Technology Acquisition Strategies in Pharmaceutical Companies through Equity Investment, Alliance and Acquisition

by

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ABSTRACT

The pharmaceutical industry is now confronted with a discontinuous time period, especially in terms of its technology. In order to maintain their advantageous positions in the industry, pharmaceutical companies have to invest not only in internal R&D but also in external sources, since technologies in the industry are too broad to enable a company to cover all of the new technologies. Allotment of investment in internal and external R&D, however, is hard to determine; moreover, the selection of targets and styles of external technology acquisition by pharmaceutical companies requires deep deliberation on all the scientific and business aspects.

In this thesis, I have analyzed the correlation between technology acquisition activities and the internal technological strength, or product development, in nine pharmaceutical companies in three countries: U.S., Japan, and Germany.

Styles of technology acquisition deals vary among the three countries. German companies showed the most aggressive technology acquisition strategies in overall technology deals. U.S. companies exhibit strong technology acquisition strategies with prominent equity investment deals. Japanese companies were discreet about their technology acquisition deals, although they showed a similar degree of eagerness for product acquisition. The number of technology acquisition deals by Japanese companies, however, has increased during the past two or three years.

A positive correlation between the number of all deals and product development (the number of pre-clinical drug candidates) was detected. On the other hand, there is no clear correlation between technology creation deals or technology frontier deals and product development.

In order to assimilate the growing amount of external property, pharmaceutical companies must consider setting up an appropriate management organization because the deals between biotech enterprises and pharmaceutical companies involve dissimilar organizations in terms of culture, size, power, and expertise. I studied the organization of alliance management in Eli Lilly as an example.

Thesis Supervisor: Edward B. Roberts
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CHAPTER 1

Introduction

1.1 A PHARMACEUTICAL INDUSTRY OVERVIEW FROM A TECHNOLOGY ACQUISITION PERSPECTIVE

Since the late 1980s, the pharmaceutical industry has gone through a period of mergers and acquisitions as the large pharmaceutical companies strive for greater economies of scale for R&D and marketing. This phase has been driven in part by shareholder expectations of steady and substantial growth and in part by the rapid globalization of pharmaceutical businesses. The intent was to acquire complementary R&D and marketing skills, fulfill the companies' product pipelines, and expand their presence in the worldwide market.

Despite the media's scrutiny and celebration of these M&As, the performances of the merged companies have not necessarily been enhanced if considered on the basis of their research performance and/or the extent of the product pipeline (*Business Week*, 12/99). The giant global companies that became connected through ownership may not be able to keep up with the speed of business in this new era (Thompson, 2001).

As new technologies, such as genome technology and information technology, emerge and the pace of technological growth accelerates, unprecedented capabilities are required just to stay competitive with other companies. Uncertainty about new technologies

in many cases pushes companies into strategic alliances rather than acquisition as a means of reducing expensive investment. Actually, the number of alliances in the pharmaceutical industry has increased by more than 500% since early 1990 (Thought Leadership Series Report, 1998). In addition, the last twenty years have seen the emergence of many small, nimble biotechnology[1] companies (Appendix 1 for a representative sample) that specialize in niche areas of drug discovery and development, and the technologies that have emerged recently have been applied more frequently than ever. Equity investment is also considered as a strategy for obtaining innovative technologies.

In recent years, business trends in the pharmaceutical industry appear to be changing. Companies have strengthened their performance and presence by opening their minds, cooperating even with rivals, instead of remaining independent and barricading themselves inside their own territories. Also, companies have invested in and/or encouraged startups to enhance their core competencies and incorporate innovative skills and knowledge. Figure 1 illustrates the general strategy pursued to introduce technology from external sources.

Some biotech companies, like Amgen and Elan, have strengthened not only their core competencies but also have expanded their business capabilities through aggressive acquisition and alliance strategies, thereby becoming "biopharmaceutical" companies or mid-sized pharmaceutical companies. With yet another challenge, traditional pharmaceutical companies cannot cling to obsolete business strategies, such as pursuing only economies of scale or depending solely on internal technology development. A key challenge, then, for biotech companies and pharmaceutical corporations is to learn from collaborations with

[1] Biotechnology is defined as the application of scientific knowledge to transfer beneficial genetic traits from one species to another to enhance or protect an organism. Leaders in biotechnology development apply

external parties, and to construct portfolios of collaborators that enable access to both emerging science and technology and the requisite organizational capabilities (Powell, 1998).

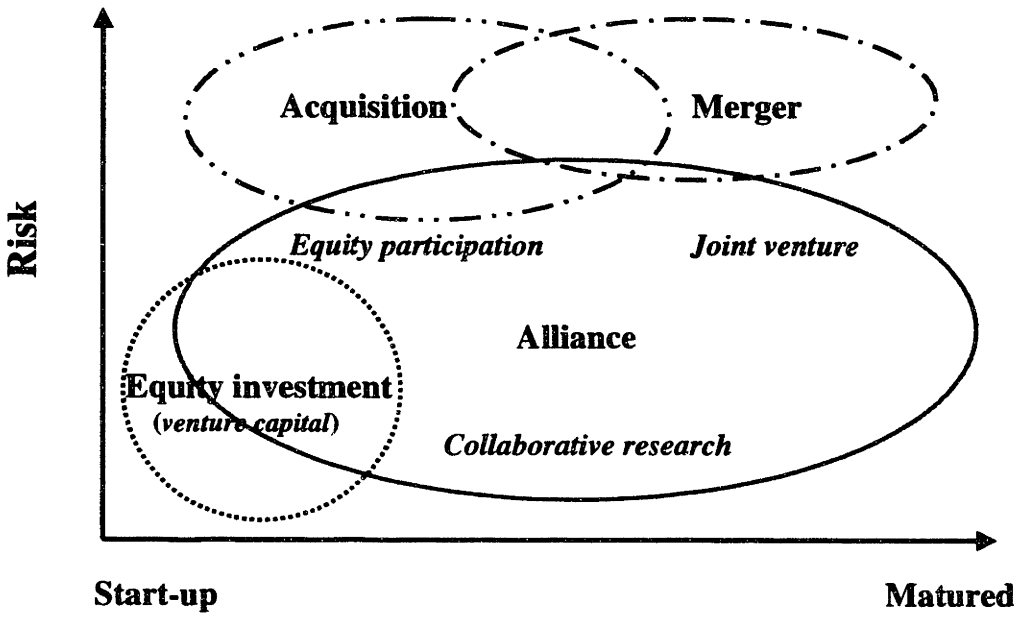


Fig. 1. Strategies of Technology Acquisition Strategy

Source: Muranishi (author)

In this thesis, I will investigate technology acquisition strategies, namely, acquisition, alliance, and equity investment, in pharmaceutical companies. Then I undertake a series of comparative studies with three pharmaceutical companies in three major drug development regions, the U.S., Europe, and Japan (3 companies x 3 regions = 9 companies). My final analysis involves a case study of a successful company that has developed an institutionalized organization for technology acquisition strategies (TAS). By analyzing these various TAS, the best practice for technology introduction in the pharmaceutical companies will be discussed.

1.2 TECHNOLOGY ACQUISITION STRATEGIES IN THE PHARMACEUTICAL INDUSTRY

In order to ensure that the TAS they pursue will pay off, companies must master tactical execution. They must determine their overall priorities and evaluate their product (candidate) portfolios, their competitive positions in each therapeutic area, their qualities and

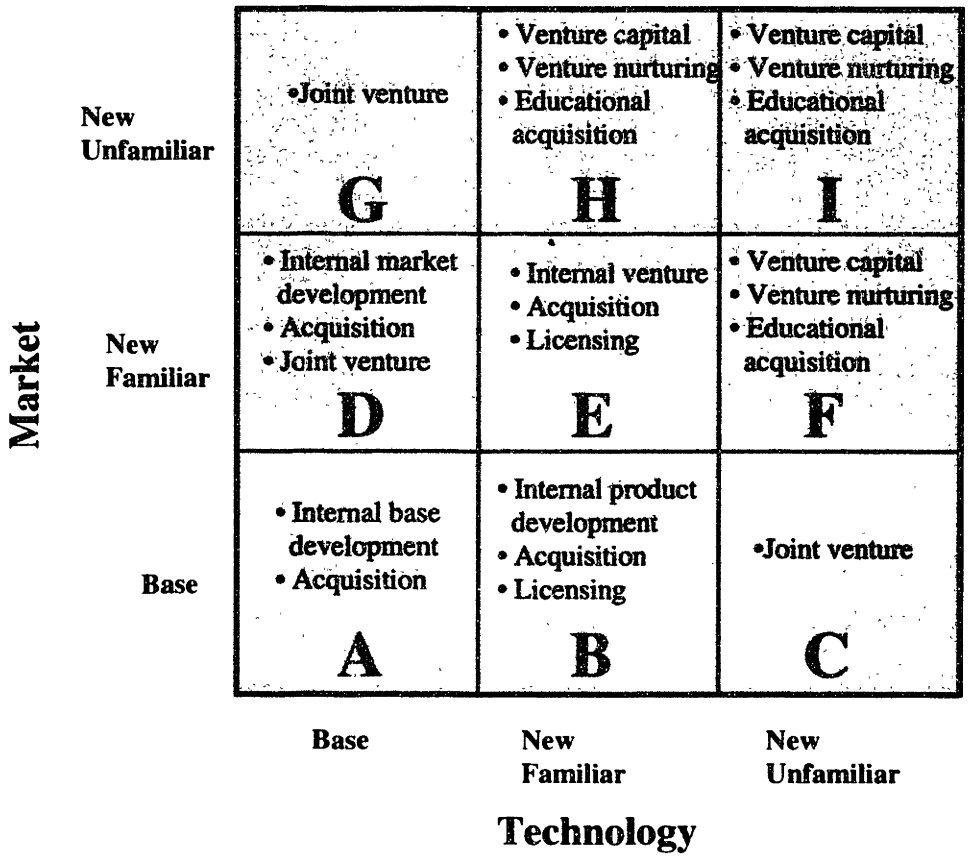


Fig. 2. Roberts and Berry Familiarity Matrix for Entry Strategy

Source: Roberts/Berry, 1985.

volumes of R&D projects, and their organizational capabilities. Then they can focus on whether to develop products internally, acquire the targets, ally with them, or invest in them with an eye to future growth (Aitkin et al, 2000). Framework for entry into new business

was proposed by Roberts and Berry (Fig. 2.) as an attempt to rationalize the choice of TAS appropriate to different technology and market innovation objectives..

1.2.1 **Acquisition** (Section A, B, D, E in Fig. 2.)

An acquisition occurs when "one company takes over controlling interest in another company". A merger is "the combination of two or more companies where the accounts are combined; a purchase where the amount paid over and above the acquired company's book value is carried on the books of the purchaser as goodwill; or a consolidation where a new company is formed to acquire the net assets of the combining companies" (OTA, 1991).

Through successful mergers and acquisitions, a company can, within a relatively short period, assimilate new technologies, products, product candidates, marketing networks, developmental know-how, and managerial skills into their businesses. An acquisition tends to be effective when a company seeks to strengthen its core business and identify opportunities for launching into new businesses surrounding its core business. In particular, an acquisition is an optimal strategy when the key measurement of success in the new field is intangible, e.g., R&D skills. These functions tend to be difficult to replicate and take too much time if approached through internal development (Spilker, 1994).

Executing an acquisition strategy effectively, however, is not easy. Evaluating intangible skills is difficult for any company that does not already possess the skills or expertise to develop those skills. An acquisition also tends to be costly, although a successful acquisition, well executed, can cost less than internal development. An acquisition may also result in duplicating an asset that then needs to be rationalized.

In order to make acquisition an optimal strategy, a company should not only consider matching targeted skills or knowledge with its core competencies, but also evaluate other concomitant skills that might not be useful to the company.

One or more of the following reasons may motivate a pharmaceutical company to adopt an acquisition strategy (Spilker, 1994):

- the desire to build a vertically integrated pharmaceutical company
- diversification into new business areas (e.g., therapeutic disease area) by acquiring critical new technologies or products
- improving the quality and increasing the quantity of the company's portfolio of pharmaceuticals
- improving the company's product pipeline (drug candidates).
- improving technical expertise and know-how or increasing the professional staff (e.g., R&D team)
- expanding the company's sales force or its geographical scope.

1.2.2 Alliance

An alliance is "an association between separate business entities that falls short of a formal merger but that unites certain agreed-on resources of each entity for a limited purpose. Examples are equity purchase, licensing and market agreements, research contracts, and joint ventures" (OTA, 1991).

The structural form of an alliance is often confused with its purpose. In fact, there is only an indirect relationship between the two (Gomes-Casseres, 1993). In broad terms, there are two business statuses by which the alliance structure is determined: contracts, and equity

relationships (see Fig. 3.). On one end is the short-term contract, which might be considered a market transaction. On the other end is whole ownership, i.e., mergers and acquisitions. These two business statuses fall outside the definition of an alliance. In between, moving from one end of the figure to the other, are medium-term contracts, long-term contracts, minority equity investments, 50/50 equity partnerships, and majority equity control. Moving along the continuum, the degrees of control, commitment, cost, and risk increase as they approach M&A. An alliance can be classified as a joint venture, licensing, a minority investment, and R&D collaboration.

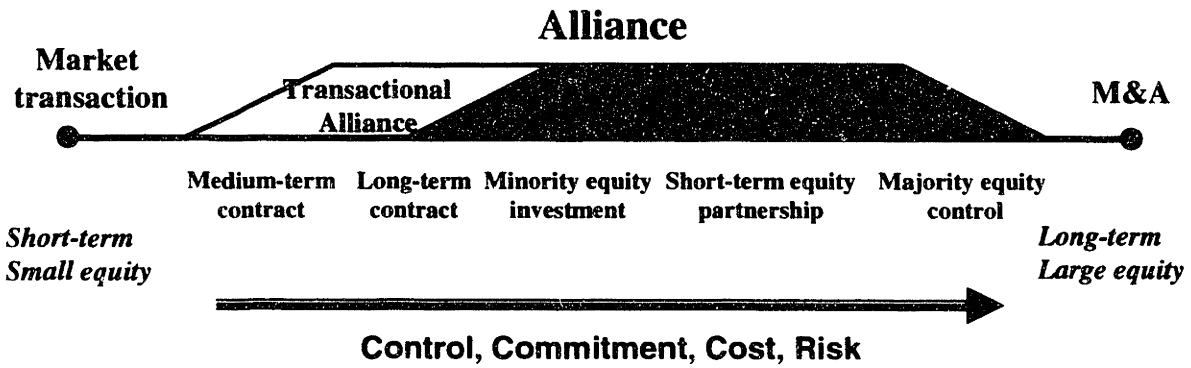


Fig. 3. Structural Form of Alliance in terms of contract and equity

Source: Gomes-Casseres, 1993 (figured by author)

a) Joint Venture (Sections C, G in Fig. 2.)

In a joint venture, the aim and benefit are relatively clear compared with a strategic alliance. Joint venture agreements are usually designed to cover a specific area or topic for two companies. A joint venture often expedites a drug development or enhances drug sales

and profits, although the goal is sometimes set to develop R&D expertise. The partners may or may not have an equal relationship. They will probably have different roles in the venture.

