared to clusters elsewhere.

There may be a need for a comprehensive strategy effort that necessitates more coordination and involvement from state authorities, which in turn may be at odds with the predominant market-driven model of partnerships. It remains uncertain whether the Piedmont Triad biotech community will be able to constitute a central component in a possible process of centralization and strategic planning. This report, however, states that the dominant partnership model will remain based on market-driven and pluralist institutional arrangements for cluster enhancement throughout the state. The capacity to adjust to external pressures and intense competition remain great resources since picking winning instruments and policies is by no means an easy task in the biotech field. Moreover, competition for large contracts and grants requires specialization and flexibility.

This project represents a pilot study as part of a larger ambition to generate information that is useful for policymakers and the larger biotechnology-

pharmaceutical community. Biotechnology is here defined as the application of biological knowledge and techniques pertaining to molecular, cellular, and genetic processes to develop products and services, including applications in medicine, agriculture, and environmental management. The field of life sciences is broader and covers medical devices and instruments, contract research organizations and the pharmaceutical industry, as well as animal and veterinary specialties. These two terms will be used (with some exceptions in data collection) largely interchangeably in this project.

North Carolina ranks among the five leading states in the field of biotechnology in the United States due to its strengths in research and commercialization capacity and activity. The highest-ranking states are Northern California on the West Coast (which encompasses the North Bay with San Francisco, East Bay and San Meteo and Santa Clara counties), followed by the Boston-Worchester (Route 128) corridor in Massachusetts in New England on the Atlantic Coast. North Carolina has several features that are similar to Sweden. First, its biotech assets are concentrated in certain geographical areas that have different strengths and weaknesses, companies with specialized techniques and knowledge, topographical landscapes and climatic conditions, and economic and industrial histories.

The high degree of concentration in biotech capacity in certain metropolitan areas and regions throughout the state makes it similar in outlook to the concentration of biotech assets in Stockholm and Uppsala, Lund and Malmö, Göteborg, Umeå, and Linköping and Norrköping. Second, it is comparable to Sweden in terms of the size of population (about 8.2 and 8.5 million inhabitants, respectively), even though it is less than a third of the size of Sweden in terms of territory. Third, both North Carolina and Sweden have a relatively high percentage of small- and medium-sized biotech companies, a relatively high level of international collaboration, and enjoy strong medical research institutions in a global but regionally highly concentrated industrial sector. There are few competitive places and they have strong ties with one another.

Both the established and emerging biotech regions seem to have a need for more frequent contacts with customers (other companies), which further reinforce the importance of continuing efforts to generate and support a critical mass of biotech assets and relations. This trend is demanding more collaboration within and between Swedish clusters.

In addition, there are also various types of connections between Sweden and North Carolina. The Swedish biotech community is relatively familiar with North Carolina and has experiences from working in and conducting business with this state. The United States is the favored target for firm-firm and university-university partnerships for the Swedish biotech community. This is a mutual relationship; the larger North Carolina biotech-pharmaceutical community invests in and tries to recruit talent in Sweden and, at the same time, the Swedish presence in North Carolina is noticeable.

We provide a number of policy recommendations, which are aimed primarily at the Swedish policymaking and biotech community. They are further elaborated in the concluding chapter.

Policy Recommendations

REGIONAL PARTNERSHIP PERFORMANCE

Encourage regional and inter-regional task forces based on concerted efforts among business leaders, government agencies, economic development bodies, academia and other actors with the objective of analyzing the need for reinventing current models of regional economic and biotech development in order to be well-prepared to make flexible adjustments and to meet changing markets and needs.

PUBLIC-PRIVATE PARTNERSHIPS

Support the creation of a national initiative and public-private partnership aimed at making some of the assessments regarding the effective connection of public and private biotech investments and at encouraging policy discussions about alternative paths and solutions. This partnership initiative should be independent of specific industries and state-sponsored organizations in its day-to-day activities, but be actively supported by the government to encourage genuine political interest and active participation of high-level business and entrepreneurial organization representatives. It could function as a model for concerted and long-term national strategic efforts that are anchored in and reflect regional realities. Such a national umbrella initiative could be important to generate discussions, to identify and prepare the ground for real actions (for example, discussions about investments to reduce bottlenecks where risk capital is likely to materialize), and could have broader positive impact in the long run.

CROSS-BORDER POLICY INTELLIGENCE

Support the need for policy intelligence about international trends concerning evolving regional partnership models and strategies; the relationship between regional concentration and global market pressures; the use of incentive structures, models and mechanisms for commercialization and technology transfer. We have identified the demand for a critical mass of policy intelligence that supports informed public policymaking and evaluations about what is being done and what remains to be done. Representatives of biotech regions cannot be expected to gather such knowledge and information or to generate benchmarks themselves. Government agencies may assist them to collect, analyze and provide such information and knowledge.

Strategier och partnerskap för biotechregioner

Projektledningens sammanfattning

Syftet med detta projekt om regionala innovationer och partnerskap är att bidra till en välinformerad offentlig politik för teknikbaserad ekonomisk utveckling. I rapporten analyseras innovationer (från forskning till kommersialisering av produkter inom bioteknologi och livsvetenskaperna) genom en undersökning av partnerskap och strategier. Ambitionen är att identifiera och analysera kritiska faktorer för att nyttiggöra innovationer, och beakta de institutionella miljöer inom vilka innovationsorienterade organisationer verkar. Studien behandlar pågående debatt och aktiviteter i North Carolina som på olika sätt anknyter till den omgivande regionala miljön och uppmuntrar till tillväxt. Fokus i den regionala analysen ligger på ett antal områden som förväntas vara centrala för konkurrenskraft och kapacitet att ta tillvara innovationer.

I VAR OCH EN REGIONERNA UNDERSÖKER VI:

Regional utvecklings- och innovationsförmåga

Strategier för konkurrenskraft och positionering

Regionala partnerskap

Regioner och städer satsar på bioteknik för att stimulera skapandet av jobb, företagstillväxt, tillverkning, forskning, riskvilligt kapital och skatteintäkter. De flesta stora stadsregioner i världen utvecklar för närvarande strategier kring bioteknik. Det förekommer uppgifter om att det i dag sannolikt finns runt två hundra stadsregioner i världen som gör anspråk på att vara platser att räkna med inom bioteknikseksektorn. Men det finns kanske bara 25 bioteknikcenter av högsta klass att räkna med.

På grund av historiska faktorer och styrkan inom Research Triangle och den flexibla bioteknikstrategin och klusterutvecklingen som stöds av North Carolina Biotechnology Center, är North Carolina sannolikt en av dessa toppregioner. I North Carolina finns idag en strategi på delstatsnivå för bioteknikseksektorn som syftar till att identifiera befogenheter och förmåga till utveckling inom varje region inom delstaten. Men för tillfället finns ingen sammanhållen övergripande plan, eller ett samordnande organ som kan positionera North Carolina inom bioteknik. Försöken till en samlad strategi reser en rad frågor som diskuteras i denna rapport:

- Om bioteknikresurser ska koncentreras?
- Om resurserna ska spridas över större geografiska områden?
- Hur drar man på bästa sätt nytta av existerande resurser och stimulerar framtida tillväxt och med hjälp av vilken sorts institutionella arrangemang?
- Hur svarar man på en högst konkurrensutsatt omgivning?
- Hur kan man balansera breda och nischorienterade bioteknikstrategier för att svara mot konkurrensen och minska sårbarheten i ekonomiska nedgångar?
- Behövs det nya modeller för regionalt samarbete och offenlig-privata partnerskap för befrämjande av tillväxt?

- Vilka behov av strategiska överväganden och partnerskapsmodeller finns på lokal, regional och delstatsnivå?
- Vilka respektive roller ska offentliga myndigheter, den privata sektorn och andra parter ha?
- Hur kan stöd ges åt lärande och hur kan man dra nytta av sådana processer?

Rapporten visar att goda förutsättningarna för vetenskaps- och teknikbaserad ekonomisk utveckling och innovationer är koncentrerade till ett fåtal geografiska regioner och städer.

Bland annat framhävs behovet av att stödja ekonomisk utveckling och innovationer i en tidig fas, förmågan att fånga upp nya idéer som kommer ut av investeringar i grundforskning och humankapital; uppmuntra en entreprenörskultur som anpassar sig till marknaden på effektivt sätt, en ledarskapskultur bland företagsledare som ger aktivt stöd för ekonomisk utveckling; balans mellan konkurrenskraftiga modeller av akademiskt entreprenörskap och understödjande verksamhet för att närma sig mindre tillväxtföretag med en samarbetsinriktad modell för relationerna mellan universitet och andra institutioner; reducera intressekonflikter som kan skada ekonomiska värden och uthållig tillväxt; identifiera hur offentliga investeringar i vetenskap och teknikdrivna ansträngningar för ekonomisk utveckling relaterar till privata investeringar, och delegering av en del uppgifter som kan koppla ihop offentligt och privat i ett organ och är oberoende av specifika branscher och statsunderstödda organisationer.

NÅGRA AV RESULTATEN:

- Ekonomisk utveckling inom bioteknik är koncentrerad till specifika geografiska områden. Regioner investerar ambitiöst inom bioteknikseKtorn och konkurrerar om kapital, företag, kompetens och skatteintäkter. Resultatet är intensiv konkurrens mellan regioner utöver konkurrensen som finns mellan företag och institutioner.
- Den regionala nivån och regionala partnerskap – och de samlade tillgångarna inom bioteknik på regional nivå – växer i relevans som faktorer för ekonomisk utveckling, delvis som ett resultat av begränsade resurser och kapital.
- Bioteknikindustrin inser behovet av samordning av statliga och regionala ansträngningar och starkt offentligt stöd för bioteknisk ekonomisk utveckling. Den privata sektorn arbetar parallellt med olika offentlig-privata partnerskap för att mobilisera resurser.
- Ansvaret för att utveckla strategier för bioteknikseKtorn är baserad på och genomförd inom ramen för decentraliserade och flexibla institutionella arrangemang av klusterstimulerande åtgärder och marknads-orienterade incitament.
- Den ekonomiska utvecklingen inom bioteknik uppmuntras att diversifiera statlig och regional ekonomi och reducera sårbarhet.
- Biotekniksektorn stödjer delstatliga övergripande strategiska planer och är engagerad i en process som identifierat all tillgänglig kapacitet och kompetens i olika regioner som ett sätt att bygga på existerande styrkor och unika egenskaper i varje region.
- Framväxande bioteknikregioner strävar efter att dra nytta av närheten till mer etablerade regioner och utveckla kapacitet inom avgränsade nischer som kompletterar existerande styrkor. Det finns behov av att dra nytta av varje regions speciella egenskaper och deras olika fördelar genom att eftersträva skräddarsydda strategier för att maximera nyttan.

- Vikten av att gynna små, snabbväxande företag är erkänd som en avgörande strategi för teknikbaserad ekonomisk utveckling i kombination med attraherandet av externa investeringar, företag, kunnande utifrån som kompletterar det existerande klustret och i värdekedjan i produktförnyelsen.
- Konkurrenskraft och regionala fördelar reflekteras i form av innovationskapacitet och attraktionsförmåga på riskvilligt kapital för att mobilisera affärsänglar genom olika typer av nätverksorganisationer och identifiera kompletteringsmöjligheter mellan riskkapital, privata investeringar och offentliga investeringar, allt viktiga ingredienser i tidiga faser av teknikbaserad ekonomisk utveckling.
- Myndigheter fyller en roll i kunskaps- och tekniskspridning. Ansträngningarna balanserar den höga graden av koncentration på bioteknikområdet, men bara i begränsad omfattning. Kraften i koncentrationen är stark i termer av kapitalförsörjning och potential för nyföretagande. Regionala strategiers betydelse är på väg att öka och spelar en aktiv roll för spridningen.
- De högre utbildningsinstitutionerna, särskilt i det etablerade Research Triangle återspeglar stor kapacitet när det gäller att kommersialisera idéer och uppfinningar och spelar en viktig roll genom att bidra till entreprenörskap och ekonomisk tillväxt. I den framväxande regionen, Piedmont Triad, återstår en rad åtgärder för att kunna bygga upp en plattform för vitala och övergripande regionala partnerskap. Bioteknikföretagen befinner sig fortfarande i ett skede där det handlar om att skapa en identitet och större sammanhållning inåt och enighet om prioriteringar. Denna region har med några få undantag varit mindre framgångsrik i fråga om att attrahera statliga forskningsanslag och kontrakt. I tider av ekonomisk nedgång och intensiv konkurrens blir en sådan region sårbar.

Piedmont Triads regionala ekonomiska strategi för bioteknik syftar till att befrämja bilden av en högteknologisk region och dra till sig offentliga pengar som skapar förutsättningar för större framtida investeringar i regionen. Den framväxande regionen behöver attrahera mera offentliga anslag och kontrakt. Eftersom den framväxande regionen ännu inte har en tillräcklig kritisk massa i form av kapacitet inom bioteknik och infrastruktur i jämförelse med mera etablerade bioteknik-regioner är den inte redo att ta upp kampen som utmanare. Snarare är det troligt att denna region slår in på en kompletterande strategi som eftersträvar att dra nytta av närheten till en mer etablerad region. Ambitionen verkar vara att bygga på existerande styrka och en tradition av tillverkningsindustri genom att inrikta sig på en nischstrategi för att befrämja och understödja den nuvarande kapaciteten inom tillverkning av biotekniska produkter och bioteknisk processindustri som är relativt sett mindre känslig för forskningsorienterad utveckling, och tillgång på kvalificerad arbetskraft och prestigefyllda forskningsanslag.

I den mer etablerade regionen, Research Triangle, som är en av de ledande bioteknikregionerna i världen, ligger fokus på att dra nytta av dess styrka genom att koordinera tillgänglig kapacitet i partnerskap. Bioteknikföretag blir i ökande grad föremål för uppmärksamhet och inbjuds att bli aktiva medlemmar i olika former av partnerskap. Data på tekniskspridning, antalet uppstartade företag och entreprenörsutveckling är uppmuntrande. Research Triangle är tack vare sin höga nivå på den kritiska massan inom bioteknik, relativt sett mindre sårbar för ekonomisk nedgång och mera kapabel att skaffa kapital och har potential för tillväxt av egna företag. Karaktären på de relationer som växer fram i kluster inom en regions bioteknikssektor, och deras kopplingar till relaterade sektorer, är högst interaktiv och ökar möjligheterna att bibehålla sin tätposition inom teknikbaserad ekonomisk utveckling.

Specialisering och koncentration verkar oundviklig i både etablerade och framväxande regioner. Regionens innovationskapacitet och styrka inom aktiv kapitalanskaffning är högre än i den framväxande regionen Piedmont Triad. Research Triangle framstår med hjälp av sin större institutionella täthet för kapitalanskaffning som mindre sårbar för konkurrens om kapitalinvesteringar, brist på kapital, och den troliga tendensen bland riskkapitalister att betona kommersialisering av produkter och tillverkning i senare stadier av forskningsprocessen.

Dessutom finns en växande legitimitet för att skapa regionala strategier och pröva partnerskapsmodeller, delvis som ett resultat av fortsatt hårdnande regional konkurrens om kapital, arbetskraft och företagsrekrytering. Både de etablerade och framväxande regionerna visar tecken på en stor institutionell mångfald, även om den senare typen av region har mindre resurser tillgängliga för att skapa regionala partnerskap, vilket återspeglar dess mera perifera karaktär och position. Trots att marknadsorienteringen dominerar både dynamiken och relationerna, inser de privata bioteknikföretagen behovet av någon grad av samordning för att mobilisera bioteknikresurser och därigenom stärka regionens rykte som en viktig aktör i regional, nationell och global konkurrens. Hög prestation, kvalitet och koncentration av institutioner för högre utbildning, såväl som effektiv politik och instrument för akademiskt entreprenörskap, tekniskspridning och spridning av idéer från universitetsforskningen genom decentraliserad och konkurrenskraftig incitamentsstruktur, kan bidra till att uppmuntra ytterligare uppbyggnad av partnerskap. Detta ger i sin tur ytterligare legitimitet för det regionala perspektivet på teknikbaserad ekonomisk utveckling.

En närmare titt på bioteknikindustrin visar att partnerskapen inom denna sektor är svagt utvecklade. Bredare partnerskap med myndigheter för att mobilisera resurser mera effektivt, och utvecklingen och genomförandet av strategier som syftar till att befrämja starkare innovationssystem, kan därmed få ökat stöd inom bioteknikseksektorn, särskilt i framväxande regioner där efterfrågan på samordning och förmåga att kombinera gemensamma resurser verkar vara större. Bioteknikssamhället i den framväxande regionen i Piedmont Triad behöver stötta entreprenörer och fördjupa entreprenörsandan, medan Research Triangle, som har skalfördelar, särskilt behöver arbeta med att skaffa och nyttja kapital i syfte att komma närmare kluster på andra håll.

Det finns ett behov av en övergripande strategi för koordinering och inblandning från myndigheters sida, vilket i sin tur kan komma på tvären med den dominerande marknadsdrivna modellen för partnerskap. Osäkerhet kvarstår beträffande om Piedmont Triad är kapabelt att inleda en process mot centralisering och strategisk planering. Denna rapport kommer till slutsatsen att den marknadsdrivna partnerskapsmodellen kommer att fortsätta dominera och åstadkomma klusterförstärkning i delstaten. Kapaciteten att anpassa sig till externt tryck och intensiv konkurrens fortsätter att vara viktigaste resurser genom att det är närmast omöjligt att veta vilka instrument och vilken politik som fungerar inom bioteknikområdet. Konkurrens om stora kontrakt och anslag fortsätter fordra specialisering och flexibilitet.

Denna studie är ett led i en bredare ambition att generera information som är användbar för beslutsfattare och en större allmänhet som är intresserad av bioteknik och läkemedel. Bioteknik definieras här som en tillämpning av bioteknisk kunskap och tekniker som har att göra med molekylär, cellulär, och genetiska processer för att utveckla produkter och service, inklusive tillämpningsområden inom medicin, jordbruk, och miljö. Beteckningen ”livsvetenskap” är bredare och täcker medicinska preparat och instrument, organisationer som forskar på kontrakt och läkemedelsindustri, såväl som djur och veterinärprodukter. De två termerna används omväxlande som beteckning på samma sak i rapporten.

North Carolina är rangordnat som en av de fem ledande staterna inom bioteknologi i USA tack vare sin styrka inom forskning och kommersialisering. De högst rankade staterna är norra Kalifornien på västkusten (som inräknar North Bay med San Francisco, East Bay och San Meteo och Santa Clara), följd av Boston-Worchester (Route 128), korridoren i Massachusetts i New England på Atlant-kusten. North Carolina har flera egenskaper som påminner om Sverige. För det första, bioteknikresurserna är koncentrerade till särskilda geografiska områden som har sina egna styrkor och svagheter, företag med specialisering inom vissa tekniker och kunskapsområden, det topografiska landskapet, klimatförutsättningar, och ekonomisk och industriell historia. Den höga graden av koncentration inom bioteknikbranschen till några få städer och regioner i delstaten gör att det är enkelt att se paralleller med koncentrationen av bioteknisk kapacitet till exempelvis Stockholm och Uppsala, Lund och Malmö, Göteborg, Umeå och Linköping.

För det andra är North Carolina jämförbart med Sverige mätt i befolkning (8,2 respektive 8,5 miljoner invånare), även om delstaten är mindre än en tredjedel så stor som hela Sveriges storlek. För det tredje, har både North Carolina och Sverige en relativt hög procentandel små- och mellanstora bioteknikföretag, en relativt hög nivå på det internationella samarbetet, och starka medicinska forsknings-institutioner i en global men höggradigt koncentrerad industrisektor. Det finns endast ett fåtal konkurrenskraftiga platser med starka band till varandra.

Både etablerade och framväxande bioteknikregioner ser ut att behöva tätare kontakter med sina kunder (oftast andra företag), vilket ytterligare förstärker vikten av ständiga ansträngningar för att generera och stötta framväxten av en kritisk massa av bioteknikresurser och relationer. Denna trend förstärker behovet av sam-arbete mellan kluster.

Därtill finns olika typer av förbindelser mellan Sverige och North Carolina. Det svenska biotekniksamhället är relativt bekanta med North Carolina och har erfarenheter av att arbeta i och göra affärer i delstaten. USA är prioriterad måltavla för partnerskap mellan företag och universitet för den svenska bioteknikbranschen. Det är en ömsesidig relation: det större bioteknik- och läkemedelsklustret i North Carolina investerar i och försöker locka till sig välutbildad arbetskraft från Sverige och samtidigt är den svenska närvaron i North Carolina klart märkbar.

Vi presenterar ett antal politik rekommendationer som framför allt vänder sig till svenska beslutsfattare och biotekniksamhället. De återfinns mer utförligt beskrivna i slutkapitlet.

Politikrekommendationer

REGIONALA PARTNERSKAPETS FÖRMÅGA

Uppmuntra framväxten av en regional och mellanregional agenda baserad på gemensamma ansträngningar bland företagsledare, myndigheter, regionala utvecklingskontor, den akademiska världen och andra aktörer med syfte att analysera behovet av att förnya modellerna för regional ekonomisk utveckling och utveckling inom det biotekniska området för att vara förberedd för att göra flexibla anpassningar och möta behoven på en föränderlig marknad.

OFFENTLIG-PRIVATA PARTNERSKAP

Stödja skapandet av nationella initiativ och offentlig-privata partnerskap som syftar till att skapa en effektiv koppling mellan offentliga och privata investeringar inom bioteknik och uppmuntra diskussioner om politiska åtgärder, alternativa vägval och lösningar. Ett sådant initiativ bör vara oberoende från specifika företagsintressen och statsunderstödda organisationer i sina dagliga aktiviteter, men stödjas aktivt av regeringen för att uppmuntra ett genuint politiskt intresse och aktivt deltagande från högsta nivå inom affärs- och entreprenörsorganisationer. Det kan fungera som en modell för en samlad och långsiktig nationell strategi som är förankrad i och återspeglas bättre på den regionala nivån. Ett sådant nationellt paraplyinitiativ kan vara viktigt för att skapa fruktbara diskussioner, identifiera och lägga grunden för verkliga åtgärder (till exempel, diskussioner om investeringar för att minska flaskhalsarna där riskkapital sannolikt finns), och kan ha ett bredare positivt inflytande i det långa loppet.

GRÄNSÖVERSKRIDANDE OMVÄRLDSANALYS

Understödja behovet av omvärldsanalys beträffande internationella trender och utvecklandet av regionala modeller av partnerskap och strategier; relationen mellan regional koncentration och globalt marknadstryck; användning av förbättrade incitament, modeller och mekanismer för kommersialisering och tekniskspridning. Vi har identifierat efterfrågan på en kritisk massa av omvärldsanalys som stöder en välinformerad offentlig politik och utvärderingar av vad som görs och vad som återstår att göra. Representanter för bioteknikregioner kan inte förväntas samla in sådan information själva, inte heller systematiskt studera goda exempel internationellt. Myndigheter kan tänkas assistera dem när det gäller att samla in, analysera och ta fram sådan information och kunskap.