There are various reasons that cause pharmaceutical companies to consider entering joint ventures:

- sharing risk on an expensive and high-risk project
- sharing costs on an expensive project
- achieving a better entry into a desired and unknown market
- satisfying a foreign government that requires the participation of a local company
- achieving a larger and more knowledgeable group of experts for a specific project (Spilker, 1994).

b) Licensing (Sections B, E in Fig. 2.)

Through licensing, one company (the licensee) obtains the right to develop and/or market one or more medicines of another company (the licensor). In general, licensing meets short-term needs. In some situations, companies will exchange the right to license medicines, referred to as cross-licensing. A company may also license technologies (e.g., drug delivery systems or patented drug formulations). Some pharmaceutical companies attempt to acquire most or all of their products through licensing. Some have the motto, "Search and Development" instead of "Research and Development." Nowadays, large pharmaceutical companies are eager to possess both "S&D" and "R&D" functions.

The sales achieved from licensing activities have increased among large pharmaceutical industries. The revenues from licensed-in products among large

pharmaceutical companies are estimated to reach 35-45% of their total revenues by 2005 (Aitkin, et al, 2000).

As licensing grows more popular, the number of companies competing for deals increases, negotiation become more complicated, and costs rise. For licensees who seek opportunities, it is important to show strength in the relevant therapeutic areas and emphasize their clinical development savvy, market positions, and expertise in sales and marketing.

c) Strategic Alliance (Sections B, C, D, E, F, G, H in Fig. 2.)

While an alliance can describe a broad range of relationships, from short-term projects to long-lasting affiliation, strategic alliances are usually located between longer transactional alliances, such as research contracts, and acquisitions (refer back to Fig. 3.). Strategic alliances have the following distinct characteristics:

- a commitment for a long term
- a linkage based on equity or shared capabilities
- a reciprocal relationship with a shared strategy
- an increase in the companies' value in the marketplace, putting pressure on competitors
- a willingness to share and leverage core capabilities
- a desire to create new competencies or develop new markets (Harbison and Peckar, 1998).

Although often confused with joint ventures or cartels, strategic alliances have more "strategic" implications, such as long-term networking and flexibility. For example,

pharmaceutical companies sometimes ally with research centers, universities, or biotech companies in order to develop new medicines. Along the way, however, these allied facilities often encounter uncertainty and are urged to change their initial strategy. Therefore, companies entering a strategic alliance should select partners based on their objectives and experience, carefully assess realistic feasibility by examining all the variables of the alliance, and implement the alliance by communicating frequently with the partners and continually assessing potential risks.

1.2.3 **Equity Investment** (Sections F, H, I in Fig. 2.)

Equity investment is one of the most effective ways for a large company to capture unfamiliar emerging technologies or to enter new markets (see Fig. 4.). The large company plays the role of venture capitalist. When attempting to acquire technologies in sections F, H, and I of the familiarity matrix (Fig. 2.), an approach via internal development within the large company will encounter difficulties in establishing an R&D environment, finding talent, and accessing the information required. Alternatively, pursuing an acquisition strategy in this area can dampen the entrepreneurial spirit in a venture company and stagnate the integration of the two organizations, frequently resulting in the eventual failure of the strategy.

Corporate equity investment gives a large company opportunities to open its technology windows and develop a new market. From the standpoint of technology introduction, corporate equity investment can accomplish some goals: providing a window on the real world, saving time for development, and filling in product lines and technology gaps (Hegg, 1990). Although it gives companies a jumpstart for a new technology or market, it is my belief that corporate equity investment is only a temporary solution and a beginning

that requires subsequent reinforcement, and that the resulting external ventures are no substitutes for R&D. In many cases, corporate equity investments need to be followed by mergers and acquisitions, alliances, and joint ventures in order to realize potential opportunities.

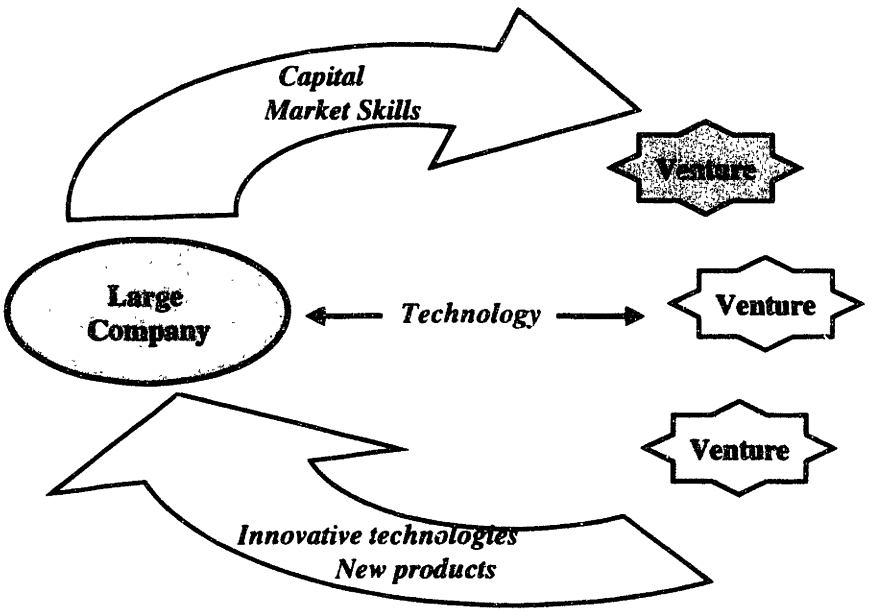


Fig. 4. Strategic Partnering through Equity Investment

Source: Muranishi (author)

For successful outcomes from corporate equity investments, a large company should consider the following points:

- establish a clear understanding of the venture's strategic focus and identify sources of sustainable competitive advantage;
- determine the entrepreneurial mindset and available success factors;
- Create effective bridging mechanisms and incentives for joint undertakings (Roberts, 2001).

1.3 OVERVIEW OF THE PHARMACEUTICAL INDUSTRY

The pharmaceutical industry is dedicated to the discovery, pre-clinical development, clinical development, manufacturing, and marketing of pharmaceuticals to end customers. Barriers to entry are high, and it is a high-risk industry. Currently there is an estimated ten to fourteen year lead time between drug discovery and the time a new product eventually reaches the marketplace (see Fig. 5.). In addition, for every successful drug, the companies have to screen about 10,000 potential compounds. To make it worth the financial risk, companies are given exclusive right to sell successfully patented drugs for the length of the permitted period: 6-10 years.

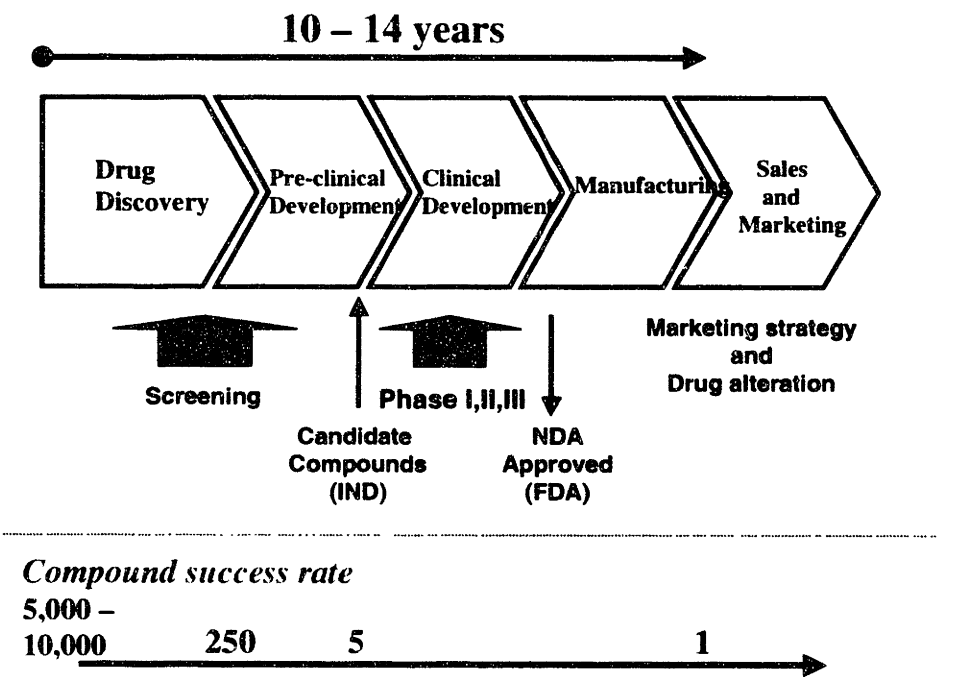


Fig. 5. Value Chain in Pharmaceutical Industry

Source: Spilker, 1994. (modified by author)

In order to build presence in the industry and successfully develop such blockbuster drugs, pharmaceutical companies have to maintain their skills and expertise along the entire value chain of the industry and continually develop new capabilities, at times augmented by both acquisitions and alliances. The key building blocks of this value chain include:

- ***Drug discovery*** — the synthesis and screening of compounds for potential candidates for specific diseases. Technologies include synthetic technologies, seeds identification technologies, applied genome technologies, and screening models.
- ***Pre-clinical development*** — This phase focuses on verifying and optimizing drug efficacy and safety. Requisite expertise includes efficacy and toxicity validations *in vitro* and *in vivo*, drug metabolism and disposition, and drug formulation.
- ***Clinical development*** — This is the first phase where testing on humans is tried. There are three distinct phases:

  ① Phase I: Safety is tested on healthy volunteers.

  ② Phase II: Efficacy and safety are tested on a small group of patients.

  ③ Phase III: Efficacy and safety are tested over a larger number of patients (More practical questions are asked.).

  During these three phases, the possibility of drug termination is still high (80%.). After this phase, regulatory approval will be given in successful cases. Expertise in the phases includes patient collection, statistical analysis, and preparing regulatory proposals for the FDA (U.S.).
- ***Manufacturing*** — This includes both active compound production as well as drug formulation. Sometimes marketing requires value-added drug formulations (e.g., timed-release capsules, sustained release injectable drugs, patches, etc.).

- ***Sales & marketing*** — Making drugs available through a network of hospitals, pharmacies, and doctors, both domestically and internationally.

The pharmaceutical industry is highly regulated by the government along its value chain, from the clinical trial phase to manufacturing—even to how the drugs are marketed. Dealing with the regulators requires specialized skills and expertise.

CHAPTER 2

Research Design and Methods

In order to analyze the technology acquisition strategies (TAS) of companies in the pharmaceutical industry, three companies in each of three major drug development countries, the U.S., Germany, and Japan (3 companies x 3 countries = 9 companies) were selected. These countries represent the top three pharmaceutical markets. Three mid-size companies were selected from each of these three markets based on their revenues from ethical drug products; i.e., each company has less than $10 billion revenue from the business field in 2000 (Eli Lilly revenues were just over $10 billion). Table I shows the 9 pharmaceutical companies that were selected for the comparative studies.

Table I. Pharmaceutical companies analyzed in TAS studies

Location	Company	Sales (2000) ($ billion)	Net Income (2000) ($ billion)	R&D Expense (2000) ($ billion)	Therapeutic areas	No. of employees (total)
U.S.	Abbott Laboratories (pharmaceutical)	13.7 (pharma: 5.65)	2.8	1.4 (10.2%)	• Diabetes • Pain management • Respiratory infections • HIV/AIDS • Men's and women's health • Pediatrics	57,100
U.S.	Eli Lilly and Company (pharmaceutical)	10.86 (pharma: 10.19)	3.06	2.02 (18.6%)	• CNS (Central Nervous System disorders) • Endocrinology • Infectious diseases • Oncology • Cardiovasculars	35,746
U.S.	Schering Plough (pharmaceutical)	9.82 (pharma: 8.35)	2.42 (total)	1.3 (13.3%)	• Allergy & respiratory • Oncology • Infectious diseases • CNS • Cardiovascular • Dermatologicals	28,100
Japan	Takeda Chemical (pharmaceutical)	8.71 (pharma: 6.4)	1.55 (operating income)	0.73 (11.4%)	• Diabetes • Cardiovascular • Bone and joint diseases • CNS • Urogenital diseases • Allergy	16,254
Japan	Yamanouchi	3.6	0.48	0.46 (12.8%)	(unstated)	9,000

Table 2-1 (continued)

Japan	Sankyo (pharmaceutical)	4.3	1.32	0.59 (11.0%)	• Cardiovascular • Diabetes, obesity • Bone and joint diseases • Immunological and allergic diseases • Oncology • Infection	11,329
Germany	Bayer (pharmaceutical)	9.32 (pharma: 5.71)	1.24	1.27 (13.6%)	• Cardiovascular • Diabetes • Genitourinary • Immunological • Infection • Oncology • Musculoskeletal • CNS • Respiratory • Biotechnology (Gene therapy etc)	21,500
Germany	Boehringer Ingelheim GmbH	5.35	0.33	0.84 (15.7%)	Respiratory (COPD) Cardiovascular Diabetes CNS (Alzheimer's) Oncology Allergy and autoimmune Virology (HCV)	27,000
Germany	Merck KGaA (pharmaceutical)	6.1 (pharma: 2.7)	-	0.5 (8.2%)	Cardiovascular/ thrombosis CNS Oncology	28,294 (total)

2.1 CAPSULE OVERVIEWS OF EACH COMPANY

(1) Abbott Laboratories

Abbott was founded in Chicago, Illinois in 1888. Its strengths are in pharmaceuticals, nutritionals, hospital products, and diagnostics. It has functional bases in more than 130 countries. Some 5,000 scientists worldwide are committed to developing new, innovative health care technologies. Additional information can be found at the corporate website: <http://abbott.com>.

(2) Eli Lilly and Co.

Eli Lilly was founded in Indianapolis, Indiana in 1876. In 1993, it sold its medical device and diagnostics unit in order to focus on the pharmaceutical (therapeutics) business. At that time, the new management slashed the workforce by 10%. The company now has 35,000 employees in 159 countries. Additional information can be found at the corporate website: < http://www.lilly.com/index.html>.

(3) Schering Plough Corporation

Schering Corporation was established in the late 1800s as the U.S. subsidiary of Schering AG, a German-based pharmaceutical and chemical company. In 1928, Schering Corporation was incorporated in New York City and in 1935 in New Jersey. During the 1940s the company evolved from a European-based company with U.S. operations, into a fully American enterprise.

In 1971, Schering merged with Plough Inc., a worldwide manufacturer of consumer products, to create Schering-Plough Corporation.

In the 1980s and 1990s, Schering-Plough divested and acquired businesses and entered into alliances to strengthen its worldwide competitiveness.

Today about 3,500 scientists around the world are committed to researching and developing pharmaceuticals. Additional information can be found at the corporate website: <http://www.sch-plough.com/main.html>.

(4) Takeda Chemical Industries

Takeda was founded in Osaka, Japan in 1781. It is the largest pharmaceutical company in Japan and ranks among the world's leaders. In order to focus on the pharmaceutical business, Takeda recently divested its animal health company, food and vitamin company, and fine chemical company. In 2000, the company earned more than 70 % of its revenue from pharmaceuticals. Nearly 2,000 research scientists are engaged in developing innovative pharmaceuticals. Additional information can be found at the corporate website: <http://www.takeda.co.jp/index-e.html>.

(5) Sankyo Corporation

Sankyo was founded in Tokyo, Japan in 1899. Its businesses are pharmaceuticals, medical devices, agrochemicals, animal health drugs, and chemicals. More than 75% of the company's sales come from pharmaceuticals. It has announced its intention to exit the chemicals business and focus exclusively on its core pharmaceuticals business by March

2003. Additional information can be found at the corporate website: <http://www.sankyo.co.jp/menu_e.html>.

(6) Yamanouchi Pharmaceuticals

Yamanouchi was founded in Osaka, Japan in 1923. Seeking to become a truly global enterprise by the early 21st century, the company has laid the foundations for an integrated organization encompassing R&D, manufacturing, and marketing in Asia, Europe, and North America. Its research facilities are located in Japan (Tsukuba, Yaizu, Tokyo, Takahagi), Europe (U.K., Netherlands), and the U.S. Additional information can be found at the corporate website: <http://www.yamanouchi.com/eg/index.html>.

(7) Bayer AG

Bayer AG was founded in 1863. It has four main divisions: Health Care, Agriculture, Polymers, and Chemicals (63% of its R&D budget was spent on Health Care in 2000.). It sells its products in over 100 countries through 50 subsidiaries and distributors. Its pharmaceutical research centers, located in Germany, U.S., and Japan, focus on 13 core indications. Additional information can be found at the corporate website: <http://www.pharma.bayer.com/servlet/Satellite?pagename=Bayer/BPP/Home>.

(8) Boehringer-Ingelheim

Boehringer Ingelheim was founded in Ingelheim am Rhein, Germany in 1885. It is owned by a committee of private shareholders who are dedicated to the long-term interests of the corporation's stakeholders, including its customers, employees and the communities

within which it operates. It is focuses especially on the pharmaceutical business with 95% of its revenues from human pharmaceuticals and 5% from animal health. Additional information can be found at the corporate website: <http://www.boehringer-ingelheim.com/corporate/home/home.asp>.

(9) Merck KGaA

Merck KGaA had its beginnings in a Darmstadt (Germany) pharmacy purchased by Jakob Merck in 1668. A branch office was established in New York in 1887 which led to the independent development of Merck and Co., Inc. Merck KGaA conducts its international business in three business sectors: Pharmaceuticals, Laboratory, and Specialty Chemicals, and is active in 46 countries worldwide with production facilities at 63 locations in 26 countries. Lipha, a major subsidiary in the U.S., focuses on metabolic disorders and alcoholism. Additional information can be found at the corporate website: <http://www.merck.de/english/corporate/index.htm>.

2.2 FACTORS TO BE ANALYZED

2.2.1 Technology Deals

Technology deals in each company were examined qualitatively and quantitatively by sorting and calculating parameters from five years of transaction data (from mid-1996 to 2001). The empirical analysis was based on data from PharmaVentures Ltd., an Oxford, a UK-based consulting firm.[1] The deals that related only to sales and marketing or property

[1] Datasoft (CD-ROM): PharmaDeals/Discovery, August 2001, Strategic Intelligence Services, PharmaVentures Ltd., Oxford, UK.

and equipment were excluded from analysis. Technology deals include the following:

A. Facts about TAS

Acquisitions

- ***Asset or business acquisitions***, which influence technology development
- ***Product acquisitions***: Acquisition of launched products, clinical-stage candidates, and pre-clinical-stage candidates

Alliances

- ***Technology licensing***: License of rights of technology in return for a license fee, milestone, or royalty. Direct acquisition of technology.
- ***Technology access***: Ability to access database of technology usually by means of licensing (not exclusive rights).
- ***Contract research***: One company performs research on behalf of another.
- ***Collaborative research***: Co-research contract especially in early stage research
- ***R&D Joint ventures***: Process whereby two (or more) companies combine their efforts and/or resources for R&D. Achieved by formation of a new company, in which each of the companies is nearly equal partner.

Equity investments

- ***Venture investment***: Purchase of part (stock) of a R&D venture company especially for the purpose of technology acquisition.

B. TAS analysis using the Roberts/Berry Familiarity Matrix

The Familiarity Matrix analysis was used to evaluate the strategies being followed in each company. Each technology deal was placed in the matrix according to the criteria stated in Appendix 2. I analyzed the level of in-house technology based on data taken from annual reports and a general consideration of the technologies involved in the deals.

C. Parametric analysis of deal characteristics

- Technology orientation level
  - TOL_1: NUM(technology deals)/(revenue of a company)
  - TOL_2: NUM(technology deals)/NUM(all deals)
- Technology creation level (extent of deals for explorative technologies)
  - TCL_1: NUM(collaborative research, R&D joint ventures and venture investment)/(revenue of a company)
  - TCL_2: NUM(collaborative research, R&D joint ventures and venture investment)/NUM(all technology deals) [includes: technology licensing, technology access, contract research, collaborative research, R&D joint venture, venture investment]
- Technology frontier level (access to new technology platforms)
  - TFL_1: NUM(new technology* deals)/(revenue of a company)
  - TFL_2: NUM(new technology deals)/NUM(all technology deals)

* New technology platforms were defined here as including:
Bioinformatics (genomics, proteomics, gene therapy)
New drug design (pharmacology, toxicology, ADME)
New combinatorial chemistry, New high-throughput screening
New drug synthesis
New drug delivery (gene delivery, protein delivery)

D. Comparison of timing to make emerging technology deals*

Comparison of number and timing of deals

* Emerging technology platforms are limited here to:

Pharmacogenomics (genomics, proteomics, gene delivery, gene therapy)

2.2.2 Analysis of Technology Performance

Technology performance in each company is measured using the following indicators:

A. Number of patents relating to emerging technologies over ten-year period[2]

The relevant patents are found by designating the assignees and any of the following words: "gene", "gene therapy", "DNA", using the "Search" function in the database.

B. Number of pre-clinical drug candidates in 2001[3]

Each batch of pre-clinical drug candidates is divided by revenues earned by the corresponding company and the resulting values (R_p) are used for the analysis. Correlations between the R_p ranking of companies and the parameters TOL_1, TOL_2, TCL_1, TCL_2, TFL_1, TFL_2 (defined in Section 2.2.1C.) are analyzed using Daniel's Test for Trend[4].

In addition, the ratio of the number of all deals in each company to their revenue (R_a) is analyzed for correlation with R_p. "All deals" includes not only technology deals but also manufacturing, sales, and marketing deals.

2.2.3 Case Study of Alliance Management

For the final topic, I will examine the organizational structure and system of one company, which has successfully built an organization for alliance management. Eli Lilly and Co. was selected as a model of this topic. The data were collected through the

[2] Source used was an online database: DERWENT Innovation Index (Chemical section).
[3] Datasoft (CD-ROM): The Pharmaceutical Companies Fact File, Script Reports, PJB Publications Limited, 18-20 Hill Rise, Richmond, Surrey TW10 6UA, UK.
[4] Conover, William J., Practical Non-parametric Statistics (3rd edition), 323, Wiley NY, 1999.

company's annual reports, published documents[5], and an interview with Michael Ransom, Manager of the Office of Alliance Management (OAM) at Eli Lilly.

[5] Anton Gueth, *Pharmaceutical Technology*, 132-135, October, 2001.
Anton Gueth, Nelson Sims, and Roger Harrison, *IN VIVO*, Business and Medicine Report, **19(6)**, (A#2001800126), June 2001.
David Thompson, *Research/Technology Management*, **44 (6)**, 22-25, Nov/Dec 2001.

CHAPTER 3

Analysis of Technology Acquisition Deals

3.1 ANALYSIS OF TAS DEALS OF NINE PHARMACEUTICAL COMPANIES

In this chapter, I present an in-depth look at technology acquisition deals undertaken by pharmaceutical companies. I did a series of comparative studies with three pharmaceutical companies in three major drug development countries—the U.S., Germany, and Japan—three companies in three countries for a total of nine companies. Summaries of the technology deals of the nine companies are shown in Appendices 3 to 11.

The deal of Abbott with Weston Medical Group plc in Appendix 3 is explained as an example. The aim of the deal was to acquire the "Intraject" needle-free drug delivery technology for multiple disease areas. Abbott is committed to developing the technology, and it will pay royalties for the licensing deal and will pay as milestones are attained.

The numbers applicable to each deal are summarized in Table II. In order to standardize the numbers in terms of the size of the company, the numbers in each deal were divided by the revenue of the corresponding company (Table III). The propensity of the deals in each company was evaluated primarily by comparing the standardized numbers.

A familiarity matrix analysis was also used to evaluate the propensities in the companies (Figs. 6 –14.). Each technology deal was positioned in the matrix according to the criteria stated in Appendix 2. The valuation was based on analysis of in-house

technology levels taken from annual reports and a general consideration of the technologies present in the deals. This work was carried out by the author who has eight years of work experience in the pharmaceutical industry.

Figures 15, 16, and 17 are a graphic representation of the ratio of number of deals to the revenues of the corresponding companies.

a) ***Abbott Laboratories*** (Appendix 3, Table II, Table III, Fig. 6, Fig. 15)

Abbott has executed a wide range of technology deals. It acquired four R&D-based businesses in huge deals with a total value of $8.62 billion. Included in these, Abbott paid $6.9 billion to acquire BASF AG with 10,700 employees. As a result of these deals, a wide variety of product candidates, from pre-clinical to phase III clinical, were acquired by Abbott, resulting in the highest product acquisition (PCA) value among the nine companies.

In terms of technology alliances, Abbott has a well-balanced alliance portfolio, and the majority of its deals are directed to challenging areas that include a variety of technologies, such as drug discovery, new animal models, and drug delivery systems.

Abbott has actively invested in seven startups in order to acquire drug candidates or to capture the technologies of drug discovery or drug delivery. In the familiarity matrix analysis (Fig. 6), Abbott's venture investment deals are placed in sectors B and C, meaning that Abbott invested in technologically challenging areas but the targeted markets were defined.

Abbott also has had three long-term strategic development alliances in challenging areas, ranging from the discovery stage to the marketing stage.

b) **Eli Lilly and Co.** (Appendix 4, Table II, Table III, Fig. 7, Fig. 15)

Eli Lilly has executed no asset acquisitions, but it has acquired a moderate number of product candidate acquisitions that are specifically focused on early-stage drug candidates. Eli Lilly has also licensed out eleven products and product candidates.

In terms of technology alliances, Eli Lilly showed an interesting tendency: it opted to focus on creative and bilateral alliances such as collaborative research, rather than short-term and/or one-way alliances such as technology licensing. Regarding technology access deals, Eli Lilly appeared to exploit new technologies without restricting its market fields (Fig. 7). Also, Eli Lilly entered into three R&D joint ventures with both private companies and an academic institute. Further, it has created a corporate venture capital operation. The company's propensity for focusing on creative technology deals probably originated from the company's strong in-house R&D culture.

Eli Lilly has entered into three long-term strategic alliances. Two cases were directed toward challenging technology areas: (1) oral drug delivery: Emisphere Technologies Inc.; and (2) drug discovery and development: Vertex Pharmaceuticals Inc.

Eli Lilly has co-developed considerable expertise in a variety of new areas such as a new application for Prozac, gene therapy, clinical information management system, and supply-chain management system.

c) ***Schering Plough*** (Appendix 5, Table II, Table III, Fig. 8, Fig. 15)

Schering Plough has executed no asset acquisitions but it has acquired a moderate number of product candidate acquisitions, especially focusing on late-stage drug candidates including three approved products. It has licensed out three product candidates.

New technologies such as functional genomics, gene delivery, and gene therapy have been acquired directly through technology licensing. Schering Plough has had a moderate number of contract research and collaborative research alliances. It has not developed any R&D joint ventures nor executed any equity investments.

Although Schering Plough had two cases of strategic R&D contracts, their focus was on product development, not technological development.

d) ***Takeda Chemical Industries*** (Appendix 6, Table II, Table III, Fig. 9, Fig. 16)

Takeda has acquired one approved product and ten drug candidates, which is an average ratio of product acquisition deals to revenue. Takeda has made no deals for technology licensing or venture investment.

Although the ratios of technology alliance deals, such as technology access, contract research, and collaborative research, are relatively low, Takeda has made deals with companies that have played pivotal roles in the new technology areas: Affymetrix Inc., Celera Genomics Inc., and Human Genome Sciences. Over the past five years, Takeda's technology area deals have been restricted to drug discovery technology or chemical seeds-finding technology; no deal has been made for process technologies or other complementary technologies such as screening technologies, antibody production, and drug delivery technology.

In 2001, Takeda entered into a joint venture with BioNumerik Pharmaceuticals for development of anti-cancer drugs.

Takeda has had no venture investment or strategic R&D contracts in the past five years.

e) ***Sankyo Co.*** (Appendix 7, Table II, Table III, Fig. 10, Fig. 16)

Sankyo has acquired four drug candidates over the past five years, a relatively low number for the size of the company.

Sankyo is the only one company among the Japanese companies to have conducted positive technology licensing deals. It has similar numbers of technology access, contract research, and collaborative research deals.

Sankyo has executed no R&D joint venture or venture investment during the five years.

f) ***Yamanouchi Pharmaceuticals Inc.*** (Appendix 8, Table II, Table III, Fig. 11, Fig. 16)

Yamanouchi has focused strongly on launched products and late-stage product candidates, acquiring five launched products and two late-stage candidates.

Yamanouchi has entered into six collaborative research alliances with academic and private companies, with one technology licensing deal, one technology access deal, and one contract research deal. It has licensed out the WOWTAB technology, an internally developed drug delivery technology, to three companies.

As is the case with the other Japanese companies, Yamanouchi has not invested in startups. However, it did establish Yamanouchi Venture Capital in the U.S. in 2001 to invest in startups there. Therefore it is expected that the number of venture investment will increase in the near future.

g) ***Bayer AG*** (Appendix 9, Table II, Table III, Fig. 12, Fig. 17)

Bayer has executed no asset acquisitions, but it has acquired two launched products and seven drug candidates, with a special focus on early-stage compounds, indicating a mid-range ratio of product acquisitions to revenue among the nine companies studied. Bayer showed its willingness to take on a challenge by acquiring a gene therapy candidate for the treatment of blood and clotting.

Bayer has executed numerous technology alliances in the past five years. Six were technology licensing deals and nine were technology access deals, all related to genetic technology. Four of the nine contract research deals were related to drug discovery and four of the remaining five cases were associated with drug delivery technology.

Bayer has entered into a variety of collaborative research contracts for various technologies: gene technology, medicinal chemistry, antibody technology, drug formulation, drug delivery especially for gene delivery, drug disposition, and drug discovery, but confined itself strictly to its core disease areas. The ratio of the collaborative research cases to revenue is 3.68, by far the largest number among the nine companies. Among the 22 contracts, there was a landmark five-year deal in 1998 with Millennium Pharmaceuticals Inc. Bayer paid $465 million, including equity investment, for the contract and 300 researchers have been working for Bayer to identify 225 disease-related gene targets (Bayer.com, 2002). By 2000, Millennium had identified 90 targets in the human genome, and Bayer had started developing a drug candidate for cancer therapy as a result of the alliance.