1. Analyzing Biotech Regions

The purpose of the Regional Innovation and Partnership Project (RIPP) is to support informed public policymaking concerning technology-based economic development. Thus, this particular report focuses on the ability to transform basic research into start-up firms and on improvements of the institutional framework for the promotion of regional clusters in the biotechnology sector (hereafter biotech). The aim is to provide policymaking input in Sweden on the further development and promotion of technology transfer, commercialization of basic research, support of start-up companies and job creation in the biotech sector. In the concluding chapter, we present empirical findings, suggest major challenges, and generate a number of policy recommendations. The major challenges that we identify and the recommendations that we produce are primarily directed at the Swedish policymaking community.

We have chosen to examine North Carolina, a state that overall is one of the leading biotech areas in the United States. In addition, we will examine partnerships and strategies for biotech regions in North Carolina by selecting an established biotech region (the Research Triangle) that has a relatively high level of critical mass of biotech assets and performance in research and commercialization capacity, and one emerging biotech region (the Piedmont Triad) that has a relatively lower level of biotech assets and research and commercialization capacity. We study and analyze North Carolina and these particular regions since they have a number of similarities with the Swedish biotech sector in terms of geographical concentration and distribution, and the nature of their state and regional innovation systems. The biotech sector is knowledge-intensive and as a rule highly concentrated in areas around universities, colleges and science parks. This makes the regional level particularly legitimate to study.

THE STUDY WILL FOCUS ON THREE MAJOR ASPECTS:

- Regional performance and innovation capacity
- Strategies on competitiveness and positioning
- Regional partnerships

The analysis has similarities with the debate on the performance of national innovation systems that has evolved over the last fifteen years (Freeman 1987). The relevance of the national innovation system is detectable in terms of the capacity of the educational system to provide companies with competent workforce and universities with excellence in research. In addition, taxing incentives, grants, venture capital and subsidies are measures that supposedly affect the overall performance of a national (or state) and regional innovation system. Clusters are strong since firms are so concentrated around education and research. Markets and key institutions in the innovative infrastructure are often found at the same locations.

Increasingly competition takes place at the regional level. The reason is that few locations are able to compete in the biotech sector. In fact, the concentration of venture capital associated with biotech firms has increased throughout the United States over the last decade, whereas public grants and contracts are becoming less concentrated (public investment, private equity investment and various types of seed financing, though, can often play a significant part in early-stage development). The performance of universities is singled out as decisive for companies that are entering new technology-intensive fields. Another crucial factor that is stressed in the literature is the promotion of exports since it puts direct pressure on the competitiveness of firms and thereby encourages them to adopt new technologies at an early stage (Nelson 1993).

In recent years, both scholars (Etzkowitz 1994, Porter 1994, Etzkowitz and Leydesdorff 1997) and policymakers have singled out the regional arena as crucially important for policies aimed at improving the competitiveness of innovation systems. In Sweden, Vinnova (the Swedish Agency for Innovations Systems) is an organization that works with the promotion of both the national and the regional innovation system. Its programs represent attempts to stimulate fruitful university-government-industry-relations in Swedish regions, particularly with the objective of targeting clusters of competitive firms in various high-tech sectors; biotech is one of the prioritized sectors.

In this study, the Swedish Institute for Growth Policy Studies (ITPS) has the twofold interest of gathering relevant information and providing input to the development of public policy for innovation. It initiates a learning process by drawing on some experiences from biotech regions in the United States. There are reasons to believe that these experiences could serve as benchmarks for a Swedish policy targeting the innovation system, since the parallels and linkages to the Swedish biotech community are many.

The relevance of innovation systems for economic growth is obvious. Though it can be argued that “innovation policy” is a discrete area, the focus of which is to assist firms and organizations to enhance their innovativeness and competitiveness (possibly at the expense of employment), this argument cannot be sustained. Both employment and growth effects must be taken into account since a significant portion of the latter is explained by technological innovations (Freeman 1995). In sum, innovation capacity is closely related to economic growth, by the technological changes that it supposedly brings forth (Carlsson 1997). An early entry into a product cycle is likely to result in quick returns in number of jobs and economic turnover, significantly benefiting regional and national economies. If governments want to exert influence in order to improve capacity for technological progress and innovation, they will be forced to develop policies supporting a continuing learning process.

Whereas the market situation is determined by interactions between industrial sectors, production and demand, the formation of partnerships is heavily dependent on the surrounding institutions, culture and readiness among stakeholders to cooperate. We know surprisingly little about such processes since market situations

have received most attention. However, we do know that expectations are high on attempts to design policies that can improve the output of what are often referred to as Triple Helix arrangements, which are designed to enjoy the fruits of better coordination that supposedly unleashes creative solutions in organizing regions, ideally with a triangle of interests involved – industry, government agencies, and universities (Nilsson and Uhlin 2002). There is great potential in the ability of actors to associate and build cooperation and trust (Cooke and Morgan 1998).

Definition of the Biotech Sector

The biotech sector includes elements of both biotech and life sciences in the broader meaning of the concept. Different organizations and statistical units use different definitions of the biotech sector. The definitional task is rendered even more complex when considering the great number of sectors in the economy that use and benefit from biotech research and applications, the sectors in which biotech can and will expand, and those that will generate inter-sectoral cross-fertilization (for example, bioinformatics).

The definition used in this study is based on the definition used by the Biotechnology Industry Organization in the United States (*State Government Initiatives in Biotechnology 2001*). Biotech is here defined as the application of biotech science and technology associated with molecular, cellular and genetic processes for the development of products and services (including medicine, environment and agricultural products.) The ”Life Sciences” sector, normally seen as a broader area, includes medical equipment and instruments, research contracts, the pharmaceutical industry, animal and veterinary products, but excludes medical centers, labs and hospitals. The concepts of biotech and life sciences will basically be used interchangeably throughout the report. The official classification of industries for the United States used by the Department of Commerce (North American Industry Classification System, NAICS) will be used in this study in a bottom-up method whereby the companies surveyed define their core business along this classification (Exhibit 1). We added “distribution” as a category in order to broaden this classification. The selection of companies is based on the North Carolina Biotechnology Center’s company directory and the member organizations of the Piedmont Triad life sciences CEO roundtable. We include biotech, pharmaceutical, and medical device companies, but exclude contract research organizations, service providers, labs, and hospitals (see appendix 1 for the total results of the regional opinion survey).

EXHIBIT 1
The biotech industry

Industries	Classification code
R & D, Life sciences	NAICS 541702
Research and development in the life sciences	
Pharmaceutical- and medical manufacturing	NAICS 325411–14
Medicinal and botanical manufacturing	
Pharmaceutical preparation manufacturing	
In-vitro diagnostic substance manufacturing	
Biological product (excl. diagnostic substance) manufacturing	
Distribution	

Different Understandings of Regional Competitiveness

In this study, innovations are viewed as being parts of a regional innovation system made up of complex dependencies between agents. In the literature and in policymaking, innovation systems are often analyzed at the national level, particularly in smaller countries (Lundvall 1992, Edquist 1997). We believe that the mutual dependency between public and private activities on the one hand, and between cross-sector activities on the other, has to be explored in greater detail, not least at the regional level, in order to provide support for informed policymaking. Partnerships seem to be an appropriate concept for capturing these activities.

The system-dependent qualities need to be kept separate from individual driving forces, which by nature are non-systemic. The entrepreneurial incentives to start-up companies, invest capital and conduct research are decisive for fulfilling the potential of any innovation. Therefore our analysis must cover multiple areas of interaction underlying what we here call a partnership (Exhibit 2). It is closely related to what are called Triple Helix relations elsewhere (Etzkowitz 2002). The following interlinked arenas seem particularly meaningful to examine in a more detailed and systematic manner:

1) *The innovation system* – includes what we label the infrastructure of innovations, systems for subsidies, financing, and the forms of governance associated with these activities. For instance, research and research-funding institutions and universities belong to this category. The system needs to be brought into closer contact with the market since systems for funding research are somewhat detached from the market and their commercial usages. In a regional innovation system, firms, government agencies and research institutions are active elements. Improvements of existing innovation systems and clusters are the key to forming productive links between basic research and its potential commercial applications within partnerships.

2) *Clusters* – are predominantly defined by market relations. The market establishes flexible relations between, for example, manufacturers, suppliers, and users within various business areas. The relations are mutual and competitive within dynamic clusters (Porter 1990). There are several barriers to entering the market. Moving from being a researcher to becoming an entrepreneur may be a challenge. Likewise, going from being a supplying firm on a lower level in the

value chain to becoming a leading innovative firm can be a tremendous effort. Problems with costs and documentation in the patenting and commercialization processes are widely known. Large and established firms have advantages compared to start-ups and smaller, entrepreneurial homegrown companies. However, the vitality of clusters shows that successful firms are dependent on the local environment.

3) *Partnerships* – are defined as organized relationships between several agents, both public and private, aimed at achieving better coordination among them and enhanced mobilization of resources. Partnerships are perceived as viable tools for the matching of activities, as instruments for achieving better cohesion and, in addition, for regional mobilization of available resources in existing industrial clusters. The objectives and expectation of partnerships are that they promote new forms for the organization of public and private activities and increase the potential for joint and coordinated efforts. At best, partnerships pave the way for renewal of the roles between public actors, businesses and research bodies. Compared to closely associated concepts (such as the usage of Triple Helix), partnership models explicitly include elements of active coordination, concerted action and strategic planning in a region, which manifest themselves not only by the involvement of actors that are functionally linked with markets, research or individual firms, but are also territorial in terms of how they define their responsibilities and division of labor.

EXHIBIT 2
Key concepts in analyzing commercialization of research

Levels of analysis	Main elements
Innovation system	Organizations
	Infrastructure
Cluster	Demand
	Products
	Firm collaboration
	Business strategy
Partnership	Coordination
	Mobilization of resources
	Concerted action

Innovation and Entrepreneurship

Innovations come from new processes, new technologies, new products, or new forms and methods of organization. The driving force in innovative processes varies a lot. It may be new knowledge, a new product or competition over setting standards. Previous research on innovative processes within the information technology sector reveals that over 70 percent of all innovations in the form of new products or new technologies originate from users (von Hippel 1988:5). Innovation is here defined as the transformation of knowledge into new products, processes, and services. Innovation involves more than just science and technology; improvements in organization, marketing, distribution, and service can also be

considered innovations. Patents and licenses play important roles in the biotech sector and the customers consist mainly of other biotech companies, the pharmaceutical industry, and university research institutions. By and large, the biotech sector is relatively more research-intensive, dependent on intellectual property, and is marked by a lower speed of commercialization than the IT-sector. Moreover, in industries that are going through rapid transformation, such as the biotech industry, product innovations are more frequent than process innovations. In more mature sectors the reverse situation applies (Utterback 1994).

Entrepreneurship is defined as an individual or a group made up of a small number of individuals. The inventor seldom has the qualities necessary for running a business. The first step involves the step from promising research to an application for a patent. If there is commercial potential, capital is needed from that stage or, alternatively, an established firm may purchase the patent already at the application stage, or later at the licensing stage. If the inventor intends to form a company, venture capital is needed at an early stage. In the process the surrounding environment (in the form of established firms, venture capitalists, research laboratories at universities, and public organizations) determine how effectively innovations may be transferred into lasting business ideas. Neither the innovator nor the entrepreneur can do this alone.

At the regional level, entry into an industry such as biotech is associated with potential risks. There is no guarantee for profitable firms, job creation or economic growth in the short term. The risk associated with a regional strategy that puts all eggs in one basket is considerable. The risks at stake, the high initial costs and the need for protection of innovations are strongly emphasized factors in the biotech industry. Strategic thinking is therefore necessary within partnerships.

Partnerships

The performance of regional partnerships is here assumed to depend on the overall quality of the biotech innovation system defined as:

The players that develop, produce, analyze, or use biological systems on a micro-, cellular, or molecular level and the public and private institutions that affect their behavior (*The Swedish Biotechnology Innovation System*, Vinnova Innovation in Focus VF 2001:2).

We start out from the assumption that the success of a partnership is not only dependent on planning and regional strategies. It is also dependent on the commercialization of products and processes, job creation, and the ability to foster the emergence of financially strong and profitable firms. Performance is crucially dependent on the financial, learning and productive cultures that may exist to facilitate systemic innovation (Cooke, Gomez Uranga and Extebarria 1997:157). Here the way the interplay between universities, firms and authorities is working at the regional level should be evaluated by the ability to form regional partnerships and to pursue strategies for the promotion of sustained innovation policies. Three areas seem crucial for success: the ability to explore innovations, to attract

appropriate funding, and to mobilize general support for the emerging cluster of firms within specific and related industrial sectors.

Ordinarily, alliances are associated with firm-to-firm relations. In the biotech sector, research and development alliances are commonplace. So why study partnerships from a regional perspective? For one thing, forming strategies and partnerships is about coordinating policies and various types of private and public actors. Why should individual firms bother about putting energy into regional partnerships? This study assumes that there are good reasons to make efforts to boost regional economies by promoting effective associations and investing political clout in partnerships. The main reason for creating and nurturing partnerships is not political but competition (companies, institutions, and regions) and concentration of assets in the biotech sector. Focusing on regional partnerships enables us to study both sector relations and regional relations at the same time. The biotech industry is highly concentrated in a few places. Regions characterized by innovative capacity find themselves at the nexus between regional economic development and innovation policies. Those regions that are competitive attract attention among national and state policymakers and are therefore in an advantageous position.

The quality and character of the environment in which biotech sectors evolve and operate are crucial for competitiveness on national and global markets (for example, Porter 1994; Saxenian, 1994; Storper 1997). The assumption is that dense networks among firms (and close links between academic research, educational institutions and start-up companies) are essential for making biotech regions competitive. In addition, the capacity for innovation and the competitiveness of regions are greatly enhanced by cluster concentration and associated potential for positive agglomeration, cost reduction, and learning effects. Considering the high degree of concentration of the biotech sector, regional agglomeration effects are significant. How the interchange between universities, companies and government agencies works is highlighted by a closer examination of the ability to form regional partnerships and formulate sustainable strategies in our selected regions.

Analyses of clusters focus on activities and relationships that are based on production factors and the importance of proximity to related industries (Porter 2001). An innovative regional cluster is likely to have firms with access to other firms in their sector as customers, suppliers or partners that operate in networks; knowledge centers (such as universities, research institutes, contract research organizations, and technology transfer agencies) of consequence to the sectors in question; and governance structures of private business associations, chambers of commerce, economic development organizations, training and promotion agencies, and government agencies (Cooke, Gomez Uranga and Etxebarria 1997:165). Our study is inspired by the work undertaken by the Council on Competitiveness on clusters in the United States. In our view, their perspective privileges globally excellent clusters, but has relatively little to say about the origins of clusters and their evolution, and do not bring neighboring regions into the analysis, which makes their perspective somewhat less useful in a Swedish context. This study

intends to bridge some of these gaps. Here further steps will be taken to identify any attempts to pursue regional strategies based on partnership formation.

The formation of partnerships goes through several phases, from the emerging stages to a phase of dynamic transformation, and eventually to a consolidating phase where the roles of the agents become more fixed and hopefully well functioning (the established partnership). Innovative processes may be either hindered or encouraged by existing institutional frameworks made up of actors with fixed roles, routines and worldviews. Established structures of industry and knowledge may have the same effect. Given these circumstances, effective partnerships are those that are able to combine many interests, achieve some degree of coordination and mobilize resources.

When we turn our attention to the home regions of industrial clusters, we distinguish between the Piedmont Triad, the emerging regional partnership, and the Research Triangle, the established biotech region and a serious challenger nationwide. It is an empirical question to detect differences in strategies originating from the different stages. In order to form a successful partnership with a coherent and viable strategy, the mobilization of resources and manpower is crucial. It is our ambition to clarify how partnerships for innovation and performance work concerning the creation of profitable enterprises and more jobs, and the development of enhanced competitiveness.

Any innovative organizational solution originates from the interface between public and private. In the literature on partnerships, public-private partnerships (PPP) are frequently mentioned. They may refer to an independent organizational form that allows private companies to fulfill public tasks on a contract basis. Here it is interpreted much wider[1], basically referring to any kind of public-private arrangement. Partnerships are at the heart of our analysis. Forming a partnership is a way of organizing things and therefore a policy-instrument rather than a given structure. How far businesses are ready to go in terms of engaging in development and educational issues outside their immediate interest is uncertain. The assumption is that the potential is great for transformation in regions where positions are not fixed but pave the way for changed roles and flexibility. Moreover, the public sector has a potentially important role to play as a contractor, financier, producer of public goods, and promoter of economic development.

An innovative and unregulated partnership may be more effective than any established and well-defined organization. If there is a willingness on the part of the business community to pay for building an organizational infrastructure (by, for example, creating innovation centers and business development centers, or other co-financed forms of partnerships), there is potential for cost reduction and more

[1] *A public-private partnership (PPP) is a label for any arrangement that involves the public and private sector in the distribution of goods and services (Savas 2000). Franchising, grants and contracts are also found in this category. Moreover, it may refer to complex, multi-actor projects. A third alternative is that it is the platform for formalized cooperation between firms, voluntary organizations and local and regional governments.*

effective innovation policies. The most important task of reducing the barriers between the primarily publicly governed innovation system, market introduction and entrepreneurs may be fostering effective and relevant regional partnerships. It is reasonable to believe that the soil for enhanced coordination manifests itself in regions with a good structure for competitive clusters.

The ability of partnerships to formulate strategies, manage projects, and coordinate actors and resources (and their impact on future growth and competitiveness) is of significant importance (Östhol and Svensson 2002). The starting point must be to assess partnerships in terms of the level of cohesion that they achieve, the degree of fragmentation, the ability to reach common priorities, the existence of learning processes as well as the ability to adjust to the changes occurring on the market. The mobilization of resources may be substantial or modest, external or internal, strategic or solely based on individual projects. In the project the preparedness to support innovative activities is examined. Exhibit 3 suggests central ingredients for effective partnerships. The organization of partnerships may provide added value to the region.

EXHIBIT 3
Central elements in effective partnerships

Management	Coordination	Strategy
Focused leadership, with clear objectives and good market orientation	Coordination between public and private which reduces the barriers between policy sectors and industrial sectors alike	Consensus on priorities Resource mobilization For bigger and broader sources of resources

Regional Strategies

The two regions in North Carolina that are examined both score high in terms of investments in the biotech sector and other connected sectors, such as medical equipment and life sciences. Their respective regional strategies and partnerships around the biotech industry are focal points for comparisons. They also provide a basis for comparisons with Swedish biotech clusters and their way of forming strategies and partnerships.

The Piedmont Triad and Research Triangle are both located in the state of North Carolina (Exhibit 4). The region is here defined as metropolitan statistical areas (MSA).[2] From the outset it should be noted that the two regions differ in maturity and level of critical mass of biotech assets. A relatively higher level of and capacity for research and commercialization of products and services (above average) characterize the established biotech region. The Research Triangle has a tradition of substantial investments and enjoys above-average levels of biotechnology

[2] *The Research Triangle region here includes the Chatham, Durham, Franklin, Johnston, Orange, and Wake counties. The Piedmont Triad region here includes the Alamance, Caswell, Davidson, Davie, Forsyth, Guilford, Montgomery, Randolph, Rockingham, Stokes, Surry and Yadkin counties.*

research activity and commercialization, whereas emerging biotech regions such as the Piedmont Triad have a somewhat lower research capacity, commercialization and relatively fewer firms active in the biotech field. The amount of public grants and contracts awarded to these regions differs significantly.

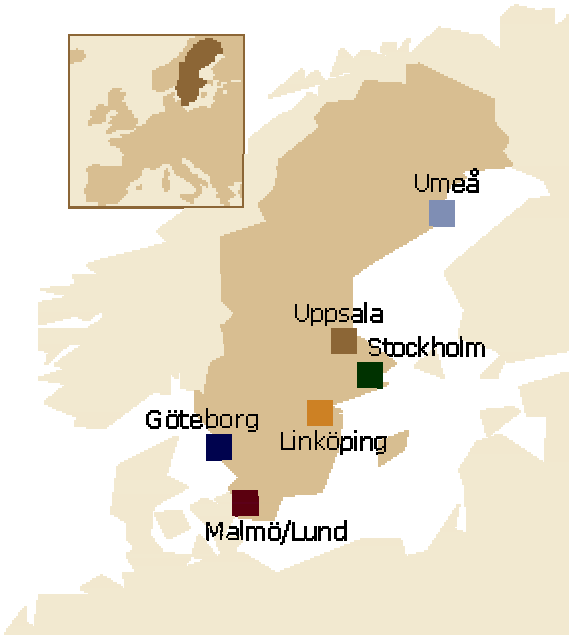
EXHIBIT 4
The overall level of maturity in the biotech regions and their major metropolitan areas

1	Research Triangle	Established Consolidation phase	Chapel Hill, Durham, Raleigh
2	Piedmont Triad	Emerging Transformation phase	Greensboro, High Point, Winston-Salem

Source: Piedmont Triad Partnership, 2003

The conditions for and structure of the biotech community in North Carolina makes it relevant to study in order to generate information for Swedish policymakers. The population size of North Carolina (about 8.2 million) is similar to that in Sweden, they both have a relatively high percentage of smaller and mid-sized biotech companies, and there is a mutual exchange of relations and investments through firm-to-firm and university-university linkages between North Carolina and Sweden. The Swedish biotech sector is concentrated in a mid-eastern belt in the Mälardalen region, with Stockholm and Uppsala as the principal biotech centers, and in a southwest coastline belt, with Malmö and Lund, and Göteborg, as the principal biotech centers (Exhibit 5).

EXHIBIT 5
The geographical concentration of the Swedish biotech sector



Source: Invest in Sweden Agency, 2003

Taking into account the strong geographical concentration of the Swedish biotech community, we explore the Research Triangle region and the Piedmont Triad region in terms of their level of development and maturity in biotech research and commercialization capacity and activity. The relationship between the two regions is increasingly perceived as a biotech corridor. As in North Carolina, Swedish biotech has relatively stronger biotech regions (Stockholm and Uppsala, Göteborg, and Lund and Malmö) and weaker biotech regions (Linköping and Umeå). The distance between the regions that we study is similar, for example, to that between Stockholm and Uppsala, and between Lund and Malmö. Additional criteria for the selection of regions were that they demonstrate dynamics, an ability to organize to mobilize and allocate resources, and have an explicit strategy to support biotech innovation at the regional level (see appendix 2 and appendix 3 for partnership models in North Carolina and Sweden, respectively). Moreover, the debate in North Carolina about concentration and distribution of resources raises an issue that is directly relevant in the Swedish context. Our focus on strategies and partnerships for biotech regions will be of interest for both policymakers and the larger Swedish biotech community.

The Research Triangle (Durham, Raleigh and Chapel Hill) is already established and widely known, ranking fourth in terms of biomedical research capacity in the United States (Cortright and Mayer 2002). The region has a longstanding tradition of considerable investments in the biotech sector. The Piedmont Triad (Greensboro, Winston-Salem and High Point) is an emerging biotech region with a relatively lower level of research capacity and commercialization. Investments in

biotech are relatively recent in the region, while the Research Triangle is a challenger at the national level. The innovation process and the partnerships in these regions are scrutinized by a regional opinion survey targeting 122 firms in order to generate new primary data. The survey was distributed in late 2002 and consists of four sections: innovation infrastructure, innovation and entrepreneurship, partnership activities, and background information. This information is supplemented by in-depth interviews with local representatives of the biotech community. In addition, information on strategies and partnerships were collected through an informal meeting in the Research Triangle organized by the Institute for Emerging Issues and a life science CEO roundtable event in the Piedmont Triad in the fall of 2002, and from local organizations and the local press.