Bayer entered into a joint venture agreement with Lion Bioscience in 1999 for the purpose of strengthening its genomic-based target expertise, with the objectives of obtaining at least 500 drug candidates. Bayer also made a fifteen-year joint venture contract with CuraGen Corp. in 2001. The deal was valued at $1,340 million, including an $85 million

equity investment. The joint venture will evaluate Bayer's preclinical and clinical development-stage pipeline for all disease areas using CuraGen's functional genomics and pharmacogenomics expertise. The joint venture is also expected to jointly commercialize small molecule drugs to treat obesity and diabetes.

Bayer has separately invested in two companies during the five year period, using its corporate venture fund, "Bayer Innovation". One company is Immune Response Corporation, which pursues research on gene therapy. The other is Symyx Technologies, which is developing combinatorial chemistry technology. In addition to the two companies, Millennium Pharmaceuticals Inc. and Symyx Technologies also received investment from the venture fund.

h) ***Boehringer Ingelheim*** (Appendix 10, Table II, Table III, Fig. 13, Fig. 17)

Boehringer Ingelheim (BI) has executed no asset acquisitions but has acquired three launched products, four phase III candidates, and two phase II candidates, with a special focus on late-stage drugs.

BI has entered into five technology licensing contracts and five technology access contracts, all of which pursue novel technologies like gene delivery, new synthesis technology, DNA array technology, and DNA sequence information. BI has tried new technologies through technology contract deals, such as nanosystem drug formulation technology, gene expression, and gene therapy.

BI has entered into ten collaborative research contracts for relatively promising technologies, as compared with other technology alliance deals (Fig. 13). However, the contracts with Valentis (gene therapy) and with Variagenics (SNPs detection) are rated as

very challenging contracts. BI has not executed any R&D joint venture or venture investment deals.

i) ***Merck KGaA*** (Appendix 11, Table II, Table III, Fig. 14, Fig. 17)

Merck acquired Biovation in 2000 as a way to acquire antibody and protein engineering technology, technology that is relatively familiar to Merck.

Merck acquired one product and three drug candidates, indicating a middle-range ratio of product acquisition to revenue among the case companies.

Merck has executed a relatively small number of technology alliance deals, focusing mainly on chemical seeds acquisition and drug discovery technologies.

Merck has made two R&D joint venture deals during the past five years, the highest R&D joint venture ratio to revenue among the nine companies. One is with Novasep SA and Institut du Petrole for the purpose of developing systems to support drug development, manufacturing, and sales. The other is with 3-Dimensional Pharmaceuticals to develop a combinatorial chemistry technology for cardiovascular disease area.

3.2 PARAMETRIC ANALYSIS OF DEAL PROPENSITIES (Table IV)

The various propensities revealed by the deals consummated by the companies have been compared using parametric analysis (refer to Chap. 2, Sec 2.2.1(C)). The resulting parameters are summarized in Table IV.

3.2.1 Technology Orientation Level (TOL_1, TOL_2)

The extent and orientation of the technology deals compared with all deals in a company were evaluated by calculating these parameters:

TOL_1 = the number of technology deals per dollar revenue of the company.

TOL_2 = the ratio of the number of technology deals to all deals in the company.

Bayer executed the highest number of technology deals per dollar of revenue with TOL_1 of 8.58; TOL_2 of 0.42, indicated high focus on technology deals. Eli Lilly had a large TOL_1 and the highest TOL_2, which means a large volume of technology deals and high focus on the deals. Boehringer Ingelheim also made many technology deals and showed comparable high technology focus.

On the other hand, Takeda and Yamanouchi had the lowest TOL_1 values with low TOL_2 values. Although Abbott and Merck indicated moderate TOL_1 values, they too were among the lowest TOL_2 values, indicating low focus on technology deals.

3.2.2 Technology Creation Level (TCL_1, TCL_2)

Deals involving collaborative research, R&D joint ventures, and venture investment imply an intention by the participants to enhance the levels of technologies that they possess and to create undiscovered technologies they do not yet possess. These parameters are represented as:

TCL_1 = the number of technology-creation deals (collaborative research, R&D joint ventures and venture investment) per dollar revenue of the company.

TCL_2 = the ratio of the number of technology-creation deals to that of all technology deals in the company.

Bayer and Eli Lilly display a strong propensity for technology exploration in their deals, reflected in much higher TCL_1 values than the other companies in this study. Both also had comparably high TCL_2 values, indicating their tendency to enter into collaborative or bilateral alliances.

Takeda had the lowest TCL_1 value but one of the highest TCL_2 values, suggesting its strong preference for creative technology deals and a lack of opportunity for overall deals. Yamanouchi's propensities were higher than Takeda on both measures, while Sankyo and Schering Plough had low preferences for creative technology deals.

3.2.3 Technology Frontier Level (TFL_1, TFL_2)

The extent of and orientation to new "frontier-oriented" technology deals in a company were evaluated by calculating the number of deals involving new technology platforms, including bioinformatics, new drug design, new combinatorial and high-

throughput systems, new drug synthesis, and new drug delivery systems (relevant deals are identified by "*" in Appendices 3 to 11).

***TFL_1* = the number of new technology deals per dollar revenue of the company.**

***TFL_2* = the ratio of the number of new technology deals to that of all technology deals of the company.**

There were large discrepancies in the relative volumes and preferences for new technology deals among the companies. For example, Bayer had made the largest number of new technology deals per its revenue (TFL_1: 5.25) with a TFL_2: 0.61, indicating that 61% of their technology deals were directed toward new technologies. Boehringer Ingelheim shows the second-largest TFL_1 value, with a TFL_2 value of 0.81, the strongest indicated preference for new technology deals. Eli Lilly has also executed a large number of new technology deals relative to its revenue with a moderate preference for such deals.

Takeda and Yamanouchi made a small number of deals for new technologies (TFL_1: 0.78, 0.83, respectively) with a low preference for deals (TFL_2: 0.38, 0.33). Abbott and Merck also show relatively low TFL_1 (1.42, 1.48) with low TFL_2 (0.29, 0.36).

3.3 COMPARISON OF EMERGING TECHNOLOGY DEALS (Figs. 18, 19, 20, Table V)

Deals around emerging technology are limited here to consideration of pharmacogenomics technology platforms.

Although the double helical structure of DNA was discovered by Drs. Watson and Crick nearly fifty years ago, the technology that exploits the discovery was not developed until recently. The Human Genome Project began in the late 1980s to clarify the sequence of

the whole human gene. The Project preoccupied the attention of most companies thinking about the future potential for innovating drug development processes and opened a variety of therapeutic methods. In 2000, sequencing of the whole human genome was completed. In the meantime, relevant technologies were developed not only by academics but also by biotech startups and research facilities in pharmaceutical companies. Advancements in genome technology, more detailed understanding of biology, and the introduction of information technology resulted in the birth of *pharmacogenomics*: the fusion of genomics, proteomics, gene delivery, gene therapy, and information technology.

Figures 18, 19, and 20 give graphic representations of the relevant deals for the pharmacogenomics technology platform, from the time period July 1992 to July 2001. Table V summarizes the number of deals and the ratio of the deals to the pharmaceutical revenue of the corresponding companies.

Eli Lilly entered into a contract for a research deal involving genetic engineering in 1992. After two or three years, Eli Lilly started a series of TAS deals relevant to pharmacogenomics using a variety of approaches. Eli Lilly invested in two companies: Millennium Pharmaceuticals in October 1995 (for cardiovascular disease), and Millennium BioTherapeutics in May 1997 (for gene therapy). However, the ratio of the deals to Eli Lilly revenue is less than the average ratio.

Abbott also started deals relevant to pharmacogenomics relatively early. It invested in three companies: Ligand Pharmaceuticals, Genset SA, and Millennium Pharmaceuticals. Schering Plough (18) and Eli Lilly (17) both made an equivalent number of deals for pharmacogenomics, but the number of new technology deals made by Eli Lilly is far more

than Schering Plough. Schering Plough tends to use technology licensing contracts for pharmacogenomics.

Until 1997, Bayer had made fewer deals compared with Eli Lilly. However, from 1998, when a collaborative research agreement with Millennium Pharmaceuticals was agreed, the number of deals by Bayer rocketed, along with the variety, resulting in an extraordinary number of deals over a ten year period. This upward movement seems to be associated with Bayer's 1997 R&D strategy (see Bayer Annual Report 2000, p.6) to set a course that positions the company for strength in genomic technology platforms. Boehringer Ingelheim also had a similar tendency: the number of such deals surged after 1999.

Takeda and Yamanouchi made a smaller number of pharmacogenomic deals, while the number of deals in Takeda increased after 1999. Sankyo made a moderate number of deals, but all were contracted within the last four or five years. The Japanese companies tend to enter into technology access and contract research deals.

3.4 COMPARISON OF DEALS AMONG COUNTRIES (Fig. 21, Table VI, Figs. 18, 19, 20.)

The technology deals were compared on the basis of the three countries in this study: the U.S., Japan, and Germany. The average ratios of each deal in those countries are summarized in Fig. 21. The results of parametric analysis in each country are summarized in Table VI.

Asset acquisition deals for R&D-based organizations are rare in all three countries, although Abbott and Merck have executed several asset acquisition deals. Product acquisition deals occur consistently among all three countries.

On the other hand, the average value varies by country for technology alliance contracts (technology licensing, technology access, contract research, collaborative research, R&D joint venture). The overall tendency in technology alliance contracts is that German companies are the most aggressive and U.S. companies are equivalent to the German companies in terms of contract research agreements. The Japanese companies are less positive in the area of technology alliance contracts, while they are comparable to U.S. companies in focus on technology access alliance.

For venture investments, the U.S. companies dominated companies in the other two countries. The three Japanese pharmaceutical companies did not execute any venture investment in the five year study period. U.S. companies made strategic alliance deals, while the others had little interest in such deals.

Preferences for technology deals and technology creation deals in each company were similar among the three countries (Table VI: Each of the average TOL_2 and TCL_2 values is comparable among the countries). However, the absolute numbers of technology deals and technology creation deals per revenue in Japanese companies are significantly lower than in the other countries.

For technology frontier deals, Germany showed a higher propensity for new technology deals than the other countries (TFL_2), and the absolute number of deals is the largest. In contrast, Japanese companies showed little interest in such deals.

In terms of timing of deals around emerging technologies, U.S. companies are the fastest movers, while German companies are reasonably comparable (see Figs. 18, 20). The Japanese companies are slow movers in this kind of deals, although they have begun to enter

into more such deals for the past several years, mainly in the area of technology access contracts (see Fig. 19.).

CHAPTER 4

Analysis of Emerging Technology Outputs Among the Companies

As an index of levels of technology capability, I compared the number of patents related to pharmacogenomics and pre-clinical drug candidates in each of the nine companies. Then I evaluated the relevance of those numbers with the status of technology licensing in the companies.

4.1 NUMBER OF PATENTS FOR EMERGING TECHNOLOGIES

Patents relevant to pharmacogenomics were analyzed using the method described in Section 2-2(2)(a)). The number of the identified patents in each company is used as an index for R&D capability in each of the companies. The ratio of the number of identified patents in each company to corresponding revenues for the past ten years are shown in Figures 22, 23, and 24.

Bayer, Boehringer Ingelheim, and Schering Plough appear to be major players in pursuing emerging technology deals, based on the number of the deals shown in Table V). Eli Lilly and Abbott are first movers in the area, as shown in Figure 18. However, Figures 22, 23, and 24 suggest that Schering Plough, Eli Lilly, and Boehringer Ingelheim have not been strong patentees in the pharmacogenomics field. Abbott has been a leading patentee in

some fields over the last five years, although it has decreased its potential in the last two years. Bayer has held a leading position especially in the last two years.

On the other hand, compared with all nine companies, Takeda has held a dominant position, especially in the DNA area for the last ten years. Merck has distinguished itself as an emerging patentee in the last two or three years. Surprisingly, despite my analysis in Chapter 3, these two companies were not particularly interested in deals for emerging technology.

The number of deals for pharmacogenomics in each of the companies does not correlate with that of patents on pharmacogenomics issued by the companies.

4.2 NUMBER OF PRE-CLINICAL DRUG CANDIDATES

Ratios of the number of pre-clinical drug candidates in each of the nine companies to the revenue of the corresponding company (R_p) are summarized in Figure 25, and the ranking of the ratios among the companies is shown in Table VII. Abbott, Bayer, and Merck have the high ratios among the companies.

The order of the companies for R_p was correlated with that of TOL_1 (Daniel's Test for Trend: Trend exists at p=0.10.). A stronger correlation of R_p with R_a (ratio of the number of all deals in each company to revenue) was detected (Daniel's Test for Trend: Trend exists at p=0.025.). Figure 26 provides a graphic representation of the correlation between R_a with R_p. On the other hand, no correlation with TOL_2, TCL_1, TCL_2, TFL_1, or TFL_2 was detected by this analysis.

CHAPTER 5

Discussion: Analysis of Technology Acquisition Deals

5.1. CHARACTERISTICS OF TECHNOLOGY DEALS

In general, asset acquisitions of R&D facilities by the nine sampled companies have been rare over the last five years. Instead of asset acquisitions, alliances (including product acquisitions) have been more numerous. My analysis suggests that the preference for technology alliance deals varies among the nine companies. Major discrepancies are suggested in the following three types of deals.

5.1.1 **Technology Deals – Focus** (Table IV, Figs. 15, 16, 17)

Abbott, Takeda, and Yamanouchi have focused on product acquisitions rather than technology alliance deals during the last five years. The numbers of technology deals by these companies tends to be small against the total number of deals among the correspondent companies (low TOL_1 or TOL_2).

On the other hand, Eli Lilly and Bayer have focused on technology alliances, especially on collaborative research agreements, rather than product acquisitions. The number of technology deals by those two companies accounts for almost half of all the deals in each company.

5.1.2 **Technology Creation Deals – Focus** (Table IV)

Eli Lilly has focused strongly on technology creation deals, such as collaborative research, R&D joint ventures, and venture investments. While Yamanouchi and Takeda have also focused on technology creation deals, the total number of technology deals has been low. Sankyo, Schering Plough, and Abbott also have few technology creation deals, choosing to focus instead on exploitative deals.

5.1.3 **Technology Frontier Deals – Focus** (Table IV)

Bayer and Boehringer Ingelheim focused on deals for new technologies, with 60% to 80% of their technology deals involving new technologies. In contrast, Abbott, Yamanouchi, and Merck took little interest in these new technologies.

There are several reasons for the variations in the nature of these deals.

First, each company's strategies affected the number of technology deals. For example, Bayer has declared that it intends to strengthen its capability in new technologies, especially focusing on alliances with biotechs and academia (Annual Report, 2000). To that end, Bayer established "Bayer Innovations", a corporate venture fund that seeks new technologies. Eli Lilly also stated its desire to combine expertise captured through alliances with its in-house R&D capability (Annual Report, 2000). Boehringer Ingelheim has stated that it will transform itself from a "research-based company" to a "research-driven company" by strengthening its emerging technology areas, such as genomics, proteomics, and bioinformatics (Annual Report, 2000).

Second, the ability to manage alliances is crucial, especially for technology creation deals, which are long-term and bilateral alliances. Eli Lilly established an Office of Alliance Management (OAM) to help manage its alliances systemically.

Third, the nature of in-house R&D affects the choice of alliances. It is apparent that companies with a strong R&D culture, such as Eli Lilly, would tend to select creative alliances.

5.2 CHARACTERISTICS OF TECHNOLOGY DEALS AMONG THE COUNTRIES

The average values of ratios of product acquisition (PCA) to revenue among the three countries in this study are almost exactly the same. PCA does not require complex management for implementation of deals, although evaluation and negotiation are requisite, meaning that the hurdles of the deals are low even for companies without sufficient expertise in alliances.

The following characteristics in technology deals were found in each country.

5.2.1 United States

The indices of each type of deal in the U.S. are largely mid-range among the three countries (Fig. 21). However, the timing of contracts for emerging technology deals has been earlier (Figs. 18, 19, 20).

Numerous venture investments (VI in Fig.21.) have been executed compared with the other countries. The reason can probably be attributed to the fact that the U.S. has a large

number of biotech firms, and the pharmaceutical companies are eager to pursue the frontiers of the industry.

5.2.2 Japan

The number of technology alliances among Japanese companies is significantly lower than those in the other countries (Fig. 21), although it has increased over the last two years, especially in emerging technology area (Figs. 18, 19, 20). One reason is that Japan has few biotech companies. Another is its geographic location, which hinders alliances with the U.S., which has the majority of biotech companies. A third might be that the Japanese companies do not have an established management organization especially prepared to deal with technology alliances.

5.2.3 Germany

German companies dominate in almost all of the technology alliances except for venture investment (*VI* in Fig. 21.). They have made a number of technology alliances not only with European companies but also with U.S. enterprises. One reason is that they own well-established research facilities in the U.S., and this has served as a platform for expanding their networks with biotechs and academic institutions in the U.S. Another reason is that the German companies have a clear vision for transforming their drug development capabilities from traditional to new platforms through alliances with external parties.

5.3 CORRELATIONS BETWEEN THE STATE OF TECHNOLOGY DEALS AND OUTPUT IN THE COMPANIES

No clear correlation between the number of patents on emerging technologies and the number and timing of technology deals was detected in the analysis. A correlation was found in technology deals by Bayer, Abbott, Sankyo, and Yamanouchi.

My research suggests that the number of pre-clinical drug candidates a company owns is directly correlated with the total number of technology deals, rather than with the amount and direction of technology creation deals (TCL_1, TCL_2) or technology frontier deals (TFL_1, TFL_2); this is true even when compared with all deals a company has made (R_a).

This analysis used data of deals covering the last five years. This period may be too short to capture the consequences of deals with the status of pre-clinical drug candidates. It is appropriate to use the status of more early stage drug candidates for evaluating technology deals. However, it was difficult to collect data about early-stage drug candidates from public databases.

5.4 SUMMARY OF THE ANALYSIS

There is a lot of discussion about the strategy of virtual integration especially up-stream of the pharmaceutical value chain. Considering the emergence of new technologies in the biotechnology industry, it seems plausible to recommend that pharmaceutical companies build external research networks.

My research, however, did not detect positive correlation between the number of patents and that of technology acquisition deals in emerging technology field. Further, there is no correlation between the number of pre-clinical drug candidates and technology creation

deals or technology frontier deals. These results suggest that the technologies in the deals are still in ferment stages while the discrepancy between the new technologies dealt and in-house research capabilities may also be a cause of the low output.

Recently, genome technology has brought a lot of new technologies, such as pharmacogenomics, bioinformatics, and gene therapy. Although the research on gene has about 50-year history, these new technologies have 10 or 20 years histories at most. The new technologies are thought to be in ferment stages while the potential of the technologies is thought to be enormous.

It seems to be a highly risky strategy to invest in these unpredictable new technologies. However, pharmaceutical companies find it to be the right way to hold on to the tails of the new technologies, considering the potential effects of them on drug development and the importance of first-mover advantage for the market in pharmaceutical industry (Tapon, 1999). Pharmaceutical companies have to keep their eyes on the new technologies, which possess potential to be disruptive technologies.

The U.S. companies were early-movers to ally with the companies and academe in the new technology fields. The German companies such as Bayer and Boehringer Ingelheim have moved in second and have augmented the new technology deals more aggressively than U.S. companies. The Japanese companies are the slowest movers in these fields but have enhanced their activities in the new technology deals during the past two or three years. Which companies will enjoy the output from their strategies? We should know the answer in near future.

CHAPTER 6

Case Study: Alliance Management at Eli Lilly

6.1 MOTIVATION FOR STREAMLINING ALLIANCE MANAGEMENT

The pharmaceutical industry, or life sciences, is too wide for one company to cover by itself (Sapienza, 1989). Therefore, companies have to capture new core capabilities and new peripheral capabilities not only through their own internal efforts but also by pursuing external resources (see Figure 27.).

Eli Lilly and Company ("Eli Lilly") has pursued a collaborative strategy of "innovation leverage" through headline-grabbing merger and acquisition approaches (Thompson, 2001). It has made use of external sources as innovation drivers in combination with its own internal R&D efforts. The company aims to build win-win relationships with other innovation leaders and to maintain a reputation as a "Partner of Choice".

The beginning of its motivation to streamline the alliance organization was the failure to consummate an alliance for a potential product in the mid-1990s. The Eli Lilly board members reviewed the failure extensively and concluded that they should take action to enhance the company's ability to capture value from alliances.

Further review by Eli Lilly managers and two consultants produced some clues about the company's alliance management (Gueth et al., 2001). First, the outcomes of earlier alliances were more dependent on the individual talent and goodwill of people involved in

the alliances than on any kind of systematic management procedures. Nobody followed a particular process that focused on improving alliance results. Few people captured information about the failures and successes in any formal way. Second, their alliances failed most frequently not because of technical issues but because of cultural and process differences between the two organizations that were proposing to ally. Indeed, badly managed relationship considerations erected barriers to scientific success of a project. Third, the company needed to improve parts of its alliance management organization in order to be a leading firm in the industry.

Eli Lilly developed an integrated approach to managing alliances based on the following four principles (Gueth, 2001):

1. Establish alliances as part of the corporate strategy of the partners.
2. Create replicable business processes that can be applied from alliance to alliance.
3. Actively capture and manage the knowledge capital specific to alliance management.
4. Shape and develop the participant's capabilities to ensure a positive relationship.

To put these principles into practice, Eli Lilly began with an organizational model that links alliance management responsibilities to existing corporate business functions. In order to manage the alliance process as rigorously as it manages its product development activities, Eli Lilly established an internal Office of Alliance Management (OAM) in 1999, which would be integrator, intermediary, and catalyst for best-practice performance.

6.2 THE ALLIANCE PROCESS AT ELI LILLY

6.2.1 Overall Alliance Portfolio Planning

Generally speaking, investors demand total shareholder return on the order of 18 to 20% annually. Eli Lilly set its objective to correspond with this value: 20% annual growth in its revenue.

Figure 28 illustrates the concept that the number of alliance that should be executed is extrapolated from the discrepancy between demanded future revenue and anticipated revenue from the internal pipeline. The stages or status of targeted products and candidates are also extrapolated by the timing of the discrepancies. Deals with gaps of more than five years will be more opportunistic and for earlier research molecule targets (Interview with Mr. Ransom).

The organization has three components, matched to the three components of the innovation value chain: "Find it", "Get it", and "Create value" components (Gueth, 2001).

6.2.2 "Find it" (Fig. 29)

Searching and evaluating potential deals is crucial before initiating alliances. It is important that the search team have extensive knowledge and experience in the scientific aspects of the deals (Campbell, 2000).

Eli Lilly's "Find it" team is made up of more than twenty senior research scientists who are charged with aggressively searching the world for innovative opportunities: new compounds, molecules, and technologies. The team evaluates data on science, patents, clinical studies, quality systems, and manufacturing standards. The team reviews about 1,500 potential opportunities each year.

6.2.3 "Get it" (Fig. 29)

The "Get it" team is the business development staff that works side-by-side with the research scientists to move quickly on opportunities they discover. Members of the team prepare the transaction, negotiate terms, and make the contracts. The "Get it" team only moves on the deal that the research scientists believe has values. They do not force any deal on the "Find it" team except late-stage product deals.

In this process, a three-dimensional-fit analysis is used to evaluate possible matches with partners in terms of compatibility of the respective management processes and cultures. The analysis includes cultural fit—how the partners think and act; operational fit—how well the operational aspects of the business models complement each other; and strategic fit—how well the partners' objectives are aligned. Discussions on the facts are focused and emotional distractions reduced, by using these three perspectives.

The "Get it" team signs 350 confidentiality agreements, conducts approximately 100 negotiations, and completes 40 deals a year.

6.2.4 "Create value" (OAM) (Fig. 29)

The "Create value" team is the alliance management team. Managers from the OAM operate and manage the team. They assist at the beginning of an alliance, check the health of ongoing operations, and manage relationships between Eli Lilly and its partners (Fig. 30). The team is the advocate and facilitator for the alliance partnership itself. For example, the success of any alliance greatly depends on the strength of the relationships among individuals in both partners. The OAM team sets up kick-off meetings filled with social issues designed to bring together team members from both companies so they can get to

know each other and determine ways to work together successfully. The team performs these services for over 140 partners.

6.3 OAM AT ELI LILLY (Gueth, 2001, Thompson, 2001, Interview with Mr.Ransom).

Eli Lilly's OAM coordinates and manages both external and internal relationships for alliances. Every alliance has its own set of two key persons outside the OAM and one person inside—alliance champion, alliance leader, and alliance manager. The *alliance champion*, usually a senior executive, is responsible for overall support and oversight of alliance. The *alliance leader*, usually a technical leader, a project manager, or other senior person with intimate knowledge of the area, is responsible for the day-to-day leadership of the alliance. The *alliance manager*, a representative of the OAM, is responsible for supporting the alliance leader and serves as an advocate for the alliance itself.

The alliance managers from OAM help resolve discrepancies between the leaders and partners, serve as chief diagnostician in assessing the health of the alliance, institutionalize the lessons learned, and provide training and development.

6.3.1 Coordinating the Alliance Environment

The alliance manager visits the potential partner during Eli Lilly's due diligence phase, in an effort to understand the potential partner's organization and culture. During contract negotiations, the alliance manager focuses on governance principles. Once the deal is signed, he/she coordinates the first interactions with new members of the team and helps set the alliance's initial agenda (Fig. 30. Phase I).

The operational manager is appointed as alliance leader. Agendas for the initial meetings are heavy on tasks: they lay out project plans in detail, assign work responsibilities, and detail expectation from each other. It is not unusual for teams to be deep into technical discussions (Fig. 30, Phase II)

While the alliance manager is part of the OAM, it is important for him/her to live with the functional area involved in the alliance. Thus, the alliance managers are recruited from a wide variety of disciplines at Eli Lilly, not only from R&D but from corporate affairs, finance, and marketing.

6.3.2 Checking the health of an alliance

The OAM has developed an extensive tool kit for assessing the health of an alliance operation. The alliance manager uses the tool kit to clarify and gain consensus on the strategic intent of the alliance, identify and leverage the capabilities of both partners, and align the work processes of each partner so that they can more effectively work together.

The OAM sends a web-based questionnaire that includes eighty questions to all employees of the alliance from both companies. The questionnaire covers fourteen distinct dimensions that have been identified as key indicators for alliance success.

The assessment questionnaire allows the alliance leader and manager to pinpoint specifically where help is most needed. The results shown in Fig. 31(B) show significant signs of stress in overall dimensions, while the results in Fig. 31(A) appear to be in good health. The dimension that displays a huge difference (e.g. "skill/competence", "knowledge management" in Fig. 31(B)) will be improved, and the one in which both partners indicate low ratings (e.g., "performance measurement" in Fig. 31(B)) also will be given help. The

alliance in Fig. 31(A) requires no particular intervention except in the area of "leadership". The results of the assessment are shared with the combined team to re-emphasize the importance of the quality of management.

6.3.3 Institutionalizing the Lessons Learned

The *Partners* database is the third component of the alliance management plan; it systemically captures, codifies, and shares the knowledge and lessons learned.

The primary responsibility for capturing and sharing the lessons belongs to the alliance manager. At each point in the alliance process, the alliance manager uses a repertoire of tools to help facilitate the partnership and then report the results obtained at each point.

The *Partners* database contains information about all of Eli Lilly's alliances, including an overview, the collaboration contracts, governance agreements and minutes, lessons learned, milestone and budget reports, existing tools and processes, and online instructions for how to use them. The database can be accessed by anyone responsible for alliances.

6.3.4 Training for Alliance Management

To highlight the importance of alliances and enhance productivity gained from them, the OAM provides training for those who are managing alliances.

In early stage of the OAM, it trained nearly 500 Eli Lilly managers and research scientists. It also held an alliance summit where external alliance experts and senior Eli Lilly managers reinforced the importance of alliances to the audience of almost 100 key Eli Lilly

managers and discussed best practices that they could use to help penetrate their organization.

Many of the educational components have been designed for alliance leaders, and sometimes for alliance champions. They share business cases involving alliances so that the leaders clearly understand the importance and procedures involved in alliances. The *Partners* database facilitates training, helping those involved in alliances to develop their skills in using the fundamental tools and processes.

The training sessions have not necessarily changed minds among Eli Lilly employees; many still believe they could have developed the products without external assistance. Nonetheless, after days of training, the attitude of the team members has improved and the productivity from alliances has soared.

6.4 OUTPUT FROM ALLIANCE MANAGEMENT

Whether the investment in the OAM actually creates a positive return on investment is less clear. The other companies do not have such a process, and it is not easy to say whether the OAM organization contributes even to Eli Lilly's short-term growth compared with those of its competitors.

The OAM team and Eli Lilly senior management are convinced that they are making Eli Lilly a more partner-friendly organization, which attracts other partners and produces greater values. The annual Alliance Health Survey of their partners shows that the new managerial processes are working. Survey respondents say that Eli Lilly has significantly improved its ability to recognize and resolve difficulties in a partnership at an earlier stage, before the problems become barriers to success. They also have quantitative evidence: its

partners more and more frequently call the OAM to ask advice on the best way to work with Eli Lilly.

Eli Lilly believes that its reputation—that Eli Lilly cares about partnerships—will bring more key partners in the end. Its alliance deals will be competitive and some popular alliance deals will be offered at high prices. In the lineup of partners offering the same economic terms, Eli Lilly needs to stand out in its ability to make an alliance successful. Eli Lilly's efforts on alliance management will give it an advantage in the long run.

CHAPTER 7

Conclusions

In this thesis, I have analyzed the relationships between technology acquisition activities and the internal technological strength, or product development, in nine pharmaceutical companies in three countries.