This report is structured in the following way: the next chapter, chapter two, focuses on regional performance and innovation capacity; chapter three examines strategies regarding competitiveness and positioning at the state level and introduces the regions that are analyzed in greater detail; chapter four is concerned with partnership models; and the concluding chapter, chapter five, presents the empirical findings, suggests major challenges, and provides a number of policy recommendations directed at the Swedish policymaking community.

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2. Regional Performance and Innovation Capacity

This report focuses on the state of North Carolina and on two biotech regions in this state. By analyzing current trends, strategies, partnerships and biotech regions that have different starting positions, we will generate useful information for policymakers and industry representatives working with biotech and life sciences in Sweden.

These regions are aggressively investing in biotechnology and are competing for jobs, companies, investments, venture capital, publicity, and tax revenues. Northern California on the West Coast (which encompasses the North Bay with San Francisco, East Bay and San Meteo and Santa Clara counties) enjoys a leadership in terms of companies and employment opportunities, followed by the Boston-Worchester (Route 128) corridor in Massachusetts in New England and North Carolina on the Atlantic Coast. The relative competitiveness of the regions is not static but undergoes changes over time. According to Ernst & Young, for example, the Greater Washington area in the Mid-Atlantic region surpassed San Diego in 2001 as the third-largest cluster of biotechnology companies, trailing only the San Francisco Bay area and New England, but facing competition to the north from significant growth in the Pennsylvania-Delaware Valley.

Economic Structure and Business Climate in North Carolina

It is often assumed that there is a strong connection between investments in science and technology and economic growth and that economic development strategies should thus include efforts to foster high-technology assets. The entrepreneurial environment is also a critical factor for competitiveness and regional advantages. Regarding the regional entrepreneurial climate in North Carolina, this study has consulted a number reports in order to determine the top ranked states in terms of business climate for small firms. One report, published in 2002 by the Small Business Survival Committee (based in Washington, D.C.), focuses on the policy environment and entrepreneurship by measuring interference (for example, taxes, electricity costs, workers' compensation costs, total crime rate, number of bureaucrats, state minimum wage). A second report, published the same year by Cognetics (based in Waltham, Massachusetts), measures entrepreneurial dynamism (the percentage of all firms in a state or metro area made up of companies started in the last ten years that currently employ at least five people, and the percentage of young businesses in a given area exhibiting fast growth). North Carolina scores high on entrepreneurial activity but lower on the environment of entrepreneurship (Exhibit 6).

EXHIBIT 6
The environment for entrepreneurship and entrepreneurial activity

The Environment for Entrepreneurship		Entrepreneurial Activity	
State	**Rank**	**State**	**Rank**
South Dakota	1	Nevada	1
Nevada	2	Arizona	2
Wyoming	3	Utah	3
Texas	4	Georgia	4
Florida	5	Maryland	5
North Carolina	37	North Carolina	6

Source: Small Business Survival Committee Survival Index 2002; Cognetics 2002

In a survey of corporate executives in 2002 by Development Counselors International, North Carolina enjoyed the second-highest ranking, behind Texas, among states with the most favorable business climate. Cognetics also ranks 50 large and small metropolitan areas in the United States based on the same measures of entrepreneurial activity. North Carolina has two areas among the top ten: (1) Phoenix; (2) Atlanta; (3) Raleigh-Durham in North Carolina; (4) Salt Lake City-Provo; (5) Charlotte in North Carolina; (6) Washington, D.C.; (7) Indianapolis; (8) Birmingham-Tuscaloosa; (9) Louisville; and (10) Memphis. More recently, North Carolina has faced the largest number of unemployment claims in the country (a rough indication of layoffs) originating from the economic slowdown in the state (even though the biotechnology sector, despite cuts in employment, has been relatively unaffected). This situation is reinforced by an expected large budget deficit of as much as US$2 billion and the first year-over-year decrease in North Carolina's operating budget in more than three decades, which in turn increases pressure on local governments.

The North Carolina Life Science Infrastructure

North Carolina ranks among the top biotech regions in the United States. In two recent reports (The Brookings Institution, *Signs of Life: The Growth of Biotechnology Centers in the United States*; and Ernst & Young, *Beyond Borders: The Global Biotechnology Report 2002*), it is positioned among the leading states in the country because of its strong biotech research and commercialization activities and innovation infrastructure. The Brookings report calls North Carolina a "biotech challenger" to Boston, San Francisco and San Diego.

North Carolina enjoys a leading position in the biotech and life sciences sector, with 38.2 percent of the state's total investment dollars, ranking second only to California in terms of total dollars raised by sector companies (Exhibit 7).

EXHIBIT 7
State investments: US dollars in life science, 2001

State	2001 Total Life Science $ Raised ($ in million)	Life Science % of 2001 Total State $ Raised	% Change From 2000
California	2,836.2	15.5%	–21.8%
North Carolina	266.2	38.2%	–38.3%
Texas	264.6	6.7%	46.6%
Florida	222.4	20.0%	403.0%
Massachusetts	188.0	11.3%	73.3%
New York	185.7	7.5%	–11.1%
Maryland	185.3	16.9%	28.4%
Georgia	128.6	13.5%	23.7%
Virginia	38.5	3.6%	–73.4%

Source: Council for Entrepreneurial Development (2002), 2001 North Carolina Venture Report

By mid-2002, the North Carolina life sciences community generated about US$3 billion in annual revenues, directly employed about 17,000 people, and included 155 biotechnology companies; 47 were publicly held (9 headquartered in the state), about one-third were large multinational companies, and about two thirds were smaller, home-grown companies. In addition, North Carolina has one of the world's strongest concentrations of contract and research organizations (75 companies with about 15,000 employees), and it is a top-ranking state in agricultural biotech (13 companies with about 2,500 employees). In total, the biotech industry in the state had a workforce of more than 32,000 people (4,000 working at biomanufacturing plants) and a payroll of more than US$1.6 billion by mid-2002. According to the North Carolina Biotechnology Center and Governor Mike Easley, the state could employ 125,000 people and account for US$24 billion of sales by 2025. The life science sector in North Carolina has a relatively strong capital accumulation record compared to other sectors of the economy in the state (Exhibit 8).

EXHIBIT 8
North Carolina deals by industry, 2001

Industry	Total NC $ Raised (Million dollars)	Percentage of NC Deals
Life Science	210.1	25.96% (27)
Software	199.0	29.81% (31)
Internet	73.8	19.23% (20)
Telecommunications	60.0	5.77% (6)
Hardware	58.4	3.85% (4)
Health Care	49.9	7.69% (8)
Networking	36.3	1.92% (2)
Industrial	6.3	2.88 (3)
Business Services	3.3	2.88 (3)

Source: Council for Entrepreneurial Development (2002), 2001 North Carolina Venture Report

The biotech and medical device industries experienced a difficult year in 2002 with only twelve initial public offerings in the United States and a significant plunge in the value of biotech stocks. In North Carolina, the value of local biotech stocks decreased between 56 percent and 98 percent in the first half of 2002. The expectation for 2003 among many analysts appears to range from a market and private financing climate that will continue to be difficult, with the possible exception of companies that have imminent drugs outstanding, to a rebounding market at modest levels. A possible change in the venture capital industry – including venture capital firms in North Carolina such as Intersouth Partners, Aurora, Southeast Interactive, and A. M. Pappas – is a shift in focus from early-stage research to later-stage manufacturing where potential is no longer as important a reason as products.

North Carolina is recognized internationally for its world-class research universities and medical institutions. In the Research Triangle region, there is a physical triangle between the three major research universities that produce engineering, science and medical science graduates: University of North Carolina at Chapel Hill, Duke University and North Carolina State University. The Universities had been established for nearly two hundred years before the concept of forming the Research Triangle Park crystallized. The inherent slow-moving nature of academic research resulted in a search for new vehicles in the Research Triangle that would have more direct impacts. The universities drove the planning and collaboration efforts.

The Piedmont Triad region has not achieved as high a level in total research and development expenditure as the neighboring Research Triangle (Exhibit 9). The region has several universities that cover biotechnology: Medicine (Wake Forest University Bowman Gray School of Medicine); Life Sciences (University of North Carolina at Greensboro); and Engineering (North Carolina A&T University and the joint Biomedical Engineering program at Wake Forest University and Virginia Tech). Regarding workforce availability, the region is also starting to generate critical resources in terms of management (14 colleges and universities with an enrollment of around 41,000 students), scientists and engineers (M.A./Ph.D. programs), and technicians (8 community colleges and 11 campuses).

EXHIBIT 9
Research and development expenditures and US ranking, 2000

	East Carolina University	Duke University	NC State University	UNC–Chapel Hill	Wake Forest University	All US universities Median
Total Research & Development	8,461,000 Rank: 251	356,625,000 Rank: 20	277,956,000 Rank: 31	269,072,000 Rank: 33	86,840,000 Rank: 107	62,369,000
Industry-Sponsored Research	3,158,000 Rank: 139 37.32% Quartile: 1	109,791,000 Rank: 1 30.79% Quartile: 1	32,804,000 Rank: 13 11.80% Quartile: 1	6,835,000 Rank: 86 2.54% Quartile: 4	15,125,000 Rank: 38 17.42% Quartile: 1	3,588,00 6.18%

Source: Technology Commercialization Group LLC, Raleigh, 2003

Technology transfer is playing an increasingly important role at universities as a means of generating economic development. An important part of a regional strategy for commercialization and entrepreneurship is to involve universities and colleges, to find better and more effective ways for them to work together, and to expose students to entrepreneurship. There are about 350 institutions in the United States that have considerable research and development activities. A number of institutions in North Carolina rank among the top 50 institutions in the country in terms of patents, licensed inventions and creation of spin-off firms.

Regarding technology licensing and technology transfer, output from the Research Triangle region has been strong over the past decade. An average of 14.5 patents were issued per 10,000 workers in the Research Triangle Park (RTP) in 1998, compared to the national average of 6.3 patents. The patent growth rate in the area was 10.9 percent, well above the national growth rate of 4.2 percent. The universities and specialized research centers are driving forces of innovation in the region. Each of the major universities – the University of North Carolina (UNC) at Chapel Hill, North Carolina State University, and Duke University – have active offices of technology transfer and licensing staffed by around 10–15 people. They created full-time technology transfer director positions in the 1980s (the UNC at Chapel Hill did not create such a position until 1995). Moreover, each major federal and private research institution in the RTP has a technology transfer and licensing office, which are important for commercialization of ideas and inventions. The North Carolina State University's Office of Technology Transfer – with one of the highest technology licensing rates in the country – has been a model in licensing technologies to start-up companies. The university strives to keep the spin-off companies located in North Carolina by providing incentives, such as equity investment.

The Piedmont Triad region has three universities with technology transfer offices: Wake Forest University, University of North Carolina at Greensboro, and North Carolina A&T University. There are also a number of university and community college actors who are involved with training biotech workers. The Forsyth Technical Community College has developed a biotech curriculum for a two-year

technical program. In addition, the Guilford Technical Community College offers a chemical process technology curriculum. Biotech companies, however, stressed in our regional opinion survey that there was a need to increase the relevance of community colleges to meet expected demand for workforce, particularly concerning the fields of biomanufacturing and bioprocessing. There are also a number of university programs that provide related programs. In late 2001, the Wake Forrest University announced its plans to form a School for Biomedical Engineering and Sciences through a joint project with Virginia Tech. It is estimated that the biotech component of technology transfer and licensing activities represent between 60 percent (conservative estimate) and 80 percent of the total activity, in particular in the Research Triangle and Piedmont Triad that has a biotech emphasis (Exhibit 10).

According to a set of national rankings on technology transfer by the Chronicle of Higher Education for 117 research universities throughout the country, East Carolina University obtains a high ranking in terms of number of spin-off companies formed per US$ 10 million spending on research as a result of new companies since 2000. This data places it in second position (0.52), followed by Wake Forest University (rank: 39; 0.15), North Carolina State University (rank: 46; 0.13); UNC at Chapel Hill (rank: 90; 0.06); and Duke University (rank: 97; 0.05). However, since these rankings compare marketed discoveries with dollars spent, the method could give smaller universities better results because they have fewer research dollars, which in turn could raise the significance of every patent, license or spin-off company that they create. The relatively high ranking of the East Carolina University, is thus due to its smaller base compared to the major institutions in North Carolina. Moreover, one contributory reason for the high ranking of the leading universities could be that they include clinical trials performed in their medical centers. The table below presents data on technology transfer and licensing performance among the major research universities in North Carolina.

EXHIBIT 10
Technology transfer outcome, FY 2000

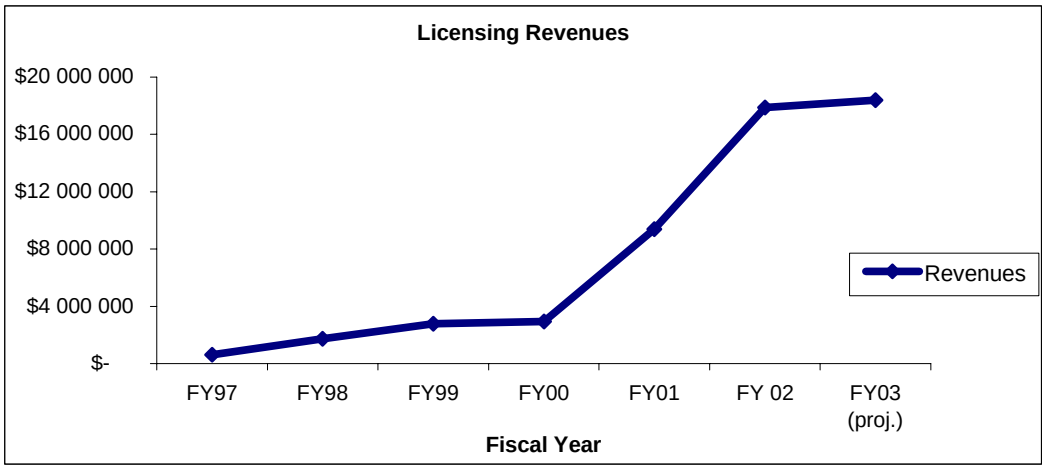
	East Carolina University	Duke University	NC State University	UNC–Chapel Hill	Wake Forest University	AUTM Survey Median
Active licenses/options	5	322	547	292	21	51
Rank	156	15	7	29	134	
Per $10 million	5.72	9.14	19.94	11.19	2.48	5.09
Quartile	2	2	1	1	3	
New licenses to small and start-up companies	0	25	33	29	7	2,442
Percentage	0	52.08%	70.21%	51.79%	77.78%	60.66
Quartile	4	3	2	3	2	-
License income	101,446	4,282,309	2,558,479	942,535	2,953,600	1,130,013
Rank	139	42	58	91	53	
Royalty return on investment	1.16%	1.22%	0.93%	0.36%	3.48%	
Quartile	2	2	3	3	1	
In-state start-ups 1999–2000	0	2	14	4	3	1
Quartile	4	2	1	1	2	
Per $10 million 1999–2000	-	0.057	0.510	0.153	0.354	0.116
Quartile	4	3	1	2	1	
Start-up business 2000	1	8	25	8	4	6
Quartile	4	2	1	2	3	
Per $10 million	1.14	0.23	0.91	0.31	0.47	0.56
Quartile	1	3	2	3	3	

Source: Technology Commercialization Group LLC, Raleigh, 2003

Much of the attention concerning the university system and the biotech field in North Carolina has been focused on the Research Triangle region. Let us take a closer look at Piedmont Triad region and its most active university in terms of technology transfer. Wake Forest University (WFU) is a local actor situated in Winston-Salem, originally a manufacturing-based economy, which has a relatively affluent and well-educated population of around 187,000 people. Its Medical, Business and Law Schools are highly ranked nationally. The Winston-Salem area is at the core of the transition to a more high-technology economy and a biomedical growth region. Its Baptist Medical Center is the county's largest employer. Health care services jobs represent around 15 percent of the total local workforce.

This private university plays a central role regarding university impact on economic development (Exhibit 11). In 1994, the WFU established a 12-acre downtown research park that today employs 600 people and has a combined payroll of around US$25 million. In 2000, it invested US$2 million in a North Carolina venture fund to assure an office in downtown Winston-Salem, and in 2001 it purchased a building to ensure that a growing new drug discovery company would remain in the area. In the same year it announced that it would create a small high-technology incubator. In 2002, finally, it announced the expansion of the Piedmont Triad Research Park to 180 acres, which currently is in a nascent stage, which is estimated to create 10,000 jobs and generate US$2.5 billion in the local economy. It also decided to invest US$100,000 in a new, locally managed business angel fund.

EXHIBIT 11
Wake Forest University and technology commercialization



Source: Wake Forest University's Office of Technology Asset Management (2002)

The WFU's Office of Technology Asset Management markets medical technology through the Wake Forest University Baptist Medical Center. In 1999, the structure of the Wife's Office of Technology Asset Management was changed toward a strong technology commercialization focus. It would no longer be responsible for industry research and related research agreements. Instead, it would have a strong and higher-risk business development orientation – guided by a Board of Directors, new reporting practices (it hired a vice president for business and finance from the research field), and increased professional staff – and be involved in a range of activities: business plan development, management recruiting and management, and early investment.

The WFU has helped to foster a number of local companies since 1999, such as Pilot Therapeutics (Winston-Salem, 1999, public company), Point Dx, Inc. (Winston-Salem, 2000), Amplistar, Inc. (Winston-Salem, 2000), Kucera Pharmaceutical Company (Winston-Salem), and MRI Cardiac Services (Winston-Salem). By the fall of 2002, the WFU had invested more than US$40 million in capital or strategic partnering financing and had created more than 60 new, full-time

professional and technical jobs in downtown Winston-Salem according to its own accounts. By then it had also invested more than US$140 million in capital and strategic partner funding in a number of out-of-state companies: Viacirq, Inc. (Pennsylvania, 1999); Xenoport, Inc. (California, 2000); Viatherm, Inc. (Pennsylvania, 2001); and Advanced Cell Technologies (Massachusetts, 2001).

In recent years, several biotechnology firms have spun out of universities in the Piedmont Triad, including Pilot Therapeutics and Amplistar, Inc., which are both located in the Piedmont Triad Research Park. In 2002, however, the former company announced its intention of relocating to South Carolina, whereas the latter officially closed its operations in early 2003. Amplistar, which was formed in 1985 from research at the Wake Forest School of Medicine, was developing a test to detect cancer in its earliest stages and was supported by Wake Forest University. At the same time, the university strives to encourage academic entrepreneurship by offering liberal and competitive incentive structures and instruments to university staff that are willing to commercialize ideas. Regarding technology transfer and commercialization through institutions of higher education, we collected views from biotech companies and local representatives of the biotech community (Exhibit 12).

EXHIBIT 12
Summary of opinions on technology transfer and commercialization

Element	Assets	Challenges
Technology transfer and commercialization through institutions of higher education	– Competitive and decentralized university system and bottom-up encouragement of academic entrepreneurship and commercialization of university ideas – Supporting incentive structures and support for researchers to pursue commercial avenues (e.g., liberal procedures for academic leave, protection of faculty positions, and flexible combinations of entrepreneurship and teaching) – Property rights awarded to universities that encourage technology transfer – Strong licensing infrastructure and dense institutional environment of technology transfer offices that offer cost-reducing and extensive services (e.g., transfer instruments, compensation mechanisms) – Active encouragement of contacts between university faculty and industry – Flexible structures that allow for responsiveness to external demand - Good transfer performance through small start-up companies	– Improve the ability to support inventions – Gain better understanding of the industry (be a closer partner to industry) and science and research – Acquire a broader understanding of how to work with start-up companies – Recognize that most spin-out technology is very early-stage research – Be more reasonable and less demanding about intellectual property and in valuation of technology when setting license terms and licensing technology out to companies – Understand that entrepreneurial companies are better suited than universities for generating commercial products or processes

Source: Regional opinion survey and interviews with biotech sector representatives in North Carolina

This chapter has focused on regional performance and innovation capacity in the biotech sector, defined broadly, in North Carolina and on some central elements of the innovation infrastructure and the environment in which this sector operates. The following chapter, chapter three, provides an examination of strategies on competitiveness and positioning, such as the evolving strategy at the statewide level, which will be of interest for Swedish policymakers, and introduces the established and emerging biotech regions that are examined in this report in further detail.

3. Strategies on Competitiveness and Positioning

North Carolina has been and continues to be one of the leading states in designing public policy to support the growth and development of biotech. There is currently a vigorous renewed debate in North Carolina about how to articulate and implement a statewide biotech strategy. Some of the central topics have focused on the need to set priorities through sustained strategic planning and public engagement at a time when the majority of states in the United States are investing in biotech, the need to coordinate assets, and the need to forge creative public-private partnerships, for example by building on the role of universities and community colleges as honest brokers in economic development (Exhibit 13).

EXHIBIT 13
The relative advantage of three life sciences clusters in the United States

	North Carolina	Massachusetts	California
Tax policy	– 5% R&D tax credit – 7% tax credit for machine and equipment leases	– 10% R&D tax credit – 3% credit on depreciable assets Single sales factor	– 15% (in-house) and 24% (outsourced) R&D tax credits – 100% net operating loss carry forward – 7% job-creation tax credit – 6% manufacturing credit
State support for innovation	State-funded North Carolina Center for Biotechnology (NCBC)	Massachusetts Biomedical Initiatives (MBI)	State collaboration with industry and state universities to develop jointly funded research programs
State-funded seed capital	– $10 million North Carolina Bioscience Investment Fund ($40 million cumulative investment over time) – $42 million-$150 million in tobacco-settlement money for biomanufacturing	– $8 million cumulative MBI investment – Some state pension fund investment	– $500 million CalPERS Biotechnology Program
Cost of doing business*	Research Triangle Park = 97.0	Boston = 119.1	San Francisco Bay Area: 136.4 San Diego: 105.5
University patents (2000)**	142	314	548

Life-sciences Ph.D.s granted (1999)	Research Triangle Park: 166	Boston: 355	San Francisco Bay Area: 215 San Diego: 82
Life scientists employed (1999)	Research Triangle Park: 1,430	Boston: 4,980	San Francisco Bay Area: 3,090 San Diego: 910

**U.S. average index = 100 ** All high-technology patents (including but not limited to biotech)*

Source: Interviews; The Boston Consulting Group and Massachusetts Biotechnology Council, MassBiotech 2010 *(2002); California Healthcare Institute; North Carolina Biotechnology Center; Brookings Institution Biotech Support and Corporate Recruitment Incentives*

North Carolina has been engaged in a political and legislative process of reforming the state's corporate recruitment incentive program. Interviews with leading representatives in the North Carolina biomedical community suggested that the state needed to strengthen economic recruitment and incentives in order to provide more attractive corporate development packages (cash grants, loans, tax credits and other types of incentives).