A positive correlation between the number of all deals and product development (the number of pre-clinical drug candidates) was detected. On the other hand, there is no clear correlation between technology creation deals or technology frontier deals and product development.

I found that radical technological change via inter-firm cooperation is mainly executed through exploitation alliances (i.e., product-oriented alliances), which are a quick and cost-effective way to respond to radical technological change (Rothaermel, 2001). The outcome of exploration alliances (technology creation deals, technology frontier deals) is often intangible knowledge, which takes a long time to become tangible, not likely to be reflected in five-year data. Much more work needs to be done on the long-term outcomes achieved by exploration alliances in order to present a fair evaluation.

Styles of technology acquisition deals vary among the three countries. German companies showed the most aggressive technology acquisition strategies in overall technology deals. U.S. companies exhibit strong technology acquisition strategies with

prominent equity investment deals. Japanese companies were discreet about their technology acquisition deals, although they showed a similar degree of eagerness for product acquisition. The number of technology acquisition deals by Japanese companies, however, has increased sharply during the past two or three years.

The pharmaceutical industry is now confronted with a discontinuous time period, especially in terms of its technology (Robbins-Roth, 2000). In this industry, technology innovation is relatively slower than in other industries. In order to maintain their advantageous positions in the industry, pharmaceutical companies have to invest not only in internal R&D but also in external sources, since technologies in the industry are too broad to enable a company to cover all of the new technologies. Allotment of investment in internal and external R&D, however, is hard to determine; moreover, the selection of targets and styles of external technology acquisition and the timing of the deals by pharmaceutical companies require deep deliberation on all the scientific and business aspects.

In order to assimilate the growing amount of external property, pharmaceutical companies must consider setting up an appropriate management organization. Some companies have already done this as a method for evaluating, capturing, and managing technology acquisitions. Alliances between biotech enterprises and pharmaceutical companies involve dissimilar organizations in terms of culture, size, power, and expertise (Sapienza & Stork, 2001). Managing the interface of deals between two different dimensions of these companies will be crucial for successful technology acquisition.

Table II. Number of TAS Deals in Each Company (1996-2001)

	Pharma Revenue ($ billion)	*Asset or business acquisition (AA)*	*Product or Candidate acquisition (PCA)*	*Technology licensing (TL)*	*Technology access (TA)*	*Contract research (ConR)*	*Collavorative research (ColR)*	*R&D joint venture (RDJV)*	*Venture investment (VI)*	*Strategic development contract (SDC)*	*Co-development Co-marketing (CDM)*	Technology deals	All deals
Abbott	5.7	4	16	3	2	9	4	0	7	3	0	28	129
Eli Lilly	10.2	0	10	2	9	16	27	3	4	3	5	64	120
Schering-Plough	8.4	0	9	9	4	9	8	0	0	2	1	32	76
Takeda	6.4	0	11	0	3	3	5	1	0	1	0	13	46
Sankyo	4.3	0	4	4	4	4	5	0	0	0	3	17	32
Yamanouchi	3.6	0	8	1	1	1	6	0	0	0	1	9	27
Bayer	5.7	0	9	6	9	9	21	2	2	0	1	49	118
Boehringer Ingelheim	5.4	0	9	5	5	6	10	0	1	0	1	27	64
Merck KGaA	2.7	1	4	3	1	3	2	2	0	0	3	11	50

Table III. Number of Technology Deals per $ Revenue

	Pharma Revenue ($ billion)	Ratio versus revenue									
		AA	*PCA*	*TL*	*TA*	*ConR*	*ColR*	*RDJV*	*VI*	*SDC*	*CDM*
Abbott	5.7	0.70	2.81	0.53	0.35	1.58	0.70	0.00	1.23	0.53	0.00
Eli Lilly	10.2	0.00	0.98	0.20	0.88	1.57	2.65	0.29	0.39	0.29	0.49
Schering-Plough	8.4	0.00	1.07	1.07	0.48	1.07	0.95	0.00	0.00	0.24	0.12
US (Average)	*8.1*	*0.23*	*1.62*	*0.60*	*0.57*	*1.41*	*1.43*	*0.10*	*0.54*	*0.35*	*0.20*
US (SD)	*2.3*	*0.41*	*1.03*	*0.44*	*0.28*	*0.29*	*1.06*	*0.17*	*0.63*	*0.15*	*0.26*
Takeda	6.4	0.00	1.72	0.00	0.47	0.47	0.78	0.16	0.00	0.16	0.00
Sankyo	4.3	0.00	0.93	0.93	0.93	0.93	1.16	0.00	0.00	0.00	0.70
Yamanouchi	3.6	0.00	2.22	0.28	0.28	0.28	1.67	0.00	0.00	0.00	0.28
JPN (Average)	*4.8*	*0.00*	*1.62*	*0.40*	*0.56*	*0.56*	*1.20*	*0.05*	*0.00*	*0.05*	*0.33*
JPN (SD)	*1.5*	*0.00*	*0.65*	*0.48*	*0.34*	*0.34*	*0.44*	*0.09*	*0.00*	*0.09*	*0.35*
Bayer	5.7	0.00	1.58	1.05	1.58	1.58	3.68	0.35	0.35	0.00	0.18
Boehringer Ingelheim	5.4	0.00	1.67	0.93	0.93	1.11	1.85	0.00	0.19	0.00	0.19
Merck KGaA	2.7	0.37	1.48	1.11	0.37	1.11	0.74	0.74	0.00	0.00	1.11
GER (Average)	*4.6*	*0.12*	*1.58*	*1.03*	*0.96*	*1.27*	*2.09*	*0.36*	*0.18*	*0.00*	*0.49*
GER (SD)	*1.7*	*0.21*	*0.09*	*0.09*	*0.60*	*0.27*	*1.49*	*0.37*	*0.18*	*0.00*	*0.54*
Average (Total)	*5.8*	*0.12*	*1.61*	*0.68*	*0.70*	*1.08*	*1.58*	*0.17*	*0.24*	*0.13*	*0.34*
SD (Total)	*2.3*	*0.25*	*0.61*	*0.43*	*0.42*	*0.47*	*1.02*	*0.25*	*0.40*	*0.19*	*0.37*

Table IV. Parameters of Technology Deals in Each Company

	Pharma Revenue ($ billion)	TOL_1	TOL_2	TCL_1	TCL_2	TFL_1	TFL_2
Abbott	5.7	4.96	0.22	1.95	0.39	1.42	0.29
Eli Lilly	10.2	6.28	0.53	3.63	0.58	3.14	0.50
Schering-Plough	8.4	3.83	0.42	1.20	0.31	2.16	0.56
Takeda	6.4	2.03	0.28	1.09	0.54	0.78	0.38
Sankyo	4.3	3.95	0.53	1.16	0.29	1.86	0.47
Yamanouchi	3.6	2.50	0.33	1.67	0.67	0.83	0.33
Bayer	5.7	8.58	0.42	4.38	0.51	5.25	0.61
Boehringer Ingelheim	5.4	5.05	0.42	2.06	0.41	4.11	0.81
Merck KGaA	2.7	4.07	0.19	1.48	0.36	1.48	0.36
Average	5.8	4.58	0.37	2.07	0.45	2.34	0.48

TOL_1: NUM(technology deals)/(revenue of a company)

TOL_2: NUM(technology deals)/NUM(all deals)

TCL_1: NUM(collaborative research, R&D joint venture, venture investment)/(revenue of a company)

TCL_2: NUM(collaborative research, R&D joint venture, venture investment)/NUM(all technology deals)

TFL_1: NUM(new technology deals)/(revenue of a company)

TFL_2: NUM(new technology deals)/NUM(all technology deals)

Table V. Emerging Technology Deals in Pharmacogenomics

	Pharma Revenue ($ billion)	Number	Number/ $Revenue
Abbott	5.7	9	1.58
Eli Lilly	10.2	17	1.67
Schering-Plough	8.4	18	2.14
Takeda	6.4	6	0.94
Sankyo	4.3	8	1.86
Yamanouchi	3.6	4	1.11
Bayer	5.7	30	5.26
Boehringer Ingelheim	5.4	17	3.15
Merck KGaA	2.7	4	1.48
Average	5.8	12.6	2.13

Table VI. Comparison of Parameters among Countries

	Pharma Revenue ($ billion)	TOL_1	TOL_2	TCL_1	TCL_2	TFL_1	TFL_2
US (Average)	8.1	5.02	0.39	2.26	0.43	2.24	0.45
(SD)	2.3	1.23	0.16	1.25	0.14	0.87	0.15
JPN (Average)	4.8	2.83	0.38	1.31	0.50	1.16	0.40
(SD)	1.5	1.00	0.13	0.31	0.19	0.61	0.07
GER (Average)	4.6	5.90	0.34	2.64	0.43	3.62	0.60
(SD)	1.7	2.37	0.13	1.53	0.08	1.93	0.23

TOL_1: NUM(technology deals)/(revenue of a company)

TOL_2: NUM(technology deals)/NUM(all deals)

TCL_1: NUM(collaborative research, R&D joint venture, venture investment)/(revenue of a company)

TCL_2: NUM(collaborative research, R&D joint venture, venture investment)/NUM(all technology deals)

TFL_1: NUM(new technology deals)/(revenue of a company)

TFL_2: NUM(new technology deals)/NUM(all technology deals)

Table VII. Ranking of Ratios of Number of Pharmaceutical Pre-clinical Drugs to $ Revenue (*Rp*)

	Rank
Abbott	1
Eli Lilly	6
Schering-Plough	5
Takeda	8
Sankyo	4
Yamanouchi	9
Bayer	2
Boehringer Ingelheim	7
Merck KGaA	3

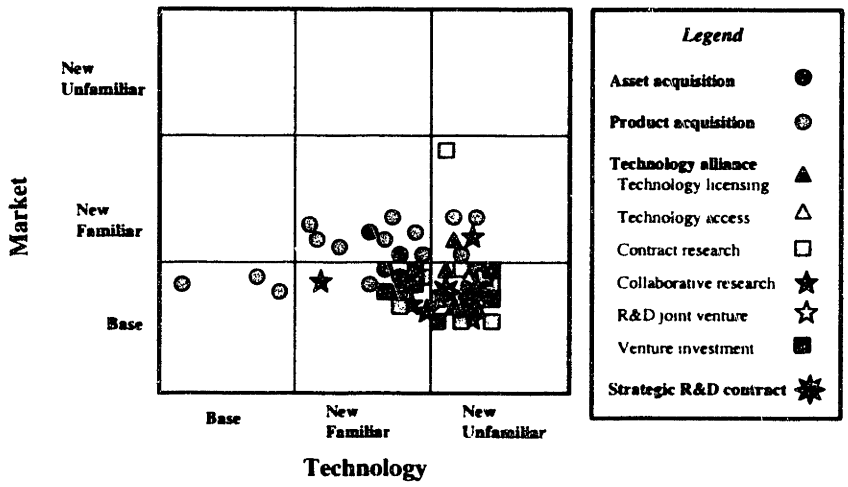


Fig. 6. Familiarity Matrix Analysis for Abbott

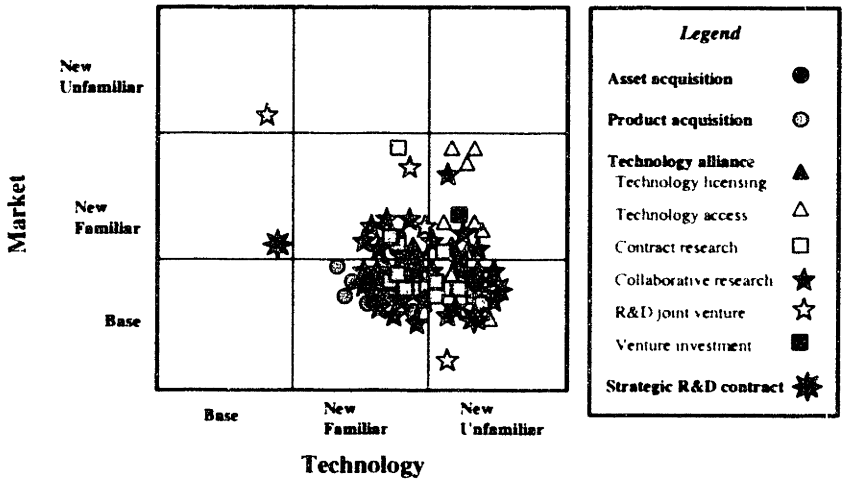


Fig. 7. Familiarity Matrix Analysis for Eli Lilly

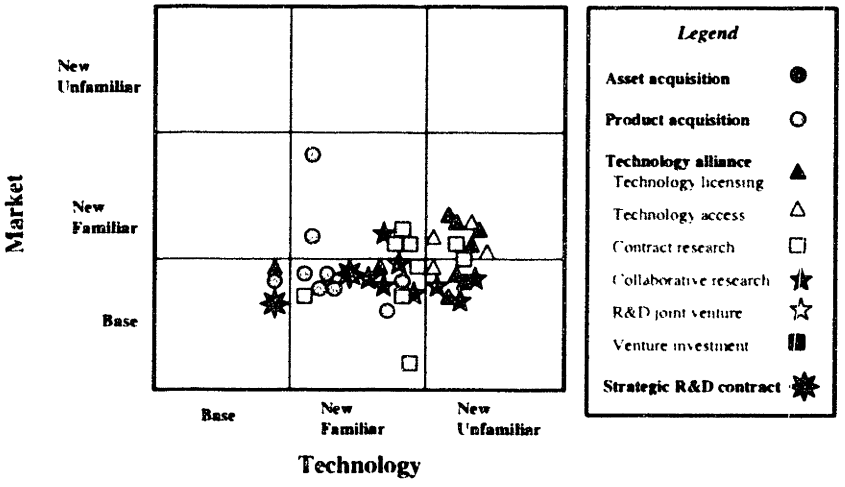


Fig. 8. Familiarity Matrix Analysis for Schering-Plough

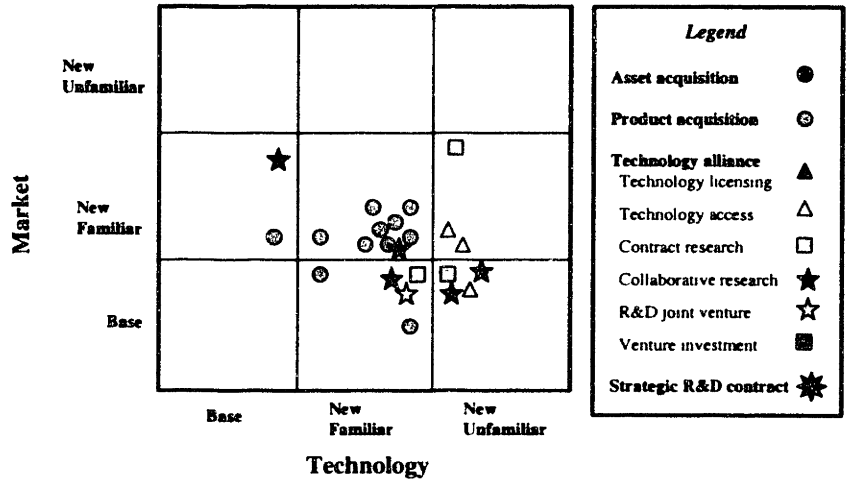


Fig. 9. Familiarity Matrix Analysis for Takeda

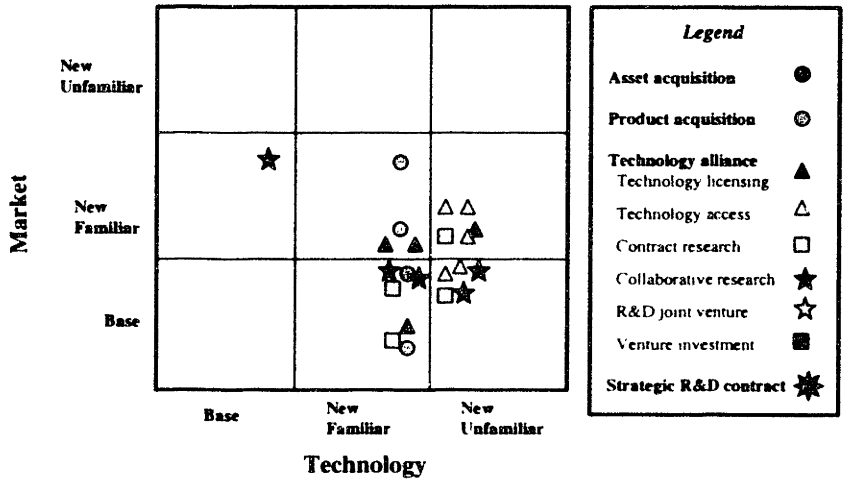


Fig. 10. Familiarity Matrix Analysis for Sankyo

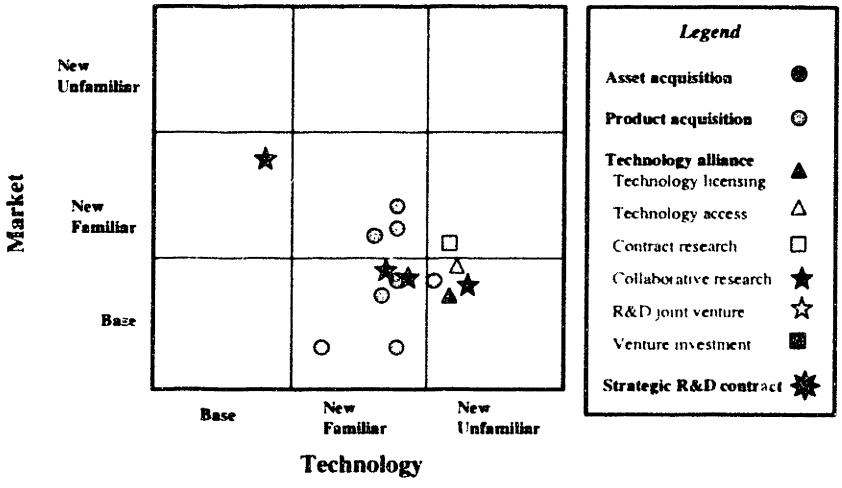


Fig. 11. Familiarity Matrix Analysis for Yamanouchi

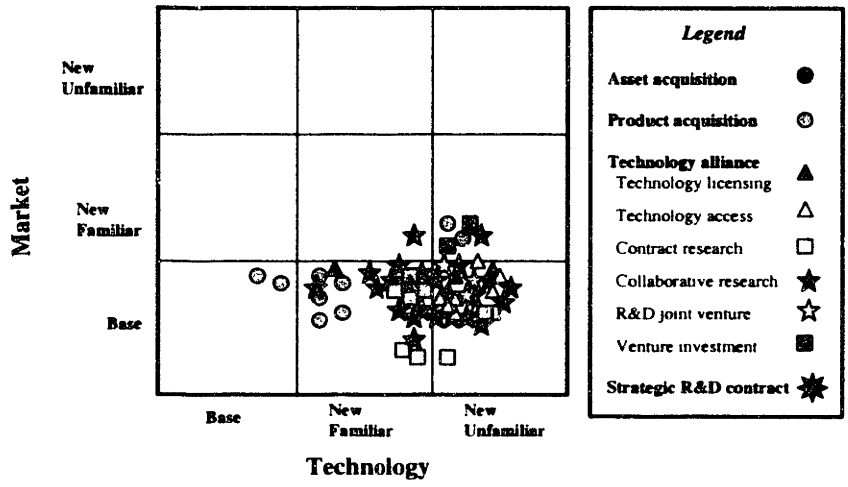


Fig. 12. Familiarity Matrix Analysis for Bayer AG

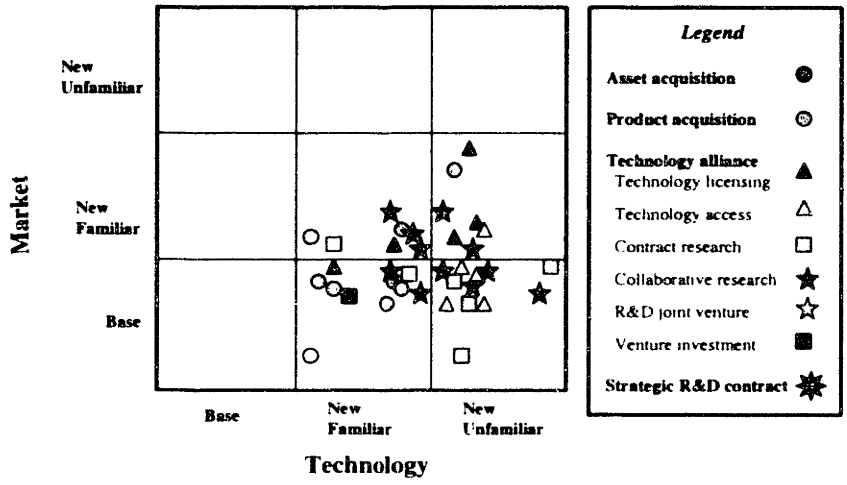


Fig. 13. Familiarity Matrix Analysis for Boehringer-Ingelheim

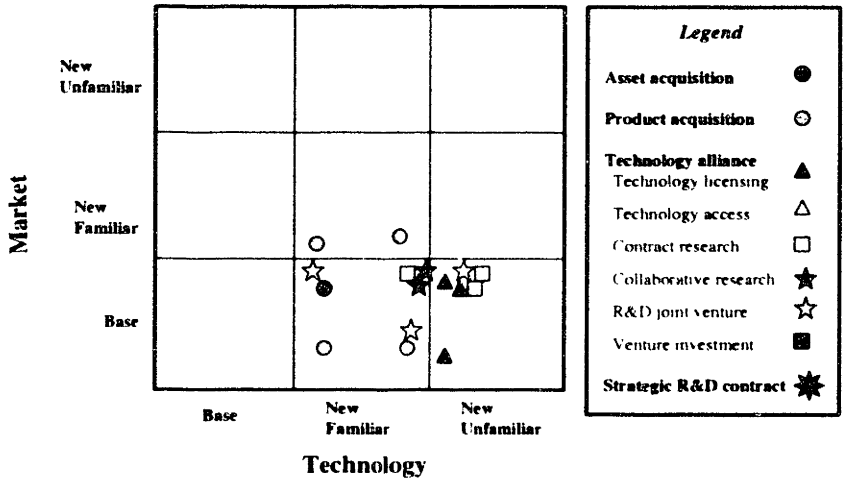
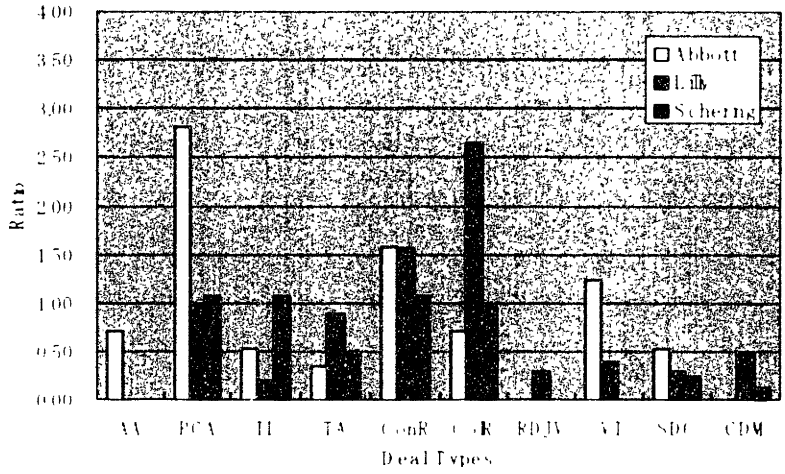


Fig. 14. Familiarity Matrix Analysis for Merck KGaA

Fig. 15. Ratio of Number of Deals to Revenue (US)



Fi. 16. Ratio of Number of Deals to Revenue (Japan)

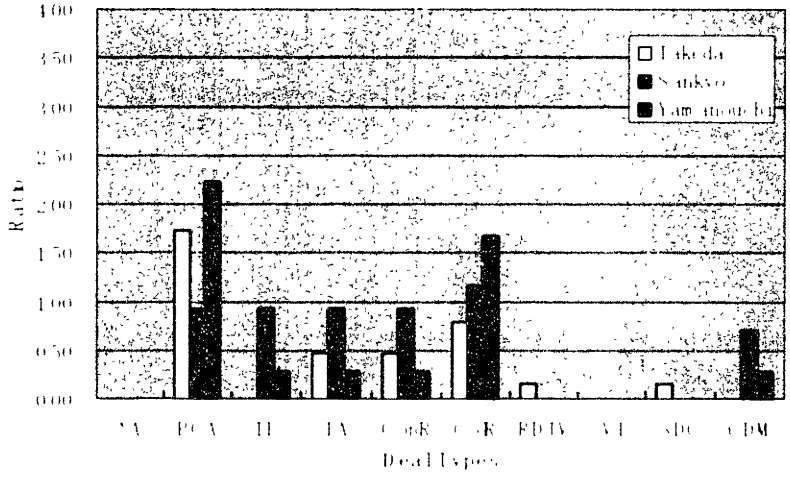


Fig. 17. Ratio of Number of Deals to Revenue (Germany)