This debate evolved during a period of economic and fiscal weakness and greater competition between states and regions (Exhibit 14). A number of cases of external recruitment of companies located in North Carolina from other regions seem to have accelerated the sense of urgency in this debate. In early October 2002, for example, Pilot Therapeutics (a small company headquartered in Winston-Salem in the Piedmont Triad) announced that it would turn down several millions of dollars in cash incentives from North Carolina and instead relocate its headquarters to Charleston in South Carolina as a result of a package of incentives (including job tax credits) offered by the South Carolina Department of Commerce. The company promised to build a US$2 million headquarters and research and development facility that would create 100 jobs, as well as a manufacturing facility. In June, North Carolina failed to attract another biotech company that it had courted with a multi-million grant, CropTech from Virginia, which instead chose to locate in South Carolina.

EXHIBIT 14
Arguments in North Carolina (2002) on state support for biotech sector

Arguments for state biotech support	Arguments against state biotech support
– Expected job creation will offset the cost	– Delivers tax breaks only to big companies
– Support will alleviate the state economy	– Depletes the tax base
– Help North Carolina compete more effectively	– Fails to guarantee long-term benefits
– Strengthen economic recruitment	– The state cannot conclude who will succeed
– Strengthen the innovation infrastructure	– The state already has a favorable business climate
– Manufacturing is a growth industry	– Money to education, workforce development
	– Fails to support regional job distribution

Source: Interviews with the biotech community and the local press in North Carolina

North Carolina leaders have stressed the importance of expanding the incentive program to create jobs, attract companies and keep the state competitive with neighboring states. Governor Mike Easley, together with the state's economic development board, pushed the legislative proposal (the North Carolina Economic Stimulus and Job Creation Act) and introduced it in July 2002. They wanted to refund a portion of the employee taxes that companies withhold and pay to the state to be offered to companies likely to locate significant operations in other states (up to 80 percent of the withholding taxes paid for workers in newly created jobs with the potential of being paid for up to 15 years).

This corporate income tax incentive (with an estimate cost of US$17 million) was supplemented by a separate proposal of job-creation grants to set up a US$15 million annual allocation and inducement fund mechanism to help attract new plants and expansion as well as companies to the state and encourage already existing companies to expand. Cash grants would be made available for companies that created at least 10 jobs in the state. The supporters cited statistics showing that there were 250,000 unemployed in North Carolina, the third-highest unemployment rate in the country.

Among subsequent additions to the bill was a proposal to reduce the state’s 6.9 percent corporate tax rate (tax on profits) for the first US$30,000 of taxable income, replacing the current flat rate with a tiered tax schedule, starting in January 2004. Another proposal was to lower the maximum amount that a company could get refunded from 80 percent to 75 percent and the maximum length of grant from 15 to 12 years and limited to 25 companies annually. Amendments to the bill in the Senate raised the estimated cost from around US$170 to around US$270 million over five years. The proposed legislation turned into one of the most aggressive corporate incentive packages in the history of North Carolina. It was an extensive bill considering that the General Assembly had recently passed a budget with US$930 million in cuts to state programs.

The modified proposed legislation included public projects such as US$45 million for a biotech-training center (a 65,000-square-foot plant), which could train 2,000 students annually and US$130 million for a cancer treatment center at University of North Carolina Hospitals (to replace an older facility). The advocates of state support for the life sciences sector argued that support would create jobs, which in turn would offset the estimated cost (more personal income tax and sales tax revenue for the state), alleviate the state economy and cutbacks in the manufacturing sector, and help North Carolina compete more effectively against other states that already provided similar financial incentives. Some senators stressed that pharmaceutical production was a growth industry in North Carolina and estimated that the state could generate 40,000 new jobs in the next decade if facilities to train workers were provided (and subsidized by the state).

Leaders in the NC Senate stressed that the incentive package must include money for larger public projects, particularly the biotech-training center and the cancer hospital. House members objected to several additions proposed by Senate members. Moreover, the Senate dropped a proposal to issue US$175 million of

special obligation bonds, financed by US$25 million in national tobacco settlement payments (lawsuits), to build a biopharmaceutical facility and a cancer research center. A number of organizations and partnerships were interested in landing the new state-funded US$35 million biotechnology training center (and a number of regional training centers), including economic developers from Winston-Salem, the Research Triangle Park, North Carolina Central University in Durham, the Centennial Campus and the North Carolina State University's main campus. While lawmakers could not agree on how to pay for the project and the bill died, they authorized planning and development. Interviews that we conducted with representatives of the biotech community in North Carolina indicate a number of assets and challenges with regard to biotech policy and strategy at the state and regional level (Exhibit 15).

EXHIBIT 15
Opinions on statewide biotech policy and strategy

Element	Assets	Challenges
Government policy and state and regional biotech strategy	– Strong commitment to biotech and life sciences and bio-sciences more broadly – Significant federal and state funding for research and development – State support for colleges and universities – Active business recruitment with cooperation between regional organizations and partnerships and state and local governments	– Develop comprehensive statewide strategic plan for biotech and life sciences – Identify the competencies and capabilities of each region throughout the state – Accept the regional economy as a true reference for economic development – Support strong regional institutional focal points with regional jurisdiction

Source: Interviews with biotech community in North Carolina

In December 2002, the Golden Leaf Foundation announced that it would be the lead partner and financial investor in a new venture capital fund, the BioVista Fund, with up to US$30 million (with a targeted total capital investment portfolio of US$120 million). This investment is part of a US$85.4 million economic stimulus package intended to support biotech and life sciences. The Golden Leaf foundation decided not to restrict the fund to North Carolina firms in order to attract additional investors and to achieve a larger total pool of money to invest. The fund will have two objectives: (1) to invest in companies that have the potential of growing into larger, profitable companies, thereby increasing the value of the initial investment; and (2) to invest in companies that will have operations in the state, thereby creating jobs and stimulating the economy.

The North Carolina Biotechnology Center (NCBC) is in the process of establishing satellite offices outside of its core campus in Raleigh and the Research Triangle Park. In early 2003, it announced that it would open its first satellite office in the Piedmont Triad by summer 2003 in order to support biotech activities in the region and its growing life sciences cluster as part of its plans to open four satellite offices across North Carolina (the other locations are eastern and western North Carolina

and Charlotte). Local organizations, including the Winston-Salem chamber of commerce, have been lobbying the NCBC and the North Carolina General Assembly aggressively to attract the NCBC office to the Piedmont Triad Research Park. Greensboro, which arguably has the largest employment base in the field of biotech, and High Point, which has a number of biotech companies, were also interested in landing the new office. In a demonstration of regional collaboration and support, nineteen chambers of commerce and economic development agencies from throughout the Piedmont Triad signed a resolution aimed at convincing the General Assembly to provide the remaining funds (the annual cost of running the office was estimated at US$200,000).

The Research Triangle region

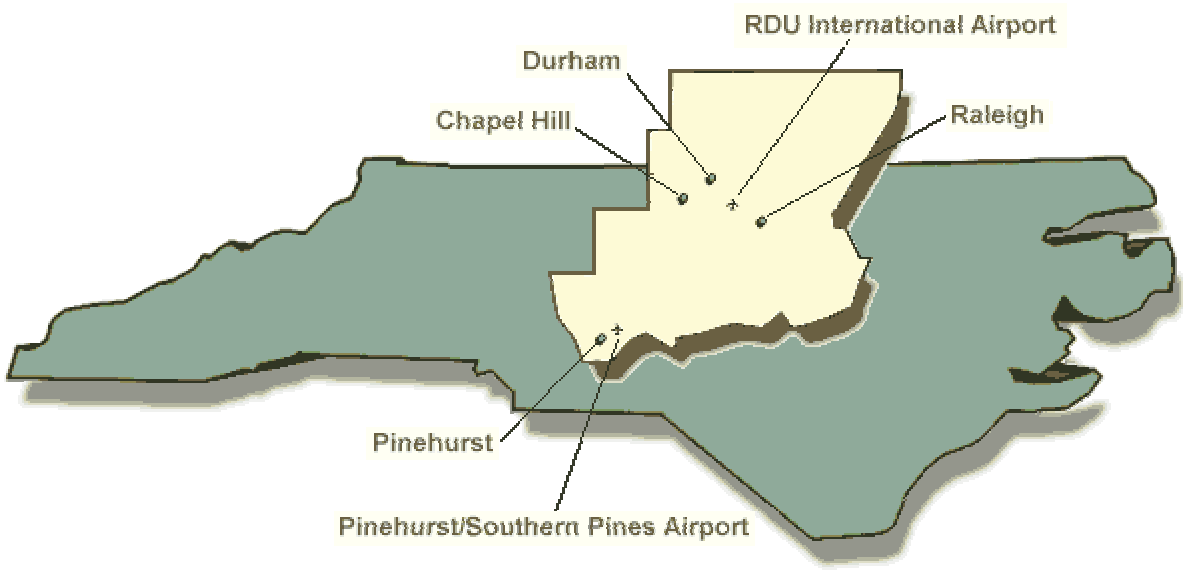
This report focuses on and compares an established biotech region, the Research Triangle, and an emerging biotech region, the Piedmont Triad. The sections below present an overview of the regions before deepening the examination in the next chapter. Initially, industrial growth in the Research Triangle region, which today has more than 1.5 million residents, was accidental but was eventually turned into more conscious attempts to capitalize on established capabilities. The initial industrial development was triggered by the investments of large companies, not least in the information technology and telecommunications sector. Spin-off companies and the emergence of an entrepreneurial climate, supported by local policy, however, are more recent developments. The seeds for the present level of entrepreneurial spirit were planted more than 150 years ago with universities working with the agricultural community.

In comparing the Research Triangle with the Piedmont Triad there is a need to look at the time differential. The Research Triangle (and the Research Triangle Park, RTP, which is the heart of the region and centrally located between the towns of Raleigh, Durham and Chapel Hill) has been in operation for more than 40 years. It is located next to the North Carolina capital city of Raleigh and at the doorsteps of the state government (and thus next to the management of the projects and programs associated with and implemented by the state government). It therefore has had and continues to maintain a competitive advantage from a governmental and state support perspective. There is a substantial and longstanding university concentration and a network of local, state and federal funding initiatives, which put this region ahead of the game. The Piedmont Triad has not yet received any similar kind of state support.

There is a triangular partnership of government, industry and education all working together in a collaborative effort. The concept of a planned research park came about in the late 1950's and the RTP was founded in 1959. The purpose of establishing a research development area was twofold. Firstly, there was a need to retain graduating students and scholars from the three major universities. Many of those with advanced degrees and high skills were leaving the state because they could not find suitable employment in North Carolina. Secondly, there was a need to diversify the state's economy. During the 1950's, North Carolina ranked 47th of

then 48 states in per capita income. The majority of the available jobs were in textiles, tobacco and furniture; that is, cyclical and low wage jobs.

EXHIBIT 16
The Research Triangle Region



Source: Research Triangle Regional Partnership, 2003

The early activities in the RTP were focused on research, but this was subsequently extended to include research applications and manufacturing of research products. This broader activity attracted IBM in 1965 to establish a manufacturing facility in the RTP, which was the company's largest US operation with over 10,000 employees. Later, leading local representatives persuaded the National Institute of Environmental Health Sciences (NIEHS), which is a part of the National Institutes of Health (NIH), to locate their national headquarters in the RTP in 1965 (about 500 acres of land were donated to the federal government). The location of a federal research agency was a major factor in the growth and development of the park. The US Environmental Protection Agency (USEPA) was recruited to this area in 1971 and its campus, located in the RTP, is the largest research arm of the agency. The presence of these two federal agencies conducting environmental research has played a major role in attracting business to the area. Before the investments by the major organizations, the RTP had less than 1,000 employees. The 1960s constituted a turning point and strengthened its recognition across the United States and internationally.

Furthermore, two centers of excellence were established in the RTP in the 1980s: the Microelectronics Center of North Carolina (MCNC), which today is a

privatized venture, and the North Carolina Biotechnology Center (NCBC). These centers became national models for the recruitment of science-based economic development projects. During the same decade, the Durham and Wake Counties formed a Research and Production Services District for the RTP – based on a statewide bill – that allowed companies located in the RTP to pay lower taxes by through relief from city taxes, while additional taxes could be levied by the park management to provide certain amenities otherwise provided by a municipality (such as recreation facilities and landscaping). The park has at least three major clusters: life sciences, communications equipment, and environmental sciences.

The RTP represents a development achievement of civilian-oriented research and commercialization. Today it comprises 2,800 hectares, is 13 kilometers long and 3.2 kilometers wide, and it took over 40 years to establish. Rules of operation for the area state that only research-oriented facilities may be located in the RTP and that those companies that have assembly and manufacturing (such as Biogen and Eisai Pharmaceuticals) ensure that manufacturing has a high degree of scientific input. Firms and other organizations looking to invest in and relocate to the RTP thus know that the local organizations are scientifically oriented. In the fall of 2002, there were 136 companies and organizations located in the park and more than 100 of these entities were related to research and development. Multinational companies employed almost half of its 50,000 workforce and the total payroll was estimated at around US$2.7 billion. The three major universities, the USEPA, the NIEHS, and the Research Triangle Institute International (RTI), which represents one of America's leading contract research organizations, together spend more than US$2 billion per year in research in the RTP. In terms of general employment, the Research Triangle has a situation similar to the Piedmont Triad.

The Piedmont Triad region

The Piedmont Triad region has emerged as a center for manufacturing, distribution, transportation and logistics. It has more than 1.3 million residents. It is a diverse region with a dispersed population and workforce. According to the Employment Security Commission, employment in the Research Triangle by August 2002 amounted to 669,000 and unemployment 36,500, whereas employment in the Piedmont Triad was 638,600 and unemployment 38,600. While much of the attention in North Carolina has been focused on the Research Triangle, the Piedmont Triad has made a commitment to support growth in medicine, high technology, banking and higher education. This emerging biotech region covers a range from university technology transfer to business incubators, which support the biotech industry.

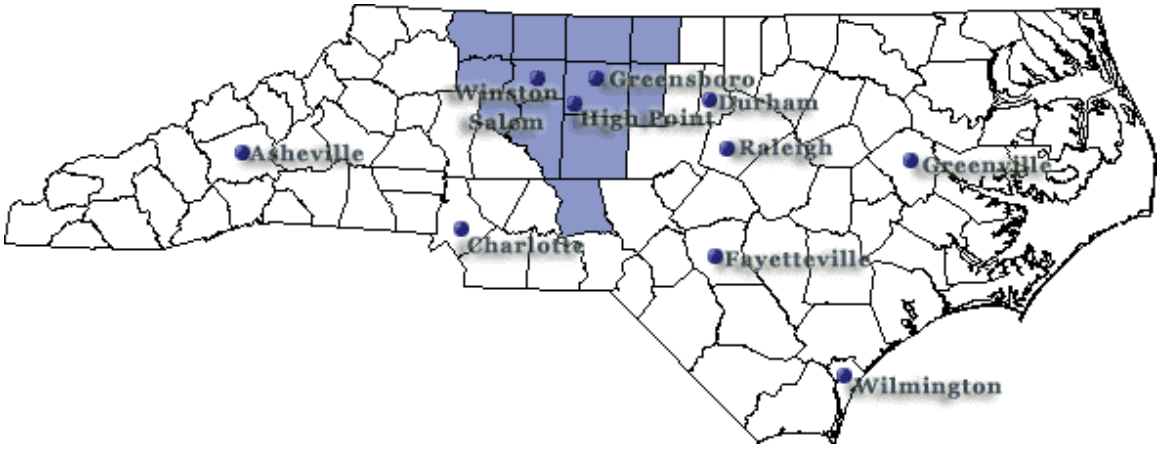
Piedmont Triad is situated on the East Coast between Washington and Atlanta and between Charlotte and Raleigh (it is located 90 miles west of the Research Triangle Park and 90 miles north of Charlotte). The location of the region has resulted in an economic development strategy that targets the manufacturing, distribution, transportation and logistics clusters. Moreover, the region encourages the positioning of the region as a technology center by building on the existing economic sectors and fostering new economy technology companies. Growth in

these sectors could reduce the reliance of the Piedmont Triad's regional economy on declining industries (such as textiles, apparel, tobacco and furniture), which makes it vulnerable to the loss and or continued downsizing of major employers that pay above average wages.

Piedmont Triad is an *emerging biotech region*. Its relative starting position and specific circumstances meant that it would not be feasible to compete directly with the more established Research Triangle biotech community. There are positive benefits accruing from the proximity to the more established Research Triangle region. This may be described as a bicycle wheel. The Research Triangle is at the hub of the wheel and Piedmont Triad is out on the rim. There is a large spoke that connects Piedmont Triad with the Research Triangle at the center (facilitated by an interstate highway). Once you go down and "open the doors" on the hub, things float out of the rim just by the sheer centrifugal force of the wheel turning.

The evolving regional biotech strategy (see chapter four) is aimed at consolidating the *Triad Biotechnology Region* as an integral and functional part of *North Carolina Biotech Corridor* that spans the area along Interstate highway 40 (I-40) from the Research Triangle through the Piedmont Triad. Among the major competitive and geographical advantages of the Piedmont Triad region regarding biotech and life sciences are (1) low-cost, readily available access to critical, industry-leading resources in the area of bio-medical manufacturing, and (2) close proximity to the complementary activities and assets of the Research Triangle region. The region has well-developed transportation and shipping capabilities as well as easy accessible freeways and a regional airport. Local organizations expect that the planned Federal Express hub in the Piedmont Triad will further enhance the attractiveness of the region to biotech and medical manufacturers, distributors and service providers. For the Piedmont Triad, the biotech and biomedical manufacturing sectors offer a narrowly focused area to target resources.

EXHIBIT 17
The Piedmont Triad Region



Source: Piedmont Triad Partnership, 2003

Traditional competition and turf wars between local administrative units in the Piedmont Triad region resulted in fragmented community efforts and a lack of regional and national recognition of the regional biotech cluster. According to local economic developers, this vacuum has hampered the emergence of a coherent region-wide strategic consensus. This indicates a number of actions that are required to bolster efforts underway in the region:

- Strengthen linkages between universities, companies and regional organizations associated with the biotech and life science sector and related fields;
- Develop networks of individuals, companies and institutions to facilitate transfer of ideas and resources;
- Differentiate the region relative to other regions with biotech efforts;
- Integrate the management teams of start-up companies (including venture-backed companies) into the regional community

Regional Innovation Performance

According to a study released in the summer of 2002 by the Brookings Institution, titled *Signs of Life: The Growth of Biotechnology Centers in the U.S*, the biotech sector in the United States is largely concentrated in nine of the country's 51 largest metropolitan areas. The Raleigh-Durham-Chapel Hill region has the fourth largest concentration of biotech activity of the metropolitan areas studied, whereas the Greensboro-Winston-Salem-High Point region is among the 28 median metropolitan areas at below average level in terms of research capacity and commercialization activities in the biotech sector. Data on federal funding in the Research Triangle and the Piedmont Triad regions, while somewhat dated, indicate the different starting positions of these regions and their different level of critical mass of biotech assets (Exhibit 18–21).

EXHIBIT 18
National Institutes of Health funding change 2000–2001*

Community	2001 Total NIH Funding	Rank by Total Change	Total Change	Rank by Percent Change	Percent Change
Winston-Salem	$95,008,218	30	$18,017,609	18	23.40%
Durham	$251,055,142	12	$42,880,689	27	20.60%
Chapel Hill	$248,500,025	14	$39,546,050	28	18.93%
Research Triangle	$52,326,197	96	$334,871	96	0.64%

** The data in Exhibit 18–20 are presented in the original form; that is, we have chosen not to create one unified category for the Research Triangle and Piedmont Triad, respectively, since they would not include the whole regions. Durham, Chapel Hill and the Research Triangle all belong to the Research Triangle, whereas Winston-Salem is the leading metropolitan area in the Piedmont Triad.*

Source: National Institutes of Health, NIH Funding to the Top 100 Cities, 2002 (Fiscal Year 2001).

EXHIBIT 19
Federal funding 2001: Distribution of all awards

Rank	City	Number	Amount 2001	Rank 2000	Amount 2000
1	Boston	3,269	$1,215,200,004	1	$1,078,198,949
2	New York	2,847	$1,062,872,344	2	$865,191,623
3	San Diego	1,445	$754,538,037	3	$680,954,889
4	Philadelphia	1,833	$659,091,430	5	$560,460,173
5	Baltimore	1,626	$618,177,078	4	$561,181,389
15	Durham (Research Triangle)	643	$251,055,142	18	$208,174,453
16	Chapel Hill (Research Triangle)	663	$248,500,025	17	$208,953,975
41	Winston-Salem (Piedmont Triad)	239	$95,008,218	47	$76,990,609
63	Research Triangle Park	60	$52,326,197	58	$51,991,326
	United States	41,616	$15,256,422,112		

Source: National Institutes of Health, NIH Funding to the Top 100 Cities, 2002 (Fiscal Year 2001).

The Research Triangle receives significantly more federal funding than the Piedmont Triad. In addition, the more established Research Triangle should be relatively better poised to benefit from the reinforced focus on bioterrorism preparedness. Some Research Triangle firms have already received federal funding for biodefense research programs aimed at helping to make preparations against terrorist attacks with weaponized viruses and bacteria that are known to cause large, lethal outbreaks. The level and success of the Research Triangle region – adding the performance of Durham, Chapel Hill and the Research Triangle Park – is much higher than that of the leading area in the Piedmont Triad, Winston-Salem.

EXHIBIT 20
Federal funding 2001: Regional distribution of awards

	Durham	Chapel Hill	Winston-Salem	Research Triangle Park
Research Grants				
Number	568	555	207	31
Amount	$225,061,331	$205,381,962	$82,372,874	$34,604,606
Training Grants				
Number	30	47	14	1
Amount	$8,859,854	$10,854,730	$2,673,037	$204,374
Fellowships				
Number	28	44	9	5
Amount	$1,014,664	$1,496,603	$312,602	$203,147
R&D Contracts				
Number	16	13	9	23
Amount	$15,506,710	$29,331,253	$9,649,705	$$17,309,070
Other Awards				
Number	1	4	–	–
Amount	$612,583	$1,435,477	–	–

Source: NIH, NIH Funding to the Top 100 Cities, 2002 (Fiscal Year 2001).

EXHIBIT 21
Innovation infrastructure in the Research Triangle and Piedmont Triad

Indicators	Piedmont Triad	Research Triangle
Biomedical research infrastructure		
Life scientists 1998	190	910
Biological science PhDs		
Institutions granting PhDs 1999	1	3
Number of PhDs granted 1999	25	166
Top-ranked research universities 1982	–	1
NIH funding to top 100 cities, 2000	76,990,609	469,119,754
NIH funding share of top 1000 cities, 2000	0.7%	4.0%
NIH research funding for medical schools		
NIH research funding 1985/share to top 50 metros	–	120,889/5.1%
NIH research funding 1990	–	205,615/5.7%
NIH research funding 1995	–	302,6896.3%
NIH research funding 2000	–	440,954/5.8%
Biotech-related patents		
Number of patents 1975–1979	12	27
Number of patents 1980–1989	10	204
Number of patents 1990–1999	64	796
Number of patents 1975–1999	86	1,027

Source: Brookings Institution, Signs of Life *(2002).*

By mid-2002, almost 5,000 university and college faculty members were conducting research in the life sciences in North Carolina, which, together with the research done in federal laboratories and non-profit institutions, represented more than US$1 billion in investments. Five of the major universities in North Carolina – Duke University, West Carolina University, University of North Carolina, North Carolina State University, and Wake Forest University – together invested more than US$800 million in new genomics and bioinformatics programs. The relatively well-established innovation infrastructure in the Research Triangle gives it a strong position compared to the Piedmont Triad (Exhibit 22).

EXHIBIT 22
Innovation infrastructure: Biotech companies

Indicators	Piedmont Triad	Research Triangle
Biotech companies with 100 or more employees		
Number	2	13
Share	0.7%	4.6%
Biotech companies by founding date		
Companies founded 1991–2001	7	46
Share of companies founded 1991–2001	1.7%	11.1%
Market capitalization of biotech companies 2000		
Number of publicly traded companies	2	10
Capitalization (millions)	6,481	9,949
Share of capitalization	1.6%	2.4%

Source: Brookings Institution, Signs of Life *(2002).*

North Carolina is currently engaged in developing a statewide biotech strategy by identifying all available competencies and capabilities in each region throughout the state. One major challenge is to assess in what way this overall strategic effort will be complemented by regional strategies and match the different starting points of established and emerging biotech regions. The following chapter, chapter four, takes a step beyond the statewide strategic effort by focusing on partnerships for biotech support, positioning, recruitment, entrepreneurship and capital accumulation.

4. Regional Partnerships

What strategies and actions do key organizations pursue in order to capitalize on and strengthen biomedical clusters in the light of regional economic competition and constraints? Public-private partnerships involving cooperative research and development activities among industry, universities and government laboratories can play a key role in speeding new technology from the concept stage to the marketplace. In addition, a number of recent strategy reports stress the need for a supporting and committed role by states and the importance of state funding in economic development and in generating high-paying jobs and tax revenues (see for example, *MassBiotech 2010: Achieving Global Leadership in the Life-sciences Economy*, by the Boston Consulting Group and the Massachusetts Biotechnology Council, and *Biomedicine: The Next Wave for California's Economy*, by PricewaterhouseCoopers and the California Healthcare Institute, both of which were published in 2002).

The regional economy (and regional partnerships) has achieved increasing legitimacy as a real reference for economic development and for biotech support. This is perhaps particularly true for the Piedmont Triad, which is at a fairly early stage of development in the whole biotech and life sciences cluster. It is an area where there appears to be a case to make that the leadership should be regional and not at the city or county level. Supporters of this view in the North Carolina economic development and biotech community would argue that the critical mass of assets (companies, universities, community colleges, and other resources) exist and should be aggregated at the regional level. The current institutional and policy landscape in North Carolina is characterized by a number of organizations and partnerships with relevance for the biotech sector. Most of the organizations and partnerships that exist in one of the regions examined here have a counterpart in the other region.

Statewide Biotech Support

The various ingredients of state and regional economic development started to coalesce with the launch and activities of the North Carolina Biotechnology Center (NCBC) in 1981 by the North Carolina General Assembly. It was the country's first major state-sponsored initiative in biotech and an example of a flexible cluster development model rather than a concentrated and top-down science and technology edifice. It has established a US$26 million venture capital fund to finance early-stage biotech companies. It created the North Carolina Genomics and Bioinformatics Consortium, which resulted in a cross-sectoral partnership bringing together all the major universities in the Research Triangle and more than 70 biotechnology and technology companies, universities and service organizations. By mid-2002, the NCBC had funded 62 early stage companies with low-interest loans totaling about US$8 million. Through its North Carolina Bioscience Investment fund it has invested US$16 million in 10 new companies and attracted co-investments totaling US$44 million from other investors.

The NCBC works closely with marketing officials in various organizations, such as the Research Triangle Foundation, the Piedmont Triad Partnership and the North Carolina Department of Commerce, to communicate with company officials outside of the state and attract corporate activities into the state and specific regions. The NCBC promotes partnerships with a view to accelerating genomics, bioinformatics and proteomics research activities, and to supporting entrepreneurship. The Research Triangle biotech community has benefited more from NCBC, even though the partnership model it has in the Research Triangle area applies to each of the regions in North Carolina. This partnership is becoming more active and present throughout the state. As a non-partisan and not-for-profit organization, it can sit in the middle of government, industry and academia. It can work effectively with each of those groups as a catalyst to bring them together on neutral territory. It has helped to support the entrepreneurial culture, particularly the Research Triangle through a host of different programs and activities, such as workforce training, community efforts, and seed funding.

In addition, the North Carolina Department of Commerce is involved at a number of different levels, including the business recruitment function and international trade relationships in trying to help North Carolina biotech and pharmaceutical companies grow and export their products.

Another organization that should be mentioned, although it is not entirely a state-regional partnership but also has a federal government component, is the Small Business and Technology Development Center (SBTDC), which is a business development service. It is entirely publicly funded through, and operated in partnership between, the US Small Business Administration out of Washington, DC, and the University of North Carolina public university system. The SBTDC is chartered to serve all of North Carolina. It has its headquarters and offices in the Research Triangle as well as offices in Greensboro and Winston-Salem and a kind of "floating" officer in the Piedmont Triad. It is involved as a strategic advisor to smaller high-growth and high technology companies to try to advise them and help them find resources. The SBTDC strategy for company growth has been more focused on the urban counties, although it does have a presence in the rural counties. It is not focused exclusively on the biotech industry, but there is a disproportionate representation from this industry.

SBTDC officials pointed out that between 3–4 percent of the total population of the companies create all the net job growth and these companies generally have less than 100 employees (about 98 percent of all companies in existence in the state) and are often not served by, for instance, the chambers of commerce. Although growth companies only represent a smaller portion of companies formed, they create about 80 percent of all jobs. They expand in revenue and jobs on average by 25 percent each year (initially expansion was much greater). Many of the private sector members in regional entrepreneurial organizations do not fit this growth definition, but want to be closely associated with the partnership and may have interesting growth plans. The SBTDC has embarked on initiatives to promote certain sectors across the state and has organized events to explore the role of different regions in the field of life sciences.

Employment and sales growth were significantly higher among SBTDC clients compared to the average in North Carolina (the cost per job generated was estimated at US$1,981). Its client companies created 14.5 percent jobs, compared to 2.6 percent for North Carolina as a whole, and generated 41.8 percent sales, compared to 3.8 percent for North Carolina. Regarding implications for economic developers, SBTDC concluded that gazelles (small, high-growth companies) are truly important for the future of North Carolina, that a business strategy focused on high-growth firms can provide meaningful returns, and that partnering and bringing in resources are needed activities. The organization will continue to develop and implement strategies to serve high-growth firms. By 2002, it focused 25 percent of its resources on such firms.

Regional Economic Development, Recruitment and Promotion

The development of a regional marketing and recruitment strategy is a real challenge considering that most metropolitan areas in the United States aggressively pursue efforts to support their biotech and life science sectors as growth engines for regional economic development. This is particularly challenging for emerging biotech regions. The Piedmont Triad biotech community pays attention to economic competition with other mid-Atlantic regions with good surface transportation capabilities and a skilled workforce, such as the Greenville-Spartanburg-Anderson and Columbia regions in South Carolina, the Richmond region in Virginia, and the Charlotte region in North Carolina.

Every region is faced with scarce resources when attempting to bolster the economic health of the community and the growth of the tax base. This constitutes a problem in terms of balancing incentives for homegrown start-up businesses and attracting new businesses from outside the region. A strategic question, then, is what should be done to maximize the region's recruitment efforts. Several regional representatives point out that the more a business is established in and networked to the community, and the stronger mutual dependence between firms and the community, the less likely it is that businesses will relocate to other regions. What is commonly referred to as "buffalo hunting", that is getting a large company to move into the region, is in the end not as productive as supporting a company that starts and grows locally.

Regional officials in the Piedmont Triad with responsibility for recruitment and marketing argue that the key is to target biotech and pharmaceutical manufacturing (biomanufacturing) and distribution facilities that do not require advanced degree professionals usually needed for research operations. Compared with typical biotech start-up businesses, biomanufacturing and distribution companies employ hundreds of people and exploit some of the region's competitive advantages: an already existing manufacturing base, a highly skilled manufacturing workforce (skilled workers in the textiles and chemical industries who can retrain and acquire biomanufacturing skills), and a ready supply of community college graduates to support biotechnology manufacturing and distribution. As we will return to later, this strategy is not unlike the situation in the Biotechvalley (Strängnäs) in Sweden.

The Research Triangle Regional Partnership (RTRP) is, like the Piedmont Triad Partnership discussed below, one of seven regional economic development organizations in North Carolina (all of North Carolina's one hundred counties are affiliated with one of these seven regional groups). Some of these organizations do not have a life sciences or biotech emphasis because they operate in rural areas of the state, but the Research Triangle and Piedmont Triad regions clearly have such an emphasis where there is probably a disproportionate orientation toward biotech and life sciences.

The RTRP is set up, funded and structured very much like the Piedmont Triad Partnership. Its history provides a good example of the growing legitimacy of a regional economic perspective and the concept of regionalism. It started marketing three counties in the early 1990s (Wake, Durham and Orange) and was funded by their chambers of commerce and the Research Triangle Foundation. A few years later it expanded to market and promote six counties and then in 1994 it again expanded to cover thirteen counties (and changed its name to the Research Triangle Regional Partnership), and it has continued expanding. The biotech and pharmaceuticals sector is one of the industries that this partnership target and market as a priority concern.

In 1999, the RTRP deliberately changed from being solely a marketing organization recruiting branch businesses to a visionary organization speaking as the "voice of regional business". Meanwhile, the other six partnerships in North Carolina have remained with their marketing mission. This strategic shift in mission is likely to be timely and valuable since recruiting branch business has become a difficult task since there has been a significant decline in branch manufacturing businesses. Interviews with regional development officials suggest that the significance of this strategic initiative is compared to the groundbreaking initiative in the late 1950s that paved the way for the Research Triangle Park and that it will change the region for many years to come by bringing more publicity, companies, money and vitality to the region. Needless to say the competition has increased since then.

The regional partnership and its institutional partners are actively engaged in reinventing the strategy and policy for regional economic development. In the fall of 2002, the Research Triangle Regional Partnership recruited the so-called *Future Cluster Competitiveness Task Force* and about a dozen institutional partners, and with active participation on the part of Governor Jim Hunt. This group has given itself six months to develop a comprehensive, collaborative and accountable regional plan to address all areas of economic development, and five years to implement it. They will use cluster analysis, informed by Porter's Cluster of Innovation Study (2001), as a tool in assessing competitive strengths, identifying weaknesses, picking strategic targets, and guiding development strategy. This collaborative strategic effort evolves, and has been influenced by, increasing competition between regions, stagnating job creation and lower levels of investments in the region, and less attention to the region in the international press. One of the initial suggestions include a "mini-hub" concept that, due to the abundance of industrial parks competing for the same business, intends to create

enhanced industrial parks with special facilities (for example, incubators, testing, research, and advanced technology), services, and incentives that would complement the focus of the overall hub, develop in a coordinated manner, and be dispersed geographically.

The Piedmont Triad Partnership (PTP) is a regional economic development partnership responsible for enhancing the economy of the Piedmont Triad region. It was incorporated as a non-profit corporation in 1991. It is a public-private partnership and receives roughly 50 percent of its funding from the state of North Carolina. The remaining 50 percent of its budget is funded privately (about 30 percent) and through contributions by local government at the city and county level (about 20 percent).

This public-private partnership has been involved in a number of areas and has been actively engaged in the regional biotech and life sciences cluster. It is the lead business recruitment organization at the regional level and is working closely with the North Carolina Department of Commerce, which are the state business recruiters, as well as with the North Carolina Biotechnology Center, the specialized state agency for biotech support. The PTP works collaboratively to position and promote the Piedmont Triad as a location for biotech, life sciences, pharmaceutical and medical device companies as part of its broad mission of recruitment. It has hired an active and well-known biotech entrepreneur as a consultant specifically to help the PTP in its positioning and recruitment effort. On the organization's behalf, the consultant has been attending trade shows, holding speeches at conferences, and meeting with companies outside of the region involved in consulting services to the biotech industry to help promote the Piedmont Triad. The PTP is expending significant resources in the recruitment area.

The location of foreign-owned subsidiaries has further strengthened the local Piedmont Triad economy and job market. MWG Biotech, for example, which is based in High Point and whose parent company is MWG-Biotech AG in Ebersberg, Germany, chose to locate its first facility in the United States in the region. The PTP states that high value-added manufacturers and distributors of high-value products, such as those in the pharmaceutical and biomedical industries, are ideal candidates to locate in the region.

To support and sustain a concentrated effort for cluster development is, in a sense, not encouraging since it will take decades to achieve. Based on a visit to the Piedmont Triad region and a number of interviews with officials in its biotech community, it is clear that there is a serious and aggressive commitment to enhance the competitiveness and further growth of the emerging biotech cluster. The regional strategy for the emerging biotech cluster in the Piedmont Triad consists of a number of key components:

The need to strengthen the biotech and life science sector by becoming a major *niche player in biomanufacturing* with an integrated institutional structure involving community colleges, universities, existing firms, entrepreneurs and all other relevant actors in the regional biotech and life science community.

The need to recruit, retain, and develop the workforce, grow local companies, and create critical mass by *pushing off from the emerging and existing cluster*.

The need to *support homegrown companies* that have the potential to grow and generate a large number of jobs in the local and regional economy, to maximize recruitment efforts by *actively attracting firms through creative deal-making packages* designed to be profitable also for the public sector, and to *immediately connect* new entrepreneurs to existing partnerships and the local community.

The need to maximize regional efforts by accepting the regional economy *as the true reference for economic development* and for mobilizing and deploying resources more effectively, by *coordinating the various agencies' strategies* and get disparate groups to work together, and by supporting *a unified, collective entity* with regional jurisdiction to bolster the clout and resources of the region.

One development target is to strengthen regional capabilities in biomanufacturing, which generally encompasses the use of living cells and microorganisms to produce products, including pharmaceuticals, and which can be distinguished from more traditional pharmaceutical manufacturing where chemical compounds form the basis of the product. Bioprocessing manufacturing and facilities (building on the region's manufacturing heritage) are viewed as vital to the state's economy and for knowledge-based growth. It is important that this effort integrates real innovation and investments in, and recruitment and retention of, a high-skilled workforce. The overall mission would be to become a major niche player in the biotechnology and medical manufacturing segment supported by a strong institutional focal point in order to mobilize regional resources, organize activities, and coordinate marketing and recruitment efforts in a cohesive manner. A regional strategy for the biotechnology and life science sector would depend on the development of linkages of complementary relationships between formal and informal organizations and networks for its implementation.

Regional Entrepreneurism

It takes a long time to change the entrepreneurial and industrial culture of a region in a way that recognizes the potential of entrepreneurs and integrates them into a broader community. A growth-from-within strategy complements efforts to retain or attract high-profile companies to the region through incentives (tax breaks, cash grants and other incentives). Local officials, however, suggested that the regions could not depend solely on homegrown companies in the start-up phase and area universities to support the burgeoning biotech sector when many other regions are actively recruiting biotech and pharmaceutical companies, talent and research facilities. The company that starts in the region is more likely to stay in the region compared to a company that is recruited to the region. Representatives from regional entrepreneurial organizations stress that one needs to use the existing cluster assets for recruitment, retention, workforce development and entrepreneurial efforts.

Several interviewees indicated that the Research Triangle is not a land and culture of audacity and tolerance of failures, risks and entrepreneurism, but a land of safe decisions. Local and statewide organizations and businesses do not always go with

the gut feeling and tend to analyze alternatives and proposals for too long. Too much strategic planning of research programs could foster rigidity at the expense of necessary grassroots initiatives. What are required, they suggested, are efforts to identify and implement ways to support innovation and to encourage policy discussions about alternative paths and solutions.

The Council for Entrepreneurial Development (CED) in the Research Triangle Park, which is the more established counterpart of the Piedmont Entrepreneurs' Network, was founded in 1984 and is the largest entrepreneurial support organization in the United States with around 5,000 members. Its mission is to stimulate the creation and growth of high-impact companies in the greater Research Triangle, to enhance the region's business climate for entrepreneurship, and to communicate its reputation outside of the region. The CED has been successful in raising capital and provides programs and services in four major areas: education, capital formation, mentoring, and communications. In 2001, it unveiled a new strategic initiative that targets, among other things, efforts to design and build programming that addresses the management and leadership of entrepreneurial companies.

There are several initiatives underway in the Piedmont Triad region to encourage a regional entrepreneurial culture. The Piedmont Entrepreneurs Network (PEN) and the Triad Entrepreneurial Initiative (TEI), supported by the Small Business and Technology Development Center, have played important roles in fostering an entrepreneurial spirit. PEN, headquartered in Greensboro, is a regional partnership and is actually patterned after CED. PEN, like CED, is a membership organization that is funded entirely through private membership. It includes investors from throughout the region and created an advisory board of established entrepreneurs. It fills an important gap in a region marked by a lack of venture funding sources. The thrust of PEN is to find and foster growth companies, support an entrepreneurial climate, and thereby seek to transform the Piedmont Triad into an entrepreneurial hotspot. It promotes the formation and success of the Triad's entrepreneurial growth by providing to members a network access to people and capital, research technology, and service infrastructure.

PEN states that it is vitally important to create more regional entrepreneurial companies for shared and sustainable regional growth and to use clusters to create those companies. Its philosophy and strategy is based on a set of ideas on research about growth companies nationwide and on previous experiences of such companies for economic development in North Carolina (e.g. RF Micro Devices in the Piedmont Triad). Accordingly, an important strategic element is to focus on smaller, high-growth companies, in combination with attracting companies from outside the region, since they create more jobs than result from the recruitment of branch businesses.

This regional partnership functions as a resource coordinator of capital, people and information. It aims to foster a highly networked regional economy by supporting entrepreneurs, influencing public policy, and addressing obstacles for regional economic growth. It provides an interactive forum for entrepreneurs, investors,

service professionals, academics, researchers and public policymakers. Moreover, it serves as a launching pad for companies by providing entrepreneurial training, mentoring and assistance, participation in business plan competitions and networking events.

The Piedmont Triad Partnership has executed a memorandum of understanding with PEN in which they have jointly agreed to develop the biotech-life sciences cluster, among other sectors, which they define broadly to include pharmaceutical and medical device companies in the region. The first deliverable manifestation that has come out of that collaboration is the creation of the regional life sciences CEO roundtable, which is under the staff administration of PEN. Both partnerships are active participants and work closely with the CEOs to both help cultivate the existing cluster of companies in the area and also to leverage their relationship in the industry in order to support the Piedmont Triad.

The PEN leadership stresses that entrepreneurs need and want to share ideas and "war stories" with their peers (which could help to accelerate business growth in early stages by reducing mistakes), combat a sense of isolation, build business alliances and fill in-house resource gaps. Moreover, local entrepreneurs could help big business by creating companies that are customers and suppliers of larger firms, increasing the level of economic efficiency, making the region more appealing to recruits, and, in general, contributing to a vibrant regional economy and high quality of life. The existence of regional entrepreneurial organizations and initiatives make it easier for a corporate representative to get connected to the local and regional community and resources, particularly for a start-up business that needs significant resources (capital, talent, supporting infrastructure and technology). If the entrepreneur feels that people in the region are attentive, PEN officials argue, the rest gets easier. As soon as small early-stage companies and spin-offs from medical schools appear on the radar screen they should be brought in and become part of the group.

In order to meet the challenges to the region's economy, the PEN leadership stresses the need to change the traditional economic development model, to abandon the city and county focus and instead take a cross-community and regional approach because economies are regional, and to leverage existing clusters of companies to recruit, retain and develop the workforce. All the PEN programming is geared towards larger strategic issues (for example, how to manage the sales process, how to raise money, how to assess the balance sheet when selling a company or looking for an investor). It collaborates with Piedmont Triad organizations to showcase university research and technology transfer activities. Some of its specific initiatives include an entrepreneurial index (an annual tool, under development with the SBTDC, to measure the Piedmont Triad's increase in entrepreneurial activity), a program for entrepreneurs to test their business plans before seeking equity funding (the FastCap program), and a Life Sciences CEO Roundtable in partnership with the SBTDC and the Piedmont Triad Partnership (see next section).

In addition to PEN, the Triad Entrepreneurial Initiative (TEI) is a regional umbrella initiative and a development program designed to leverage the support being offered by PEN, the SBTDC and colleges and universities in the region and to make Winston-Salem and the Piedmont Triad recognized centers for entrepreneurial development. It is funded by both private and private foundation grants and contributions as part of a much larger umbrella fund-raising effort and has no direct counterpart in the Research Triangle. The Piedmont Triad Partnership and Piedmont Entrepreneurs' Network have executed an agreement where the director for the TEI is employed by the PTP, although the latter is simply a pass-through organization. The funding of the TEI has come from the Action Greensboro and the Winston-Salem Alliance organizations, which are broad-based umbrella fund-raising organizations.

TEI (like PTP, PEN and PAN) represents the 12-county Piedmont Triad region and is involved in trying to nurture entrepreneurism, primarily through a series of business plan competitions each year (LaunchPad), which is part of the larger effort to promote regional economic development, revitalize the region and bolster support for the entrepreneurial community. It encourages entrepreneurs, students and others to move from an initial business idea and concept to a business plan and real strategy. If one enters with plans to grow a company and can demonstrate this in a business plan, then one is allowed to continue the competition. The competition evolves through three stages, each of which provides successively larger amounts of prize money for the winning business plans. As a tool and joint project for supporting the regional entrepreneurial strategy it received a lot of publicity because it is well funded and it puts entrepreneurism in the public eye more than individual organizations could do by themselves. TEI is also involved in providing business counseling and fast track curriculum programs at local universities for entrepreneurs. While it is not limited to the biotech sector, many of the participants on both the mentoring and curriculum side, as well as in the business plan competition, are technology companies, some of which are in the biotech and life sciences area.

Regional organization officials argue that there are several issues that need to be addressed (in addition to standard development issues) in order to support a vibrant entrepreneurial culture in the region: the need for talented people and capital, the need to develop and foster support networks for entrepreneurs that supply resources more quickly than an entrepreneur can generate alone, and the need to have research universities (and their technologies) involved on the entrepreneurial scene. In terms of workforce migration, for example, there are signs that the region is developing a better labor market. In 2002, some companies in the Piedmont Triad hired scientists from other local companies (for example, Targacept in Winston-Salem from TransTech Pharma in High Point, both pharmaceutical start-up firms). These companies also recruited workers from the Northeast and West Coast. Piedmont Triad officials propagate the message that if one comes into this region to work (and also if the local business fails) there are other companies and jobs in the region. According to biotechnology CEOs in the region, it has become easier to

recruit. In the emerging Piedmont Triad biotech region, interviewees stressed the importance of the creation and role of the Life Sciences CEO Roundtable.

Cluster Enhancement and Business Leadership

The regional Life Sciences CEO Roundtable includes most of the chief executives of the Piedmont Triad's biotech and pharmaceutical companies. PEN staffs it with adjunct assistants from the PTP who are helping guide policy development about how to grow the biotech sector of the economy. A lot of the activity in the life sciences group was first disjointed. Many of the entrepreneurs who were starting the member companies did not know each other and did not know the more established actors.

The roundtable members have been able to get people together, to increase the level of collaboration, and to raise the awareness of available resources. They meet on a regular basis, swap information and form alliances. It has resulted in an exchange of information and a greater awareness that they can be effective in marketing the region and in supporting entrepreneurism through joint efforts. Its members, for example, identify the venture capital actors that they prefer to deal with. In addition, they go to meetings in the Research Triangle region and then come back to the Piedmont Triad and report who they have met and what they have heard, sometimes suggesting that they would like to invite certain people. They also frequent domestic and international conferences and publicize the fact that the region is an attractive place for biotech start-up businesses. Moreover, some entities such as the North Carolina Biotechnology Center are becoming more aware of what is happening in the Piedmont Triad. The interchange between resources in the Research Triangle and the Piedmont Triad companies has increased and accelerated, some interviewees argued, largely because of the CEO group and the exchange of information.

Capital Investment

Regarding investment and venture capital, the global biotech industry, which in 2001 consisted of 4,284 companies (defined as entrepreneurial companies engaged in drug discovery), invested more than US$16.4 billion in research and development and employed more than 188,000 people, according to Ernst & Young's first global biotech report published in 2002. In the United States, North Carolina lags behind the leading states in capital deals in general. In 2001, companies in the state received more than US$697.0 million in venture capital investments, a decline of 51.7 percent over the 2000 total (compared to a decline of 61 percent for the country as a whole).

EXHIBIT 23
Venture capital investments by state, 2002 (in million US$ dollars**)**

State	Deals	Amount
California	1,037	9,467
Massachusetts	337	2,363
Texas	170	1,284
New York	151	803
Maryland	92	625
Washington	114	599
Georgia	85	588
New Jersey	88	568
North Carolina	88	547

Source: PricewaterhouseCoopers/Thomson Venture Economics/National Venture Capital Association MoneyTree™ Survey, 2003.

The Piedmont Angel Network (PAN) is an arm and spin-off of PEN. It is raising funds privately and pooling capital for investment in high-growth entrepreneurial start-up companies in the Piedmont Triad. PAN, based in Greensboro and formed in late 2001, is a joint project of PEN and SBDTC. One of the major founders is Wake Forest University, a private university, and it receives no direct government or public support. While this regional partnership is not limited to the biotech industry, one of its first two investments was in Kucera Pharmaceuticals, which is a biotech start-up company. With input from actors and partners in the region, they are trying to identify capital that could be used to enhance the biotech cluster. This regional investment partnership focuses on locally owned early-stage companies. It is the major regional investment agency for biotech and life science firms in the Piedmont Triad. By September 2002, it had a membership of 58 private investors and had a total capital of US$3.35 millions to invest.

Biotech and life sciences CEOs in the Piedmont Triad explore opportunities both in and outside of the region. In late 2002, Targacept landed US$46 million in venture capital financing, the eighth-largest venture capital deal in North Carolina since 1995 and the largest since the fall of 2000. The company spun off from R. J. Reynolds in 2000 (and its research activities on the effects of nicotine on the brain and central nervous system) and employs more than 60 people in the Piedmont Triad Research Park. It develops compounds that interact with the same receptors as nicotine, with the aim of treating diseases ranging from Parkinson's to Alzheimer's disease. Considering that the average infusion in 2002 was for less than US$ 10 million, it was a significant achievement (Exhibit 24).

EXHIBIT 24
Largest venture capital deals in North Carolina October 2000 – November 2002

Company	Business	City	Investment
Targacept	Therapeutics, Clinical Human Diagnostics	Winston-Salem	$46 million
Hatteras Networks	Developer of carrier access platforms	Durham	$45 million
Nobex Corporation	Biotechnology/Pharma drug products	Durham	$35 million
Amphora Discovery	Chemogenomics	Durham	$35 million
Merix Bioscience	Immunotherapy and metastatic cancer	Durham	$34 million

Source: PricewaterhouseCoopers/Thomson Venture Economics/National Venture Capital Association MoneyTree™ Survey, 2003.

Three of the biotech firms in Winston-Salem either closed their offices (Amplistar and Anasazi) or decided to relocate (Pilot Therapeutics). The lead financing entity was a company in London (Nomura International's Healthcare Private Equity Group) and other financing partners included Academy Venture Fund with offices in North Carolina, a company in Baltimore, one that operates in Taiwan and the United States, and one in New York. Targacept is a prime example of a locally grown company that remains in the home region and of the search for venture capital financing by biotech companies outside of the state. However, the capital accumulation and research and development performance of the emerging region still lags significantly behind that of the Research Triangle (Exhibit 25).

EXHIBIT 25
Venture capital, alliances and employment

Indicators	Piedmont Triad	Research Triangle
Venture capital for biopharmaceuticals		
Venture capital investments 1995–2001		
Number	3	54
Amount	38,900,000	379,687,000
Share	0.4%	3.9%
Highly active venture capital firms 1995–2001	0	2
Initial public offerings 1998–2001	0	1
Pharmaceutical/biotech alliances		
Value of R&D alliances (millions)		
1990–1995	–	33
1996–2001	–	192
Total	–	225
Pharmaceutical and life sciences research employment*		
Pharmaceuticals (NAICS 3254)		
Establishments	8	19
Number of employees (estimated)	1,195	3,679
Life Sciences R&D (NAICS 541702)	–	225
Establishments	NA	90
Number of employees (estimated)	NA	3,356

Source: Brookings Institution, Signs of Life *(2002).*

Furthermore, the participants in the regional opinion survey and a number of people who were interviewed for this study indicated a number of challenges to the North Carolina biotech community in terms of venture capital formation and entrepreneurial support. They indicated a need to deal with the following issues: promote venture capital formation and investment; provide access to risk capital for start-up companies; encourage serious venture capital firms to locate in the home region; match grants from external sources as other states do; provide grants to companies directly for research; continue to invest pension fund dollars in venture capital funds; subsidize (short-term) job creation; provide continuing education (including advanced short-term training) not only for workers but also for management.

Technology Infrastructure Support

There are other types of partnerships at the intersection of the local and regional level. While they are good collaborative models they are limited in geography and will only be discussed briefly in this report. Here we focus on technology infrastructure support.

Research parks are physical aspects of developing clusters and networks in an urban environment. Both in the Research Triangle and the Piedmont Triad, biotech and life sciences are target development areas together with information technology since the partnerships involved in parks have high expectations that the biotech and information technology worlds will converge some time in the future and will generate a synergistic creation of opportunity. They are also looking at the broader scope for being connected to and using the whole of North Carolina's resource capability that can help their partnerships and the state to create a larger biotech area.

The real estate development of these partnerships to enhance the regions' biotech clusters can help business to foster an identity in a cluster market with like-minded people that they might not have if they were located remotely in another area because they will be. The provision of physical infrastructure and its associated network assets can support the entrepreneurial culture. Businesses will have recourse to faculty and to workforce and training development that the region's universities and technical community colleges can provide. They will have an opportunity, as the regions will keep improving the capital infrastructure, of having forums, meetings and presentations to the private sector and the larger community. Moreover, they will have a market opportunity with the partnerships and the parks that will help them market and create awareness of their programs and products that they are trying to develop.

Entrepreneurial development depends on the stage at which entrepreneurs are (from learning and exposure to people who can assist, whether it is within the legal community of intellectual capital, property, patents, licensing to the business community that can help them understand what businesses is about and develop business plans). It can be specific scientists or customers who are calling the partnerships to ask about companies that might assist them, it could be CEOs or others in the medical or pharmaceutical industry who are looking for employment

or for an area in which to help start-up companies. The research parks are a source that people may go to in order to find information. They try to distribute such information to the tenants in the park and find out what their needs are in order to match needs and resources. More broadly, the research parks are intended to support the research, industrialization, recruitment efforts, and the private sector (pharmaceutical operations, manufacturing, engineering, etc.).

Regarding the partnership landscape for technology infrastructure support, several entities were established that would prove to be important for the growth of regional biotech communities. The Research Triangle Foundation, a non-profit organization, was founded by a number of political, business and academic leaders. It received the bulk of its early funding from banks and utility companies and firms in the traditional sectors, and used this to purchase land near the three major universities. The state took a backseat position financially but the Governors served (and still serves) on the Board of Directors.

The Research Triangle Foundation and the Research Triangle Park itself, of which there is no counterpart in the Piedmont Triad, is the 800-pound gorilla in the North Carolina biotech community. It is a local-regional model of collaboration and development of high-tech industries that is recognized nationally and internationally. It involves 7,000 acres, a number of research universities, various other institutions, a large number of companies, and separate counties that have collaborated in supporting its development and maintenance. A significant amount of federal and state investment has been channeled into the park. In the early years, the focus was on the information technology and telecom industry. However, as a result of the downturn in the latter industry, there has been a much greater emphasis on the biotech and pharmaceutical component of the park. The Piedmont Triad biotech community is clearly jealous of the Research Triangle Park because it has transformed that region and broadened it globally as a leader in the biotech and life sciences industry.

The Idealliance, formed in 1998 as a nonprofit community group, is a local partnership and the developer of the Piedmont Triad Research Park (PTRP) located in downtown Winston-Salem. The Idealliance and PTRP are a public-private initiative that receives funding from private investors, from the participating colleges and universities, and with some government support from the city of Winston-Salem and the county Forsyth. The city of Winston-Salem, among the cities and counties of the Piedmont triad, is considerably more advanced in developing collaboration in support of technology and life sciences development. In 2002 this local-regional initiative became formally affiliated as a division of and anchored in Wake Forest University, which dominates the park, although its board of directors includes a number of other universities, as well as other organizations and the local government through the city of Winston-Salem and the Forsyth county. It is also affiliated with Winston-Salem State and other area colleges and universities. The PTRP focuses on life sciences and information technology.

The Idealliance committed to construct all of the future medical research facilities in the PTRP. At the end of the 1990s, the anchor tenants in the PTRP were the department of physiology and pharmacology at the Wake Forest University's School of Medicine. By the fall of 2002, the park totaled about 10 acres with four buildings and 20 tenants, including biotech and life sciences companies such as Targacept Inc., Amplistar, and Kucera Pharmaceutical Corporation. In August 2002, it was announced that the PTRP would be significantly expanded (a 91,000 square-foot facility with 180 acres). The new space will be used for academic and commercial research centers, start-up companies and laboratory operations, needs that are critical for the growth of biotech across the state. This expansion was expected to help create an identity and generate further recognition of Piedmont Triad and Winston-Salem as a technology-based area. The Idealliance depends upon all their partnerships; state partnerships such as that with the North Carolina Biotechnology Center; economic partnerships with local and statewide entities such as the North Carolina Department of Commerce; marketing partnerships with the Piedmont Triad Partnership; local economic development partnerships; city partnerships with local chambers of commerce; entrepreneurial development partnerships, etc.

Both the established and emerging regions are committed to the development and additional growth of the biotech sector. Their different starting positions and strengths, however, imply that they have different ambitions, which are reflected in their strategies. The concluding chapter, chapter five, will present the empirical findings of this study and suggest some major challenges for these regions and established and emerging regions more generally. Moreover, we provide a number of policy recommendations, based on our empirical findings and the experiences that we have generated through this exercise, which are directed primarily at the Swedish policymaking community and biotech community.

5. Partnership Strategies

The purpose of the Regional Innovation and Partnership Project (RIPP) is to support informed public policymaking concerning technology-based economic development by providing policy intelligence that is independent of industrial interests and state-sponsored organizations. This particular study focuses on partnerships and their strategies in biotech regions by examining current trends, innovation capacity, entrepreneurship and commercialization in North Carolina, one of the leading states in the United States in biotech research and commercialization. In addition, it provides an analysis of an established (Research Triangle) and emerging (Piedmont Triad) biotech region. Finally, it examines partnership development in Swedish biotech regions. The information that is generated in this study should be useful not only to the public policymaking community but also to the biotech and life science sector in Sweden. The state of North Carolina, and the regions examined and the distance between them, offers a number of points of comparison with the Swedish biotech sector. This chapter summarizes the findings of this study, suggests some major challenges, and provides policy recommendations for the Swedish public policymaking community and biotech sector.

Searching for a Statewide Strategy

The state of North Carolina has made a strong commitment to the growth of the biotech and life science sector. Several elements in North Carolina touch the biotech sector with some component of state funding, including the university and community college system, regional partnerships such as the regional economic development organizations, and business recruitment and international trade.

North Carolina is diverse in terms of topography, climate, cultures, strengths, and resources. The various regions are almost like separate entities. What works in the Research Triangle may not work in the Piedmont Triad, in the mountains or at the coast. The Piedmont Triad is primarily about biomedical applications. In the eastern part of North Carolina it is more about agricultural applications, and in the western part it focuses a lot on the application of indigenous natural plants in the biotech field. In Charlotte, its strengths in computer and information science can provide a strong platform for bioinformatics. There is not as much commercial activity in the Asheville region as in the Research Triangle or Piedmont Triad. The key in this region has been, first of all, to promote awareness of biotech through an educational effort and explore what it can do for the region’s economy.

The North Carolina Biotechnology Center is working to build a community of informed leaders by getting agenda setters in the regions to better understand biotech, by putting them in a position where they could see the potential benefits of their strengths and resources, and by getting them excited about it. One challenge for this Biotechnology Center, as a statewide economic development and biotech support partnership, is to export development beyond the Research Triangle to other areas of the state. A critical strategic question is how to ensure that

communities across the state reap benefits of growth in biotech and life sciences, on the one hand, and how at the same time to concentrate resources in order to compete nationally and internationally, on the other.

What entity, then, has the overall task and responsibility to function as an institutional and strategic focal point and coordinator in North Carolina and the various regions? The answer to this question is still evolving and the organizational structure is unfolding. Currently, there is no single coherent and comprehensive statewide strategic plan, or coordinating organizational arrangement, to position the state for biotech. The regions in North Carolina seem to be in a situation where positioning strategies have been developed. They have some entrepreneurial strategies to help growing companies in these fields through technology transfer efforts at universities and a number of complementary instruments. But they will probably not have truly comprehensive strategic plans until a statewide strategic direction evolves and all the competencies and capabilities are identified and become part of that strategic plan. A lot remains before any effective public-private partnership at the state level is in place and greater coordination achieved. There is a considerable gap between the management of projects regionally and efforts to enhance concerted action at the state level.

The North Carolina Biotechnology Center (through a flexible model of cluster enhancement, economic development and biotech support) is probably best suited to lead strategic efforts. Part of the mission of the Center and its planned satellite campuses throughout the state will be to coordinate and collaborate on a statewide biotech strategy to identify the capabilities and competencies of each region in the state. Below the key findings are listed.

FINDINGS:

- Strong commitment to biotech (and life sciences and biosciences more broadly), reflected, for example, in significant public investments in and support for research and development and educational institutions.
- The state government, particularly through the Department of Commerce, is actively engaged in business recruitment and promotion of the state's biotech sector in international trade relationships in conjunction with representatives of the state's biotech community and local and regional economic development organizations.
- The biotech sector realizes the need for concerted state and regional efforts and strong public commitment in biotech economic development. The private sector is working in tandem with various public-private partnerships to mobilize resources.
- The biotech community supports a statewide strategic plan and is engaged in a process of identifying all available capabilities and competencies in different regions as a way to build on the existing strengths and the uniqueness of each region.
- Responsibility for developing strategies for the biotech sector is based on and implemented through decentralized and flexible institutional arrangements of cluster enhancement and market-oriented incentive structures.
- Biotech economic development is encouraged as a way to diversify state and regional economies and to reduce vulnerability.

CHALLENGES:

- Develop a comprehensive statewide strategic plan for the biotech and life science sector and assess how this strategic effort should be supplemented in each region with potential to generate a critical mass of, and additional growth in, biotech assets and innovation capacity.
- Support the state-sponsored North Carolina Biotechnology Center in this strategic effort through a flexible model of biotech cluster enhancement, which provides an interesting model for policymaking concerning Swedish biotech development.
- Recognize that this strategic development raises larger questions about overall public investment in biotech in relation to other science- and technology-driven investments in particular, and economic developments in general, and that there is a need to assess how such public investments relate to private investments, and that there is a need to have standards means for evaluating these investments.

A Regional Economic and Biotech Perspective

The report suggests that many conditions for success in science-based and technology-based economic development and innovation are concentrated in a few geographical urban and regional areas. There is sometimes confusion about the roles and responsibilities of the different organizations and about whether the emphasis on different types of initiatives should be at the regional or the local level. This is partly a result of competition; organizations and partnerships compete for private and public money in an environment where there is a limited resource pool to support biotech efforts. At the same time, by not having a truly coordinated approach, regional partnerships are probably not maximizing their efficiencies, and are perhaps even duplicating efforts, which in a time of scarce resources available to support efforts could be a counterproductive approach.

In the more established biotech region, which is one of the leading regions in the world, the focus is on capitalizing on its excellence and success by coordinating the capacity of partnerships. Biotech firms are increasingly being targeted and invited to become active members in various types of partnerships. Data on technology transfer, the number of start-up businesses, and entrepreneurial development are encouraging. The Research Triangle, due to its high level of critical mass in biotech assets, is relatively less vulnerable to economic downturn and more able to raise capital and create potential for homegrown companies. The nature of cluster relationships in the region's biotech sector, and their connections with related sectors, is highly interactive and increases the opportunities to remain at the cutting-edge of technology-based economic development. Specialization and higher concentration seems unavoidable in both established and emerging biotech regions. The region's innovation capacity and strengths in active capital accumulating institutions is higher than in the emerging region. The established region, due to its relatively more dense institutional landscape for capital accumulation appears less vulnerable to intense competition for capital investment, lower levels of capital available and awarded to the biotech sector, and a possible trend among venture capitalists to increase the emphasis on commercial product potential and later-stage manufacturing.

The biotech community in the emerging biotech region particularly needs to promote entrepreneurs and deepen the entrepreneurial spirit, whereas the

established region, which enjoys the advantages of scale, particularly needs to promote further capital utilization in order to gain ground compared to clusters elsewhere.

FINDINGS:

- Biotech economic development is concentrated in specific geographical areas. Regions are aggressively investing in the biotech sector and are competing for capital, companies, talent and tax revenues. The result is intense competition between regions adding an important level of competition to that between companies and institutions.
- The regional level and regional partnerships – and the aggregation of biotech assets at the regional level – are gaining increasing legitimacy as true references for economic development and support for the biotech sector, partly as a result of limited pools of available resources and capital.
- The established region has embarked on a visionary, strategic initiative (through the regional economic development organization and its institutional partners) with the intention of reinventing and reenergizing the regional perspective and developing a regional plan for economic and biotech development.
- The emerging biotech region is engaged in finding ways to implement its positioning strategy for the biotech sector and to foster a regional consensus and identity.
- While the established region welcomes better cooperation between all regional partnerships, its relatively stronger infrastructure and higher performance result in a focus on how to concentrate assets in order to compete at the national and international level, whereas emerging regions are more concerned about regional distribution of resources and investments.

CHALLENGES:

- The established region needs to identify ways to further capitalize on its strengths and successes in innovation performance and implement actions in order to compete with leading and challenging biotech regions.
- The emerging biotech needs to leverage proximity to the more established biotech region and to develop niche capabilities (such as biomanufacturing and bioprocessing) that complement existing strengths and biotech assets. Leveraging the strengths of an adjoining region is an active exercise.
- The emerging region needs to embark on deliberate, sustained actions as a response to strategic initiatives in the proximate established biotech region in order to avoid a future position where it becomes a satellite region supplying labor and services, while the established region attracts the majority of companies, money, talent and publicity. The emerging region should proactively complement the established region's strategies. It could, for example, undertake its own regional strategic assessment and suggest that the established region support the emerging region's industry clusters.
- The emerging region, in particular, should work proactively to nurture a leadership and coordination approach based on a new model of collaboration at the regional level and to move away from a city or county approach. There are no regional institutions of governance, no regional taxing authorities, and no infrastructure existing regionally other than what they build on a voluntary basis.

Regional Partnerships and Strategies for Biotech Innovation

High concentration, depth and quality of institutions of higher education, and effective policies and instruments for academic entrepreneurship and technology transfer of university ideas through decentralized and competitive incentive structures, may encourage further partnership building. This, in its turn, could provide additional legitimacy for the regional perspective. The involvement of broader partnerships with authority to mobilize resources more effectively, and the development and implementation of strategies aimed at promoting stronger innovation systems, may gain broader support in the biotech community,

particularly in emerging regions where the demand for coordination and pooling of common resources appears greater. It is, in a sense, a leadership, cultural and coordination issue where a shared economic vision among regional business leaders, universities and other institutions is indispensable for the capacity to act timely and coherently.

This report states that the dominant partnership model is likely to continue to be based on market-driven institutional arrangements for cluster enhancement throughout the state. The capacity to adjust to external pressures and intense competition remain strong resources since picking winning instruments and policies is by no means an easy task in the biotech field. Moreover, competition for large contracts and grants requires specialization and flexibility. Both the established and emerging biotech regions seem to have a need for more frequent contacts with customers (i.e. other companies), which further reinforce the importance of continuing efforts to generate and support a critical mass of biotech assets and relations.

There is a growing legitimacy for regional strategies and partnership models, partly as a result of continuing regional competition for capital and workforce and business recruitment. Both the established and emerging biotech regions show signs of institutional pluralism, even though the former region has a longer history of learning and greater resources and the latter region has fewer resources available to regional partnerships that are reflected in its relatively more peripheral character and position. Despite the dominant market-oriented dynamics and relationships, the private biotech sector recognizes the need for some degree of coordination in order to mobilize biotech assets and resources and thus strengthen the region as a reference and actor in the race for regional, national and global competitiveness.

The institutions of higher education, particularly in the established biotech region, reveal great capacity in commercializing ideas and inventions and play an important role in contributing to entrepreneurship and economic growth. In the emerging biotech region, a number of actions remain to be implemented in order to build a durable platform for a vital and comprehensive regional partnership. The biotech community in this region is still at the stage of creating an identity and greater internal coherence and consensus about priorities. In addition, with some individual exceptions, this emerging biotech region has been relatively less successful in attracting government grants and contracts. In times of economic downturn and intense competition, this makes such a region vulnerable.

The emerging region’s economic strategy for the biotech sector is intended to promote the high-tech image of the region and to attract public money that could provide greater potential for future investments. The emerging region needs to attract more public grants and contracts. Since the emerging region does not have the same critical mass in biotech assets and infrastructure as more established biotech regions, it is not able to embark on a true challenger’s strategy. Rather, it is more likely to rely on a complementary strategy that strives to leverage proximity to more established regions. It intends to build on its existing strengths and manufacturing heritage by focusing on a niche strategy of promoting and

supporting capabilities in biomanufacturing and bioprocessing, which are relatively less sensitive to research-oriented operations and workforce and prestigious research grants. There may be a need for a comprehensive strategy effort that necessitates more coordination and involvement from the state, which in turn may be at odds with the predominant market-driven model of partnerships.

FINDINGS:

- The importance of nurturing smaller, high-growth businesses is recognized as a crucial strategy for technology-based economic development in combination with recruiting external investments, companies, and talent from outside the region that complement the existing cluster throughout the value chain.
- Competitiveness and regional advantages are reflected in the innovative capacity to attract venture capital to the region and to mobilize early-stage capital accumulation through various types of network organizations, but particularly seed financing for early start-up companies remain a problem.
- There is strong support for a competitive and decentralized university system and bottom-up encouragement of academic entrepreneurship and commercialization of university ideas.
- Providing incentive structures and support for researchers to pursue commercial avenues (e.g., liberal procedures for academic leave, protection of faculty positions, and flexible combinations of entrepreneurship and teaching).
- Strong licensing of infrastructure and dense institutional environment of technology transfer offices that offer cost-reducing and extensive services (e.g., transfer instruments, compensation mechanisms).
- Active encouragement of contacts between university faculty and industry allow for responsiveness to demands from industry and the broader society.

CHALLENGES:

- Continue proactive support for improving and nurturing conditions for early-stage economic development and innovation and for the capturing of new ideas that result from investments in basic research and human capital.
- Increase the relevance of community colleges to meet expected demand for workforce, particularly concerning the fields of biomanufacturing and bioprocessing.
- Provide proactive and forward-oriented promotion of a culture of entrepreneurship that adapts to changes in the market place in a flexible and timely manner and a culture of leadership among business leaders that supports an active approach to economic development.
- Balance competitive models of academic entrepreneurship and supportive approaches to smaller growth companies with a collaborative model among universities and other institutions to reduce conflicts of interest (as a result of increasing competition for funds, talent and prestige) that could hamper the creation of economic value and sustained growth.
- Deepen understanding in university technology transfer and licensing offices about the specific needs of and how to work with start-up companies.

Policy recommendations

In this section we provide a number of policy recommendations, which are aimed primarily at the Swedish policymaking and biotech community (for further reading on Swedish biotech regions in more detail see Appendix 3).

REGIONAL PARTNERSHIP PERFORMANCE

- Encourage regional and inter-regional task forces based on concerted efforts among business leaders, government agencies, economic development bodies, academia and other actors with the objective of analyzing the need for reinventing current models of regional economic and biotech development in order to be well-prepared to make flexible adjustments and to meet changing markets and needs.
- It is important to reassess, on a continuous basis, regional strengths, mechanisms and incentive structures for technology transfer and commercialization, identify what specific actors would complement the existing cluster and value chain and that need to be supported and recruited, and how regional strengths complement those of other regions and what niches should be targeted.
- The strategic development should be based on a grassroots approach whereby business leaders and regional representatives of biotech regions determine on their own how they see biotech as important to the development of their regions and how they want to support reenergized local and regional efforts targeted to that effect. There is a need to recognize the distinct features of each region and to play to their particular strengths by tailoring approaches to maximize impact.

PUBLIC-PRIVATE PARTNERSHIPS

- Support the creation of a national initiative and body aimed at making some of the assessments regarding the effective connection of public and private biotech investments and of encouraging policy discussions about alternative paths and solutions; that is, a body that is independent of specific industries and state-sponsored organizations in its day-to-day activities.
- In times of limited resources and intense competition, reliance cannot only be on present conditions and successes. There is a constant need for concerted, active discussions among business leaders, government agencies, economic development organizations, and community representatives not only at the regional, but also at the national level. The government should actively support this national public-private partnership, which would function as a model for active and concerted strategic efforts with the active participation of high-level business representatives.
- This national initiative should help to promote policy discussions about the complementarities between local, regional and national policies, actions and instruments; that is, what specific policies, actions and instruments could be delegated to, and implemented at, the local, regional, and national level, respectively, and who should provide investments, when and how. Moreover, it should identify critical high-risk projects throughout the country that need support when financial investors are reluctant to step in due to the high risk involved.

CROSS-BORDER POLICY INTELLIGENCE

- Support policy intelligence about international trends concerning evolving regional partnership models and strategies; the relationship between regional concentration and global market pressures: the use of incentive structures, models and mechanisms for commercialization and technology transfer. We have identified the demand for a critical mass of policy intelligence that supports informed public policymaking and evaluations about what is being done and what remains to be done. Representatives of biotech regions cannot be expected to gather such knowledge and information or to generate benchmarks themselves. Government agencies may assist them to collect, analyze and provide such information and knowledge.

A SELECTION OF ADDITIONAL RESULTS FROM THE REGIONAL OPINION SURVEY

- The biotech companies surveyed in the established region appear to regard the following elements of their local and regional innovation system as more problematic, relative to those in the emerging biotech region: larger firms are granted more resources from governments and institutions than smaller, entrepreneurial firms.
- The biotech companies in the established region assign relatively higher scores to the critical importance of higher educational institutions in their region for the formation and effectiveness of regional partnerships: the importance of access to and use of entrepreneurs and institutions of higher education for their businesses in terms of commercialization of intellectual property; and the degree of dependence on entrepreneurial activities for biotech and life science research in their region.
- The biotech companies in the emerging region assign relatively higher scores concerning their activity in regional partnership activities; sharing of knowledge in regional partnerships; the proportion of commercialization that is done entirely within their firms; the importance of marketing the region and stimulating exchange of information as elements in the forming of and participation in regional partnerships.
- The surveyed biotech companies in the emerging region assign lower scores, relative to those in the established biotech region, to the following elements of their local and regional innovation system: specialized facilities for research; institutions that perform basic and applied research; and advanced education; the proportion of licensed technology from local sources; the presence of their specialized suppliers in the region; the overall responsiveness of the state and federal government to their needs and to the nurturing of an entrepreneurial economy in their region; the level of importance of universities, business incubators, suppliers and federal and other laboratories for their companies' commercialization and innovation process.
- The surveyed companies in both regions provide similar scores to the following elements of their local and regional innovation system: the available pool of relevant workers; the impact of regional customers for their products and services; the critical importance of government support for investment in research and development; the effectiveness of cooperation between local governments across administrative borders; the level of importance of financing partners, entrepreneurial partnerships, users and community colleges; research, regional entrepreneurial environment, and infrastructure and supporting technology are crucial to the growth of the biotech sector; partnerships that represent their regions; government actions that should be given priority (speed up regulatory approval in line with product life cycles, enforce intellectual property protection, implement tax reform to encourage investment in innovation, and support the particular needs of start-up companies); the importance of attracting financing to support new programs, stimulating innovation and entrepreneurship, providing business opportunities, stimulating exchange of information, as elements in forming and participating regional partnerships; higher educational institutions are engines for entrepreneurial activities.

Appendix 1: Regional Opinion Survey Results

The participants in the regional opinion survey, which were selected based on local company directories, are all dedicated biotech companies actively involved in some research and development work.[3] In total 122 surveys were distributed and accounted for in the survey process with a response rate of about 32 percent.

	Distributed	Received	Percent Received
Total	122	39	31.97%
Research Triangle	101	28	27.72%
Piedmont Triad	21	11	52.38%

About 75 percent of the surveyed companies are regionally based biotech companies with sales in and outside their region, whereas about a fourth of the companies are units of foreign companies. The majority of the companies defined the primary purpose of their business (the categories of which are based on the national industrial classification of the US Department of Commerce) as research and development in the life sciences (about 67 percent), whereas the remaining companies described their focus as biological product manufacturing (about 13 percent), in-vitro diagnostic substance and pharmaceutical preparation manufacturing (about 8 percent), and medicinal and botanical manufacturing and distribution (about 3 percent). Moreover, most companies (about 86 percent) have 75 or fewer employees and the majority (about 62 percent) of the companies have 25 or fewer employees. Finally, most of the companies (about 83 percent) were established in or after 1996.

Measure	Region	Number of Respondents	Low	Neutral	High
Specialized facilities for research in the region are:	Total	39	7.7%	10.3%	82.0%
	Research Triangle	28	–	10.7%	89.3%
Low=Limited	Piedmont Triad	11	27.3%	9.1%	63.6%
High=Readily available					

Low = 1, 2, 3 *Neutral = 4* *High = 5, 6, 7*

[3] *The selection of companies is based on the North Carolina Biotechnology Center company directory and members of the Piedmont Triad Life Science CEO Roundtable (as of fall of 2002). Excluded from the survey process: Companies that no longer existed but were still listed in company directories; companies that filed for bankruptcy after the survey was distributed; companies that merged to form new entities; companies that only had a sales and liaison office; companies that turned out not to be involved in biotechnology; clinical laboratories and contract research organizations; medical service providers. Both sources (company directories) included medical device manufacturing companies; they were included in the survey process, even though the response rate among these firms was relatively low.*

Measure	Region	Number of Respondents	Low	Neutral	High
The institutions in your region that perform basic and applied research are…for technology transfer	Total	39	7.7%	20.5%	71.8%
	Research Triangle	28	7.1%	14.3%	78.6%
	Piedmont Triad	11	9.1%	36.4%	54.5%
Low=Remote and difficult to approach High=Readily accessible					

Measure	Region	Number of Respondents	Low	Neutral	High
The available pool of relevant biotechnology and life sciences workers in your region is…	Total	39	15.4%	2.6%	82.0%
	Research Triangle	28	10.7%	3.6%	85.7%
Low=Too small and hinders further growth High= Sufficient to promote further growth	Piedmont Triad	11	27.3%	-	72.7%

Measure	Region	Number of Respondents	Low	Neutral	High
Advanced education in your region is…	Total	39	5.1%	5.1%	89.7%
Low=Provide little value to your business	Research Triangle	28	-	3.6%	96.4%
High= Provide substantial value to your business	Piedmont Triad	11	18.2%	9.1%	72.7%

Measure	Region	Number of Respondents	Low	Neutral	High
In terms of proximity, regional customers for your business's products and services…	Total	34	29.4%	23.5%	47.0%
	Research Triangle	24	29.2%	25.0%	45.8%
Low=Provide little feedback that has unusual impact on product offerings High=Provide extraordinary feedback that has unusual impact on product offerings	Piedmont Triad	10	30.0%	20.0%	50.0%

Measure	Region	Number of Respondents	Low	Neutral	High
Specialized suppliers of your business's materials, machinery, and services are…	Total	38	31.6%	18.4%	50.0%
	Research Triangle	27	25.9%	18.5%	55.6%
Low=Mostly not available inside the region High= Mostly available inside the region	Piedmont Triad	11	45.5%	18.2%	36.4%

Measure	Region	Number of Respondents	Disagree	Neutral	Agree
Larger/more resourceful firms in the region are granted more resources/ incentives from governments/institutions than smaller/ entrepreneurial firms leading to an unbalanced resource distribution	Total	39	38.5%	28.2%	33.3%
	Research Triangle	28	39.3%	21.4%	39.3%
	Piedmont Triad	11	36.4%	45.5%	18.2%

Measure	Region	Number of Respondents	<25%	25%-49%	50%-74%	>75%
What proportion of your company's revenues is spent on procurement locally?	Total	29	48.3%	27.6%	17.2%	6.9%
	Research Triangle	21	42.9%	28.6%	19.0%	9.5%
	Piedmont Triad	8	62.5%	25.0%	12.5%	-

Measure	Region	Number of Respondents	<25%	25%-49%	50%-74%	>75%
If your firm purchases research and development services, what proportion is from local sources?	Total	33	45.5%	30.3%	6.1%	18.2%
	Research Triangle	26	42.3%	26.9%	7.7%	23.1%
	Piedmont Triad	7	57.1%	42.9%	-	-

Measure	Region	Number of Respondents	<25%	25%-49%	50%-74%	>75%
If your firm licenses technology, what proportion is from local sources?	Total	28	67.9%	14.3%	7.1%	10.7%
	Research Triangle	22	63.6%	18.2%	9.1%	9.1%
	Piedmont Triad	6	83.3%	-	-	16.7%

Measure	Region	Number of Respondents	Disagree	Neutral	Agree
Lack of access to timely risk capital is an obstacle to the further growth of your firm in the region…	Total	39	23.1%	12.8%	64.1%
	Research Triangle	28	25.0%	7.1%	67.9%
	Piedmont Triad	11	18.1%	27.3%	54.5%

Measure	Region	Number of Respondents	Low	Neutral	High
The Local Government's overall responsiveness and ability to work with the needs of your business and to help nurture an entrepreneurial economy is…	Total	38	23.7%	31.6%	44.7%
	Research Triangle	27	22.2%	33.3%	44.4%
	Piedmont Triad	11	27.3%	27.3%	45.5%

Measure	Region	Number of Respondents	Low	Neutral	High
The State Government's overall responsiveness and ability to work with the needs of your business and to help nurture an entrepreneurial economy is…	Total	38	28.9%	21.1%	50.0%
	Research Triangle	27	22.2%	14.8%	63.0%
	Piedmont Triad	11	45.5%	36.4%	18.2%

Measure	Region	Number of Respondents	Low	Neutral	High
The Federal Government's overall responsiveness and ability to work with the needs of your business and to help nurture an entrepreneurial economy is…	Total	37	37.8%	27.0%	35.1%
	Research Triangle	27	33.3%	25.9%	40.7%
	Piedmont Triad	10	50.0%	30.0%	20.0%

Measure	Region	Number of Respondents	Not so important	Neutral	Critically important
State and local government support for investment in research and development is…	Total	38	10.5%	10.5%	78.9%
	Research Triangle	27	14.8%	7.4%	77.8%
	Piedmont Triad	11	-	18.2%	81.8%

Measure	Region	Number of Respondents	Disagree	Neutral	Agree
Cooperation between local governments across administrative borders in the region is effective in terms of mobilizing resources/setting priorities for the biomedical cluster	Total	35	17.1%	31.4%	51.4%
	Research Triangle	24	16.7%	33.3%	50.0%
	Piedmont Triad	11	18.2%	27.3%	54.5%

Measure	Region	Number of Respondents	Little	Some	Most	Vast Majority
What proportion of research and development is done entirely within your firm, as opposed to by/with partners?	Total	39	2.6%	17.9%	33.3%	46.2%
	Research Triangle	28	3.6%	17.9%	32.1%	46.4%
	Piedmont Triad	11	-	18.2%	36.4%	45.5%

Measure	Region	Number of Respondents	Little	Some	Most	Vast Majority
What proportion of commercialization is done entirely within your firm, as opposed to by/with partners?	Total	32	18.8%	21.9%	28.1%	31.2%
	Research Triangle	22	22.7%	22.7%	36.4%	18.2%
	Piedmont Triad	10	10.0%	20.0%	10.0%	60.0%

Measure	Description of Rating Scale	Number of Respondents	Not so important	Neutral	Critically important
Overall, what is the importance of these surrounding agents for your company's commercialization and innovation process?	Financing partners	39	20.5%	7.7%	71.8%
	Research Triangle	28	17.9%	7.1%	75.0%
	Piedmont Triad	11	27.3%	9.1%	63.6%
	Universities	39	15.4%	15.4%	69.2%
	Research Triangle	28	10.7%	14.3%	75.0%
	Piedmont Triad	11	27.3%	18.2%	54.5%
	Entrepreneurial partnerships	39	35.9%	7.7%	56.4%
	Research Triangle	28	35.7%	7.1%	57.1%
	Piedmont Triad	11	36.4%	9.1%	54.5%
	Users	38	36.8%	10.5%	52.6%
	Research Triangle	28	39.3%	10.7%	50.0%
	Piedmont Triad	10	30.0%	10.0%	60.0%
	Business incubators	39	41.0%	10.3%	48.7%
	Research Triangle	28	28.6%	10.7%	60.7%
	Piedmont Triad	11	72.7%	9.1%	18.2%
	Suppliers	37	45.9%	16.2%	37.8%
	Research Triangle	27	37.0%	14.8%	48.1%
	Piedmont Triad	10	70.0%	20.0%	10.0%
	Federal and other laboratories				
	Research Triangle	39	43.6%	23.1%	33.3%
	Piedmont Triad	28	35.7%	17.9%	46.4%
	Community colleges	11	63.6%	36.4%	-
	Research Triangle	39	69.2%	15.4%	15.4%
	Piedmont Triad	28	75.0%	10.7%	14.3%
		11	54.5%	27.3%	18.2%

Measure	Reasons	Total	Research Triangle	Piedmont Triad
Currently, what are the most important reasons your firm is located in the region? (Choose the five most important reasons)	Number of Respondents: 39 Research Triangle: 28; Piedmont Triad 11			
	Presence of key company founders	76.3%	78.6%	63.6%
	Proximity to university research and development centers	74.4%	78.6%	63.6%
	Access to skilled labor	53.8%	78.6%	54.5%
	Proximity to star scientists and researchers	43.4%	60.7%	36.4%
	Proximity to executives' principal residence	41.0%	46.4%	36.4%
	Prior relationship with local company	33.3%	35.7%	36.4%
	Proximity to private research and development centers	33.3%	35.7%	36.4%
	Business-friendly political environment	33.3%	32.1%	36.4%
	Relative cost of labor	30.8%	28.6%	27.3%
	Low cost of commercial land/property	20.5%	14.3%	27.3%
	Proximity of regional client base	12.8%	7.1%	27.3%
	Ample contract opportunities	10.3%	7.1%	9.1%
	Low tax burden	7.7%	7.1%	9.1%
	Potential market opportunities	7.7%	7.1%	-
	Proximity to competing firms	5.1%	7.1%	-
	Proximity of regional suppliers	-	-	-

Measure	Reasons	Total	Research Triangle	Piedmont Triad
Over the next five years, what do you see as crucial to the growth of biotechnology and life sciences companies in the region? (Choose the three most important reasons)	Number of Respondents: 38 Research Triangle: 27 Piedmont Triad: 11			
	Research	63.2%	66.7%	63.6%
	Regional entrepreneurial environment	60.1%	59.3%	54.5%
	Infrastructure and supporting technology	50.0%	48.1%	54.5%
	Quality of labor	34.2%	33.3%	54.5%
	Demand	31.6%	25.9%	27.3%
	Cost reduction	23.7%	22.2%	27.3%
	Patents	21.1%	11.1%	9.1%
	Quality of education	15.8%	11.1%	-
	Contracts	7.9%	7.4%	-
	Flexible leasing agreements	2.6%	3.7%	-

Measure	Description of Rating Scale	Number of respondents	Not important	Important	Critically important
How important is each of these government actions at various levels in terms of innovation, as a priority or continuing priority over the next five years?	Speed up regulatory approval in line with product life-cycles	38	10.5%	10.5%	78.9%
	Research Triangle	28	10.7%	10.7%	78.6%
	Piedmont Triad	10	10.0%	10.0%	80.0%
	Enforce intellectual property protections	38	5.3%	18.4%	76.3%
	Research Triangle	28	3.6%	17.9%	78.6%
	Piedmont Triad	10	10.0%	20.0%	70.0%
	Implement tax reform to encourage investment in innovation	38	5.3%	26.3%	68.4%
	Research Triangle	28	3.6%	28.6%	67.9%
	Piedmont Triad	10	10.0%	20.0%	70.0%
	Support the particular needs of start-up companies	38	13.2%	21.1%	65.8%
	Research Triangle	28	10.7%	21.4%	67.9%
	Piedmont Triad	10	20.0%	20.0%	60.0%
	Catalyze government-industry-academic partnerships	37	16.2%	32.4%	51.4%
	Research Triangle	27	14.8%	37.0%	48.1%
	Piedmont Triad	10	20.0%	20.0%	60.0%
	Simplify compliance procedures for government regulations	38	13.2%	39.5%	47.4%
	Research Triangle	28	14.3%	42.9%	42.9%
	Piedmont Triad	10	10.0%	30.0%	60.0%
	Increase government support for funding of specialized facilities	38	18.4%	36.8%	44.7%
	Research Triangle	27	25.9%	29.6%	44.4%
	Piedmont Triad	11	-	54.5%	45.5%
	Increase funding for university-based research	37	18.9%	40.5%	40.5%
	Research Triangle	27	22.2%	44.4%	33.3%
	Piedmont Triad	10	10.0%	30.0%	60.0%
	Promote specialized education/training to upgrade worker skills	39	30.8%	30.8%	38.5%
	Research Triangle	28	28.6%	28.6%	42.9%
	Piedmont Triad	11	36.4%	36.4%	27.3%
	Reform liability laws to reward new product innovation/safety	34	20.6%	41.2%	38.2%
	Research Triangle	25	16.0%	36.0%	48.0%
	Piedmont Triad	9	33.3%	55.6%	11.1%
	Promote antitrust legislation to encourage competition	37	67.6%	13.5%	18.9%
	Research Triangle	27	70.4%	7.4%	22.2%
	Piedmont Triad	10	60.0%	30.0%	10.0%

Provide services to assist and promote regional exports	36	47.2%	38.9%	13.9%
Research Triangle	26	57.7%	38.5%	3.8%
Piedmont Triad	10	20.0%	40.0%	40.0%
Assist in attracting suppliers/service providers from other regions	38	52.6%	36.8%	10.5%
Research Triangle	28	57.1%	35.7%	7.1%
Piedmont Triad	10	40.0%	40.0%	20.0%

Not at all important Slightly important= 1, 2 Important = 3 **Very important** Critically important = 4, 5

Measure	Region	Number of Respondents	Ineffective	Neutral	Very Effective
Partnerships and organizations that represent your region are… in promoting your business	Total	39	17.9%	33.3%	48.7%
	Research Triangle	28	17.9%	32.1%	50.0%
	Piedmont Triad	11	18.2%	36.4%	45.5%

Measure	Region	Number of Respondents	Rarely	Neutral	Frequently
Your organization participates in partnership activities…	Total	39	28.2%	2.6%	69.2%
	Research Triangle	28	28.6%	-	71.4%
	Piedmont Triad	11	27.3%	9.1%	63.6%

Measure	Region	Number of Respondents	Rarely	Neutral	Frequently
Firms and organizations in partnerships in which your firm participates share knowledge…	Total	39	23.1%	7.7%	69.2%
	Research Triangle	28	28.6%	10.7%	60.7%
	Piedmont Triad	11	9.1%	-	90.9%

Measure	Description of Rating Scale	Number of respondents	Not important	Important	Critically important
What is the importance of forming and participating in partnerships in the region?	Attract financing to support new programs	38	15.8%	21.1%	63.2%
	Research Triangle	27	18.5%	22.9%	59.3%
	Piedmont Triad	11	9.1%	18.2%	72.7%
	Stimulate innovation and entrepreneurship	38	15.8%	23.7%	60.5%
	Research Triangle	27	18.5%	25.9%	55.6%
	Piedmont Triad	11	9.1%	18.2%	72.7%
	Provide business opportunities	38	18.4%	26.3%	55.3%
	Research Triangle	27	25.9%	25.9%	48.15
	Piedmont Triad	11	-	27.3%	72.7%
	Stimulate exchange of information	37	16.2%	29.7%	54.0%
	Research Triangle	26	19.2%	38.5%	42.3%
	Piedmont Triad	11	9.1%	9.1%	81.8%
	Market the region	37	32.4%	24.3%	43.2%
	Research Triangle	26	42.3%	23.1%	34.6%
	Piedmont Triad	11	9.1%	27.3%	63.6%
	Encourage commitment by business leaders	38	23.7%	34.2%	42.1%
	Research Triangle	27	29.6%	22.2%	48.1%
	Piedmont Triad	11	9.1%	63.6%	27.3%
	Help providing access to supporting technology	36	36.1%	25.0%	38.9%
	Research Triangle	26	42.3%	23.1%	34.6%
	Piedmont Triad	10	20.0%	30.0%	50.0%
	Develop innovative programs to fill needs	38	28.9%	34.2%	36.8%
	Research Triangle	27	29.6%	33.3%	37.0%
	Piedmont Triad	11	27.3%	36.4%	36.4%
	Clarify the needs of companies and entrepreneurs	37	16.2%	48.6%	35.1%
	Research Triangle	27	11.1%	63.0%	25.9%
	Piedmont Triad	10	30.0%	10.0%	60.0%
	Promote regional identity	38	34.2%	31.6%	34.2%
	Research Triangle	27	44.4%	29.6%	25.9%
	Piedmont Triad	11	9.1%	36.4%	54.5%
	Help allocating regional resources effectively	37	45.9%	24.3%	29.7%
	Research Triangle	26	50.0%	26.9%	23.1%
	Piedmont Triad	11	36.4%	18.2%	45.5%
	Set common priorities	35	28.6%	42.9%	28.6%
	Research Triangle	25	36.0%	44.0%	20.0%
	Piedmont Triad	10	10.0%	40.0%	50.0%

Help increasing relevance of regional policy	38	34.2%	39.4%	26.3%
Research Triangle	27	40.7%	37.0%	22.2%
Piedmont Triad	11	18.2%	45.5%	36.4%
Help bringing local companies into the fold	38	44.7%	31.6%	23.7%
Research Triangle	27	51.9%	29.6%	18.5%
Piedmont Triad	11	27.3%	36.4%	36.4%
Help providing education/training for small firms	37	37.8%	40.5%	21.6%
Research Triangle	27	48.1%	33.3%	18.5%
Piedmont Triad	10	10.0%	60.0%	30.0%

Not at all important Very important

Slightly important= 1, 2 Important = 3 Critically important = 4, 5

Measure	Region	Number of Respondents	Disagree	Neutral	Agree
Higher educational institutions are engines for entrepreneurial activities…	Total	38	10.5%	7.9%	81.6%
	Research Triangle	28	10.7%	10.7%	78.6%
	Piedmont Triad	10	10.0%	10.0%	80.0%

Measure	Region	Number of Respondents	Not important	Neutral	Critically important
How important are the higher educational institutions in the region for the formation and effectiveness of regional partnerships?	Total	39	12.8%	23.1%	64.1%
	Research Triangle	28	10.7%	14.3%	75.0%
	Piedmont Triad	11	18.2%	45.5%	36.4%

Measure	Region	Number of Respondents	Not important	Neutral	Critically important
How important is access to and use of these resources for your company in terms of commercialization of intellectual property?	Entrepreneurs	39	28.2%	12.8%	59.0%
	Research Triangle	28	21.4%	14.3%	64.3%
	Piedmont Triad	11	27.3%	27.3%	45.5%
	Institutions of higher education	37	21.6%	21.6%	56.8%
	Research Triangle	26	19.2%	19.2%	61.5%
	Piedmont Triad	11	45.5%	9.1%	45.5%
	Federal laboratories	36	38.9%	25.0%	36.1%
	Research Triangle	27	40.7%	25.9%	33.3%
	Piedmont Triad	9	33.3%	22.2%	44.4%

Measure	Region	Number of Respondents	Insignificantly	Neutral	Significantly
In the region, entrepreneurial activities depend on biotechnology and life science research…	Total	39	5.1%	10.3%	84.6%
	Research Triangle	28	-	3.6%	96.4%
	Piedmont Triad	11	18.2%	27.3%	54.5%

Measure	Region	Number of Respondents	Regionally based, regional sales	Regionally based, sales in region and outside	Unit of U.S. company based elsewhere	Unit of foreign company
Which best describes the organization in which you work?	Total	33	-	75.8%	-	24.2%
	Research Triangle	24	-	79.2%	-	20.8%
	Piedmont Triad	9	-	66.6%	-	33.3%

Measure	Number of Respon-dents	Medicinal and botanical manufactu-ring	Pharma-ceutical prepa-ration manu-facturing	In-vitro diagnostic substance manu-facturing	Biological product (excl. diagnostic) manufactu-ring	Research and Develop-ment in the Life Sciences	Distri-bution
Region							
Which best describes the primary focus of your business?	Total 39	2.6%	7.7%	7.7%	12.8%	66.7%	2.6%
	Research Triangle 28	-	7.1%	7.1%	14.3%	71.4%	-
	Piedmont Triad 11	9.1%	9.1%	9.1%	9.1%	54.5%	9.1%

Measure	Region	Number of Respondents	<25	25-50	50-75	75-100	100-250	>250
Approximate number of employees in your company in the region	Total	37	62.2%	8.1%	16.2%	-	8.1%	5.4%
	Research Triangle	26	65.4%	7.7%	15.4%	-	7.7%	3.8%
	Piedmont Triad	11	54.5%	9.1%	18.2%	-	9.9%	9.1%

Measure	Region	Number of Respondents	1981-1990	1991-1995	1996-2000	2001-present
When was your business founded?	Total	30	10.0%	6.7%	56.7%	26.7%
	Research Triangle	24	12.5%	4.2%	54.2%	29.2%
	Piedmont Triad	6	-	16.7%	66.7%	16.7%

Appendix 2: Partnership Models in North Carolina

Function	Model	Funding	Partnership
State-Regional Partnerships			
Strategy Investment Training/Education	Public-private partnership	State government Private membership	North Carolina Biotechnology Center
Business Recruitment International Trade	Government	The US Small Business Administration and the University of North Carolina University public system	North Carolina Department of Commerce
Strategic Advice	Government	Federal and state government	Small Business and Technology Development Center (SBTDC)
Regional Partnerships			
Development Recruitment	Public-private partnership	State government: 50% Private: 50%	Research Triangle Regional Partnership
		State government: 50% Private: 30% Local government: 20%	Piedmont Triad Partnership
Entrepreneurism	Membership organization	Privately funded	Council for Entrepreneurial Development (CED)
			Piedmont Entrepreneurs Network (PEN)
			Triad Entrepreneurial Initiative (TEI)
Early stage capital	Membership organization	Privately funded	Piedmont Angels Network
Cluster Enhancement	Informal partnership		Life Sciences CEO Roundtable
Local-Regional Partnerships			
Technology Infrastructure	Public-private partnership	Private investors	Research Triangle Foundation
		Private investors Colleges and universities Local government	Idealliance

Appendix 3: Biotech Regions in Sweden

The biotech regions in Sweden are actively working to support stronger and more effective cooperation between universities, research institutes, hospitals, industry, local and county governments, and other relevant actors. Before presenting the policy recommendations, this section provides some information about the current status and developments concerning partnerships and geographical concentration. These regions share similar characteristics, including the distance between their major metropolitan areas and the question of concentration and distribution of resources, with the ongoing developments in North Carolina and the established and emerging biotech regions that we have examined and analyzed in this report.

A Consolidated Biotech Region: Medicon Valley

The Medicon Valley, with a total population of about 3 million people, consists of the Malmö and Lund metropolitan areas in southern Sweden and Copenhagen in Denmark. It has a high regional concentration of hospitals, universities, research parks, and pharmaceutical, biotech and medical technology companies and service providers. It is one of the leaders in Europe in the area of biomedicine and health care. It started as a cooperation agreement between the universities in the larger Öresund region with Lund University and Copenhagen University as the principal actors. This partnership was financed through the public universities in three years up to year 2000. In addition, it was financed through a European Union project. On the Danish side, funds went to a promotion agency, Copenhagen Capacity, where the owners were in the counties in and around the City of Copenhagen. On the Swedish side, though, the funding went to a part of Region Skåne organization that was responsible for promotion. The Medicon Valley Academy was indirectly linked to these promotion agencies, which handled the international promotion of the Öresund and Medicon Valley region.

EXHIBIT 27
The Medicon Valley

Source: Medicon Valley Academy, 2003

In the spring of 2000, the initial phase of the project ended and the idea and ambition was that the users and members would finance the Medicon Valley Academy and they formed a private not-for-profit organization and recruited members from not only the large universities, but also smaller universities and colleges with medical research and education, hospitals, and about 250 companies (about 100-120 biotech companies, 60-70 medical technology companies, service providers and other related companies, patent organizations, and local and county government entities. Medicon Valley Academy entered the next phase in the partnership development process and went from being a public and state-financed organization to a private not-for-profit organization based on membership. Several members are public organizations but they exercise influence through their membership fees and not through top-down planning. In the spring of 2003, a new promotion agency, Position Skåne, was created under the Region Skåne. New organizations are being launched through Lund University in the Medicon Valley (for example, information technology, food, and the environment), which are based on the same model as the initial stages of the Medicon Valley Academy; that is, a university-driven model with public funding from the universities and other public sources that after some years will become more market-driven and seek membership financing, although they may rely relatively more on mixed private-public financing than the Medicon Valley Academy. At the same time, there is a possible trend in the latter partnership organization toward more mixed financing.

Some of its members point out that many of the results that originate from the partnership activities represent investments with public impact (company establishments, stronger tax base, growth) and other actors (such as local governments) benefit from their investments and should thus contribute and co-finance activities.

In the Swedish context, the Medicon Valley is ahead in the partnership development process and has benefited from the branding effect based on the perception that it is a new and successful model, although it is not unique internationally. They have been working on their model since 1997 and partnership development takes time. The Medicon Valley Academy has a structured and coordinated organization, has achieved a consolidated and mature stage, and has a relatively stronger emphasis on the individual actors as members. It is seen as a bottom-up process.

Medicon Valley is active in further positioning the region. New partnership arrangements are created, designed for this purpose: associate membership and strategic partnerships. For example, the Kalmar region has become the first associate member of the Medicon Valley Academy and has, in principle, all the benefits of full members with the exception that it cannot select the board and thus not change the basic concept of Medicon Valley. Regarding strategic partnerships, the region now works closely with the emerging bioregion partnership between Göteborg, Västra Götaland and Oslo, with the University of Southern Denmark, and the Mecklenburg-Vorpommern region that has launched the BioCon Valley. It also forms part of the much larger ScanBalt Bioregion initiative, which is a virtual cooperation network from Iceland and Oslo all the way around the Baltic Sea up to Finland, supported financially by the Nordic Industry Fund, which has the overall objective of improving regional capabilities and strengthening the capacity to compete globally.

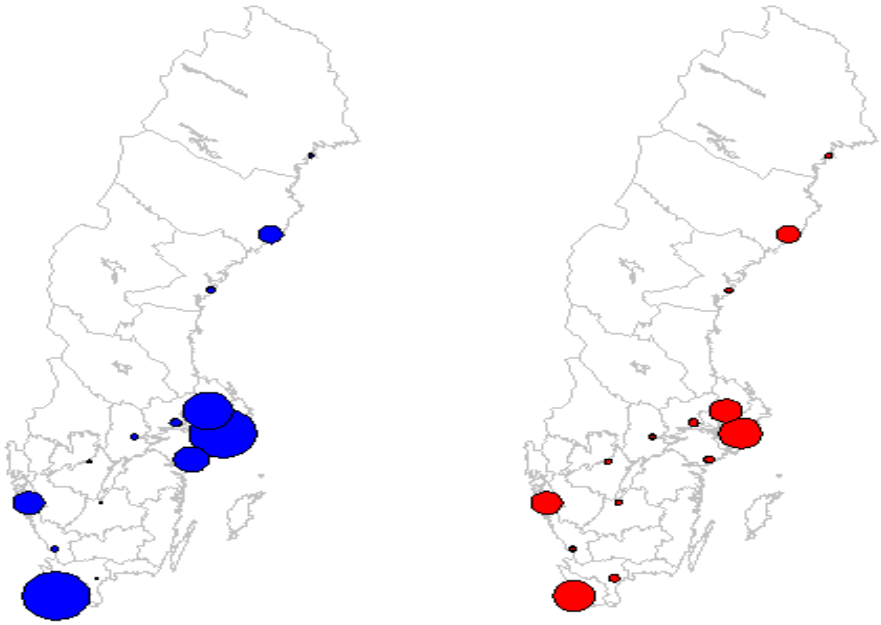
A Biotech Region under Transformation: Stockholm-Mälardalen-Uppsala

The greater Stockholm-Mälardalen-Uppsala region is the most research and development-intensive region in Sweden (with about 60 percent of the country's biotech research and development). It has more than half of the country's biotech companies, seven universities, a number of professional research institutes, three university hospitals, clinical research organizations, and a relatively high number of venture capital companies. It also benefits from the presence of the Medical Products Agency, the Swedish national authority responsible for regulation and surveillance of the development, manufacturing and sale of drugs and other medicinal products.

EXHIBIT 26
Regional distribution of the Swedish biotech industry, 1999*

NUMBER OF EMPLOYEES

NUMBER OF COMPANIES



Source: The Swedish Biotechnology Innovation System*, Vinnova 2001:2 (Authors: Anna Sandström, Lennart Norgren et al.). *The sizes of the circles are proportional to the number of employees and companies and include only micro- and small-sized companies (<200 employees) are included. Distribution is based on the seat of the county government. There have not been any significant changes since 1999.*

The Stockholm-Mälardalen-Uppsala region is at an earlier stage of the partnership development process than Medicon Valley. Many clusters start from a top-down process where regional and local actors apply for funding from the government and state-sponsored bodies. This is true for this region, as it was for Medicon Valley in the late 1990s, where a number of central actors have observed developments elsewhere and wanted to act.

The activities and projects organized by the state-sponsored Swedish Agency for Innovation Systems (Vinnova) functioned as a catalyst to mobilize regional partnership activities. The Uppsala region represented a pilot case. A number of test projects were initiated and to some extent this region had a certain lead in thinking about regional partnerships and innovation systems in the Stockholm-Mälardalen-Uppsala region. The Uppsala biotech region has a large number of smaller companies and it is particularly strong in methods, models and instruments for biotech research and pharmaceutical development. The overall leadership in the region is provided by the Foundation for collaboration between the universities in Uppsala, business and science (STUNS), which functions as a regional forum for coordinating initiatives for regional economic development. No specific organization has existed in the past to support and target the biotech sector. In

January 2003, this regional umbrella body adopted a strategy whereby, for example, the operational leadership for the biotech sector, including the tasks of implementing an action plan and further elaborate the strategy, was delegated to the new Uppsala Bio partnership, which is organized as a project under the Chamber of Commerce for Uppsala county. Its members include representatives from Pharmacia Diagnostics, Amersham Biosciences, Uppsala University, Swedish University for Agricultural Sciences, and the Uppsala local government.

When the Vinnova program started in 2002, actors in the Stockholm region formed a regional partnership that consisted of public actors, the university world and some industrial interests. They subsequently redefined this region to include the area stretching from Solna down to Strängnäs, which was a new concept. In Strängnäs, for example, they had pursued a local cluster initiative (Biotech Valley) for about two years before the Vinnova program was launched. This initiative is relatively more driven by companies, and is the result of the focus on another sector of the biotech field; the area between identifiable products to process development and production, which in turn was the result of the presence of the large Pharmacia complex in Strängnäs which is working on growth hormones. The industrial link has therefore been quite natural in this local cluster.

At the same time, this niche strategy in Strängnäs, which has similarities with the focus on manufacturing in the emerging Piedmont Triad partnership in North Carolina, triggered a desire to interact more closely with the Stockholm-Uppsala region and Stockholm BioRegion in order to leverage the proximity of the Strängnäs region and tap into and benefit from the resources of the larger region more effectively. Stockholm BioRegion is a regional partnership with members from the private sector, various universities and research institutes, and the public sector. Much of the partnership activity at the operational level is and will be coordinated by the Business Arena Stockholm (BAS), the official inward investment agency for the Stockholm-Uppsala region.

The relationship between the Stockholm and Uppsala biotech regions has been marked by historical differences and variation in development trajectories. There are a number of forces that push this region into becoming more active and transforming its past partnership models. From an international viewpoint, the Stockholm and Uppsala regions are hardly distinguishable as separate from each other. It seems natural to develop further cooperation. In addition, Medicon Valley Academy membership financing has come to function as a benchmark model and has made it more difficult not to apply a more market-oriented and bottom-up form of partnership arrangement. In the Stockholm-Mälardalen-Uppsala region, research groups and companies have not been taken the lead but rather decision makers in the policymaking community. This is a natural occurrence in regions that is at an early stage in the partnership development process.

This brings us to point out some factors that is likely to be important for the current partnership transformation process in this region: the combination of (1) an advanced infrastructure and world-class quality of research and infrastructure that has reduced the perceived need and pressure to proactively build new partnerships,

(2) its geographical position that is no longer necessarily as advantageous as it has been in the past, and (3) increasing regional competition from other strong biotech regions in Sweden and abroad. The Stockholm-Mälardalen-Uppsala region has had a strong and obvious position as a leading biotech region, but does not have the same partnership coordination and structure as that in Medicon Valley. Medicon Valley has to some extent a better geographic position in relation to the population-dense areas and markets in Europe. The building of the Öresund Bridge was a catalyst and had a positive psychological and symbolic impact on cross-border partnership activities and positioning. In addition, strong university research at Lund University is more closely tied to the larger population centers of Copenhagen and Malmö. While the Stockholm-Mälardalen-Uppsala region is still the leading region in terms of, for example, the quality of research, Medicon Valley is larger in size and has a stronger identity and brand, which is recognized in the Mideastern parts of Sweden and elsewhere. The Stockholm-Mälardalen-Uppsala region is more or less at the same stage of the partnership development process as Medicon Valley was in the late 1990s.

In parallel with work in the Stockholm BioRegion partnership, there was a discussion about how to achieve long-term cooperation that covered all work in and interaction with the Uppsala region. This strategic discussion on the necessity of strengthening cooperation, branding, and common strategies resulted in an initiative through the county governor of Stockholm, Mats Hellström, who contacted his counterparts in the counties of Uppsala (Anders Björck) and Södermanland (Bo Holmberg), high-level industrial representatives (Per From, CEO of Astra Zeneca AB, Björn Nilsson, CEO of KaroBio AB, Mats Pettersson, CEO of BioVitrum AB, and Håkan Åström, CEO of Pharmacia AB), and a number of university professors, such as Mathias Uhlén, professor in biotech at the Royal Institute of Technology, and Hans Wigzell, dean of the Karolinska Institutet and advisor to the Swedish Prime Minister Göran Persson. A new regional strategy group was formed for the Stockholm-Mälardalen-Uppsala region (including Uppsala, Solna, Stockholm, Huddinge, Södertälje and Strängnäs) at the same time as separate applications from Stockholm and Uppsala biotech regions were addressed to Vinnova. The intention of this regional strategy group is to influence other actors with its political-industrial weight.

EXHIBIT 28
The Stockholm-Mälardalen-Uppsala Region

Source: Biotechvalley.nu, 2003

The working name for the Stockholm and Uppsala interregional group became known as Standup Bio Region. In early 2003, Stockholm BioRegion, Uppsala Bio and Sweden Bio, the new industry organization, announced its ambition of developing the Stockholm-Mälardalen-Uppsala region into one of three leading biotech regions in Europe by 2006 and one of the worlds top-ten biotech regions by 2010. There existed already some de facto cooperation between actors in these regions, such as in the field of marketing and inward investment through Business Arena Stockholm, but the larger Stockholm-Mälardalen-Uppsala region had not been as successful in generating a common identity as had Medicon Valley in southern Sweden. The pressure to transform partnerships is an integral part of the thinking among the actors behind the new strategic approach to regional partnership. The county governor of Uppsala, for example, has reputedly presented a partnership model in March 2003 that in many respects is identical to that which has been pursued by the Medicon Valley Academy in southern Sweden, which is probably an effect of increasing competition.

Regional Consolidation and Diffusion

Another regional actor in the Swedish biotech sector with significant potential is the Göteborg region, which has been active in recent years in innovation policy from perhaps a relatively weaker starting position. It has a strong industrial position. Actors in this region have formed their strategy based on their strengths, which include the biomaterial field around Göteborg University. There are active discussions over cooperating with other regions such as Oslo in Norway.

In addition to the biotech regions with higher innovation capacity and performance, there are a number of smaller regions such as Linköping and Umeå. Linköping has the ambition of investing significant resources but faces the problem of geographical distance to the larger regions. The Umeå region has enjoyed an excellent and dynamic university research environment, not least within the field of molecular biology, but its industrial impact has been weaker. Kalmar has made a strong academic investment, through Kalmar Bioscience, in order to be on the radar screen, but this concept may not yet be very visible outside of Sweden. In

terms of geography and concentration of assets, there seems to be an ongoing process of regional consolidation in conjunction with a clearer division between larger regional innovation environments with relatively strong and broad partnerships (Lund-Malmö, Stockholm-Mälardalen-Uppsala, and Göteborg) on the one hand, and a number of regional academic-oriented environments (such as Kalmar, Linköping, and Umeå) that conduct research and educate and train people (even though local and county politicians may have higher ambitions for their local academic investments). Without a strong network that involves industry from the start, it will not be an easy task to create a competitive biotech region despite excellent academic research. Our analysis of current trends in North Carolina, and our empirical findings and suggestions regarding major challenges facing established and biotech regions, provide information and policy intelligence that will be useful for the Swedish policymaking and biotech community.

The examination of partnership development in Sweden and North Carolina offers insights into strategies and partnerships for biotech regions. We have chosen to position some of these regions according to the stage in the partnership development process (consolidation; transformation; emergence) in which they find themselves and to their overall model of partnership and financing (a bottom-up, pluralist partnership model based on membership financing; a mixed model of private and public co-financing; and a top-down model that relies significantly more on public funding than the two former models). Naturally, this table is a simplification of a more complex reality, but it should provide an approximate qualitative indication about variation in partnership development and models.

EXHIBIT 29
Partnership Development and Model

	PARTNERSHIP MODEL AND FINANCING		
	Consolidation	Transformation	Emerging
PARTNERSHIP MODEL AND FINANCING			
Top-down		Stockholm-Mälardalen- Uppsala	
Mixed			
Bottom-up	Medicon Valley Research Triangle		Piedmont Triad

Appendix 4: Partnership Models in Sweden

Function	Model	Funding	Partnership
National Initiatives			
International marketing and promotion	Public-private partnership	State-funded Ministry of Foreign Affairs	Invest in Sweden Agency "The Biotech Project"
International promotion	Government	State-funded	Ministry of Industry, Employment and Communications
Regional growth and innovation support	State-sponsored agency Public-private partnership Initiative to support regional growth through "dynamic innovation systems"	State-funded Ministry of Education and Science Ministry of Industry, Employment and Communications	Vinnova, The Swedish Agency for Innovation Systems The VINNVÄXT program
Strategic research initiative	Public-private partnership in the field of biological and behavioral research of the nervous system and various application areas	Combination of support from state-sponsored organizations and private research foundations	*Swedish Brain Power* Invest in Sweden Agency Knowledge Foundation Foundation for Strategic Research Wallenberg Foundation Vårdal Foundation
Interest organizations	Business to business	Private	BioteknikForum SwedenBio
Regional Partnerships			
Development Promotion	Public-private partnership Membership organization		*Lund-Malmö region* Medicon Valley Academy Region Skåne Position Skåne
Development Promotion	Public-private partnership	Co-financing model The funding from the regions to match funds from Vinnova has largely come from local and country governments, together with university resources (e.g. time)	*Stockholm-Mälardalen-Uppsala region* Standup Bio Region Stockholm BioRegion Uppsala Bio (CoC) Biotech Valley Business Arena Stockholm

Development Promotion	Public-private partnership	Local and county governments	*Göteborg region* Business Region Göteborg Medicinsk Framtid i Väst
Development Promotion	Public-private partnership	Local and county governments	Linköping region
Development Promotion	Public-private partnership	Local and county governments	Umeå region

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