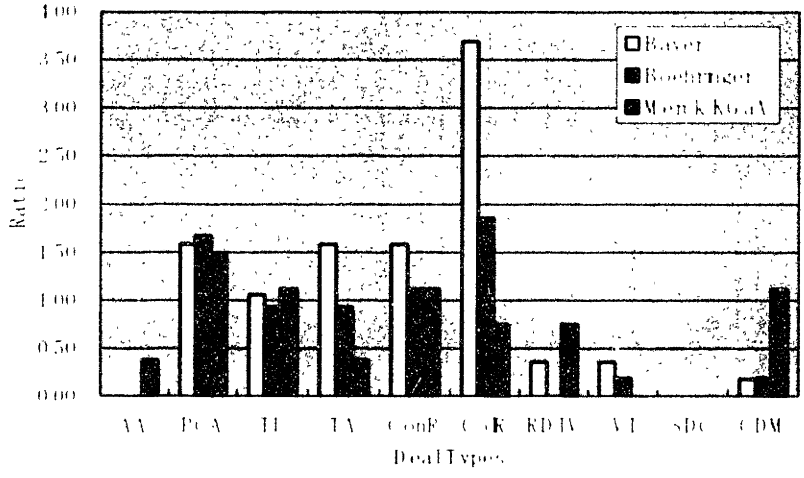


Fig. 18. Deals for Pharmacogenomics
- US Pharmaceutical companies -

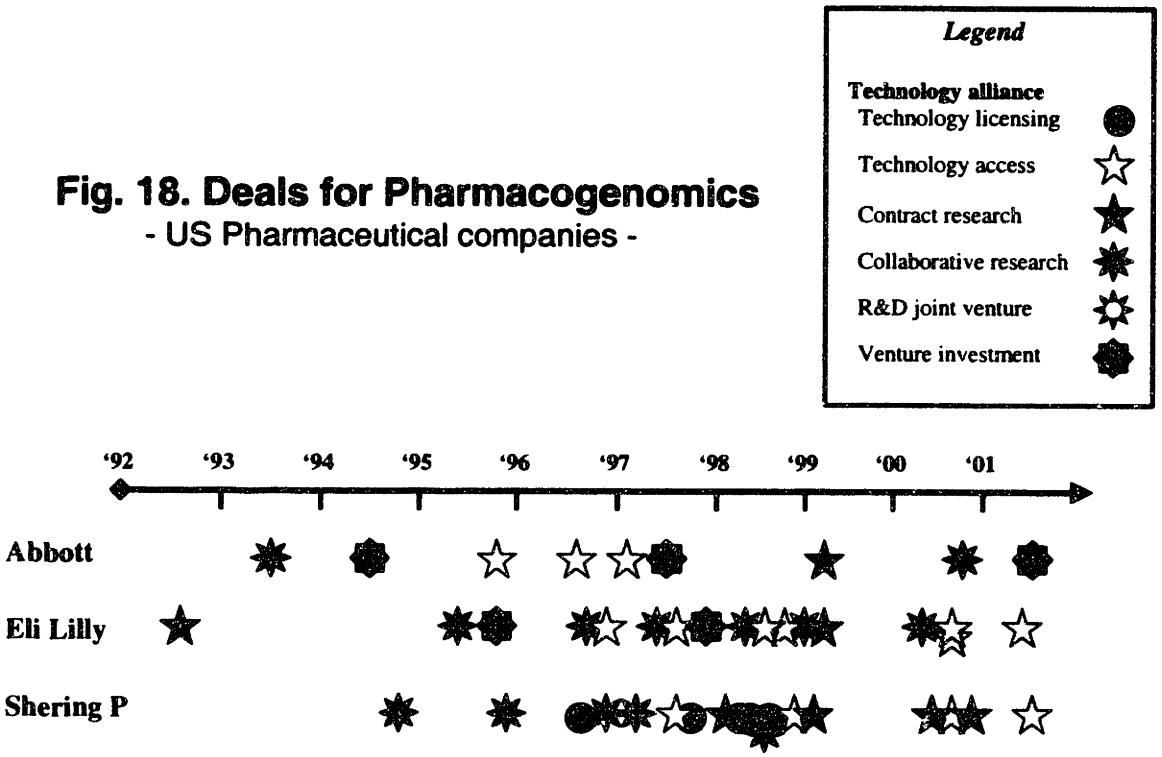


Fig. 19. Deals for Pharmacogenomics
- Japanese Pharmaceutical companies -

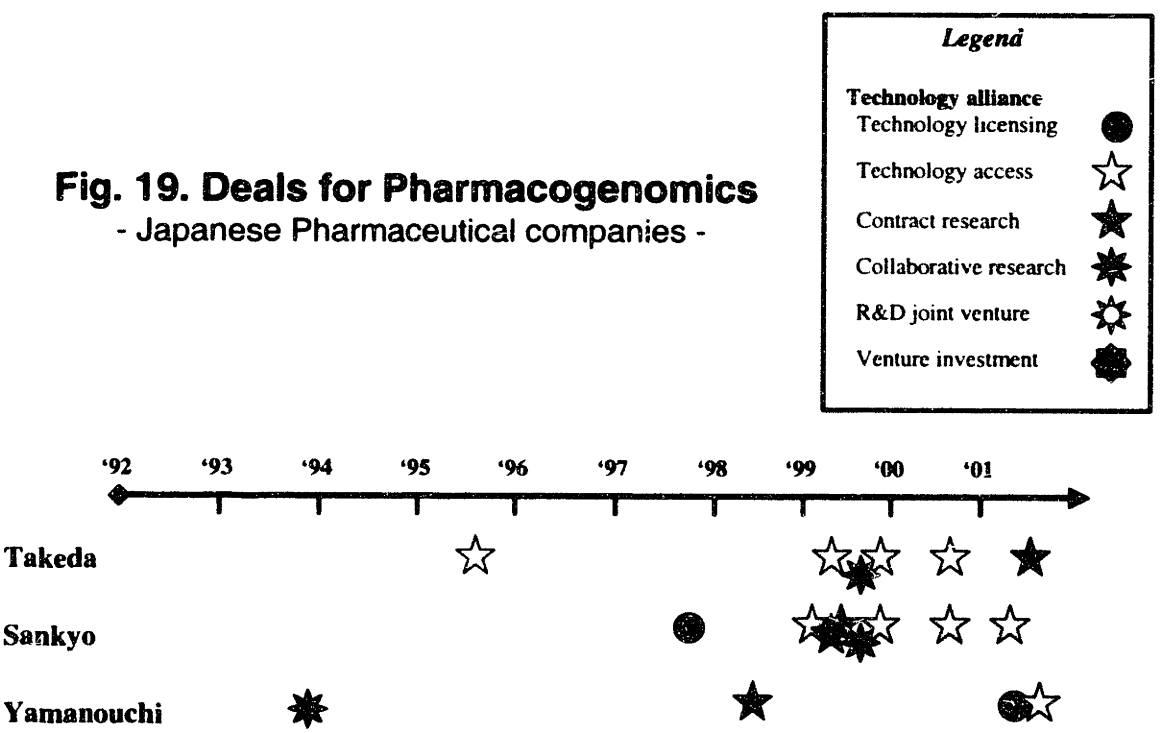


Fig. 20. Deals for Pharmacogenomics
- German Pharmaceutical companies -

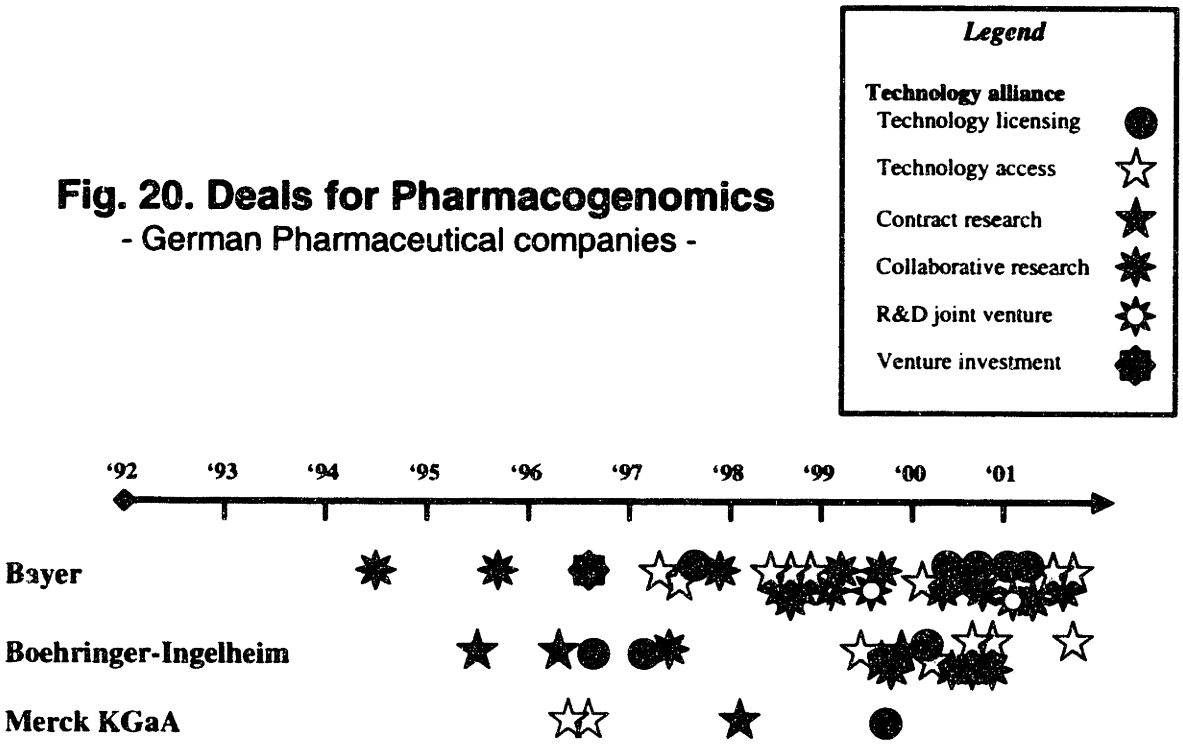


Fig. 21. Comparison of Average Ratio of Deals among Countries

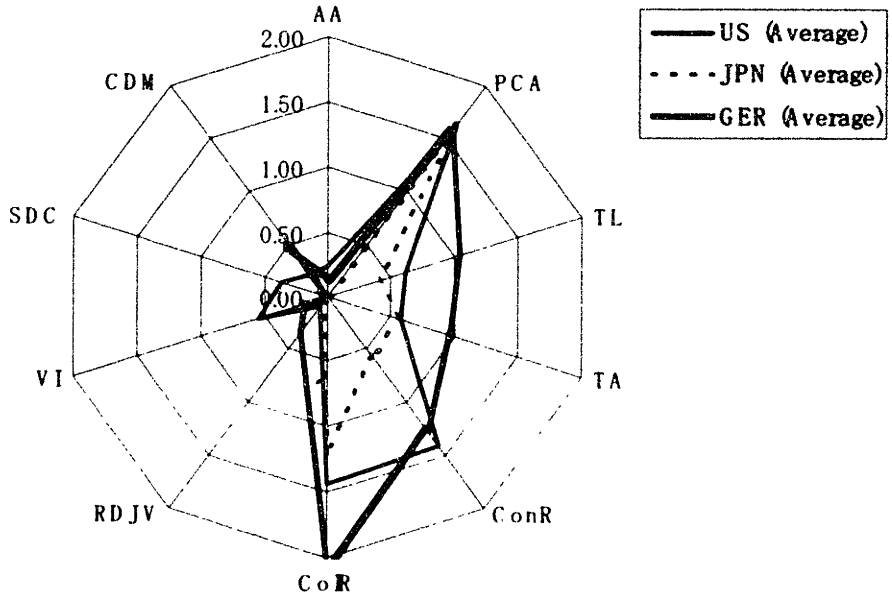


Fig. 22. Patent ("DNA")/Revenue

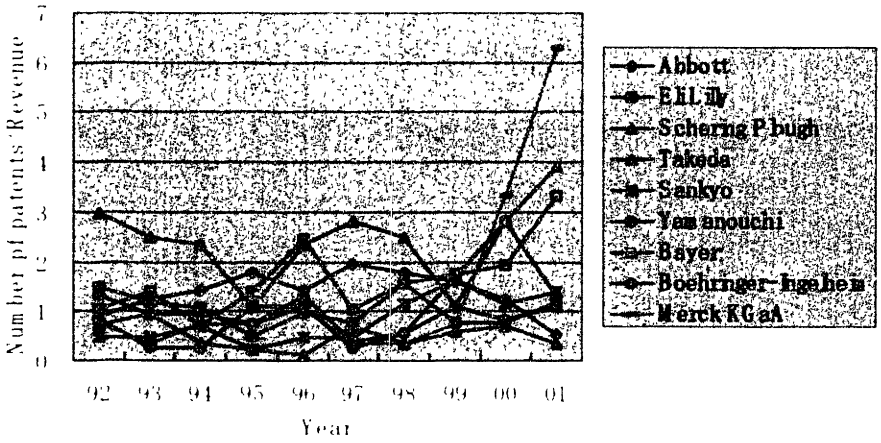


Fig. 23. Patents ("Gene")/Revenue

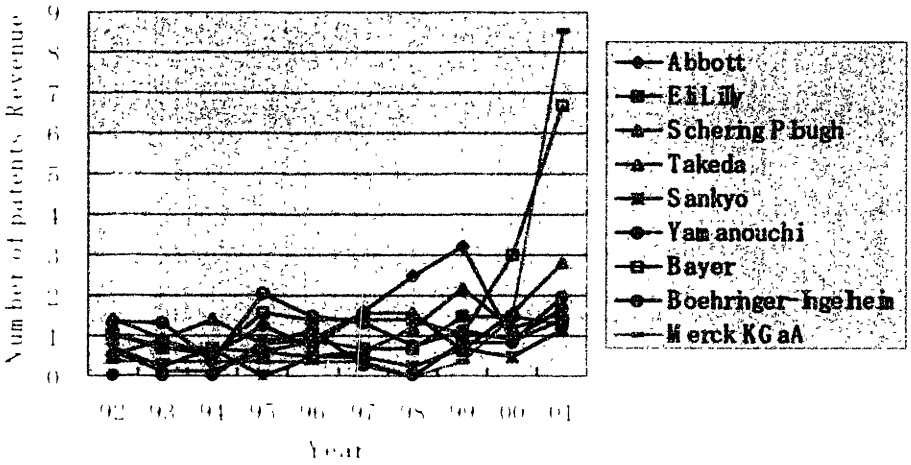


Fig. 24. Patent ("Gene therapy")/Revenue

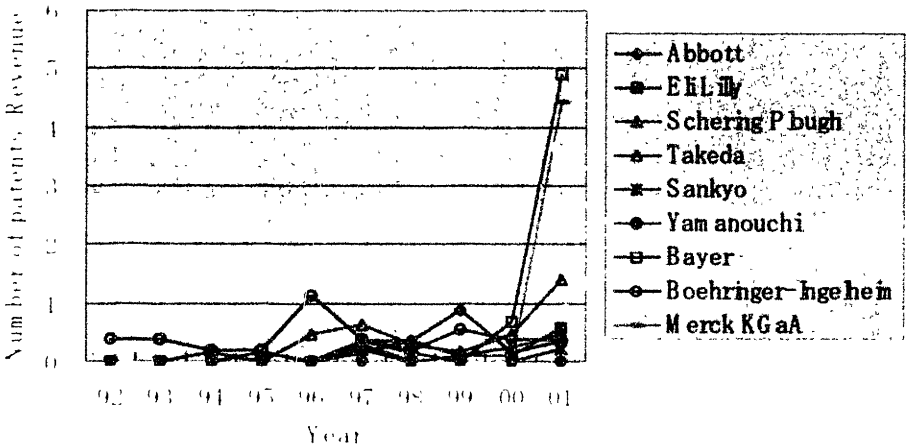


Fig. 25. Ratio of Number of Preclinical Candidates to Revenue (*Rp*)

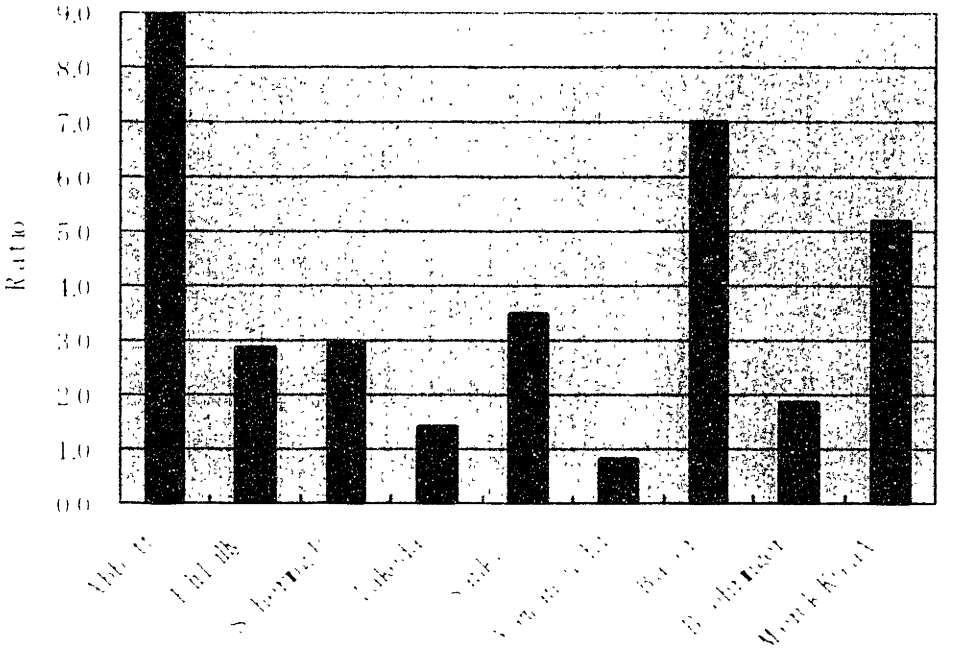
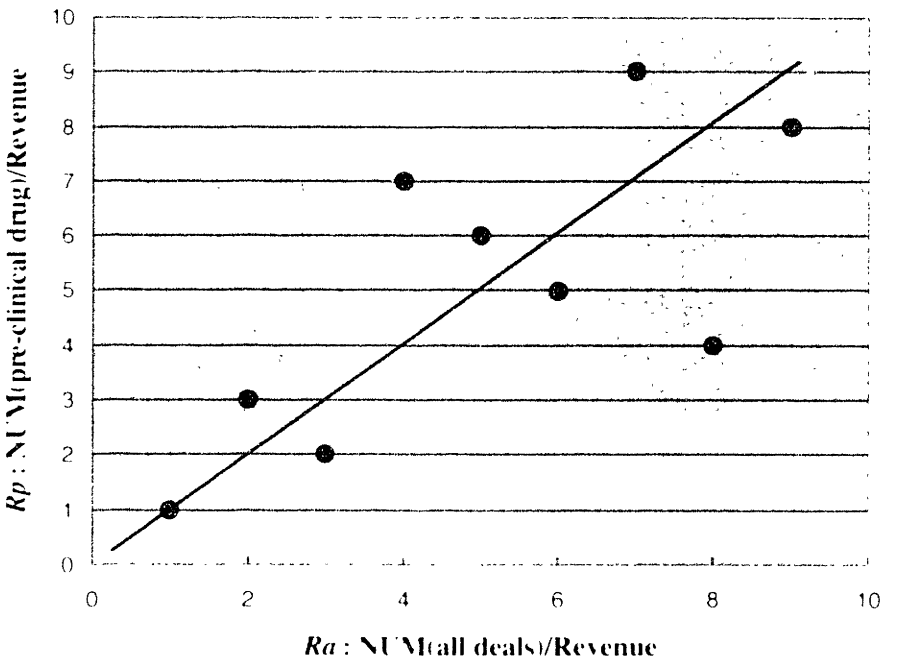
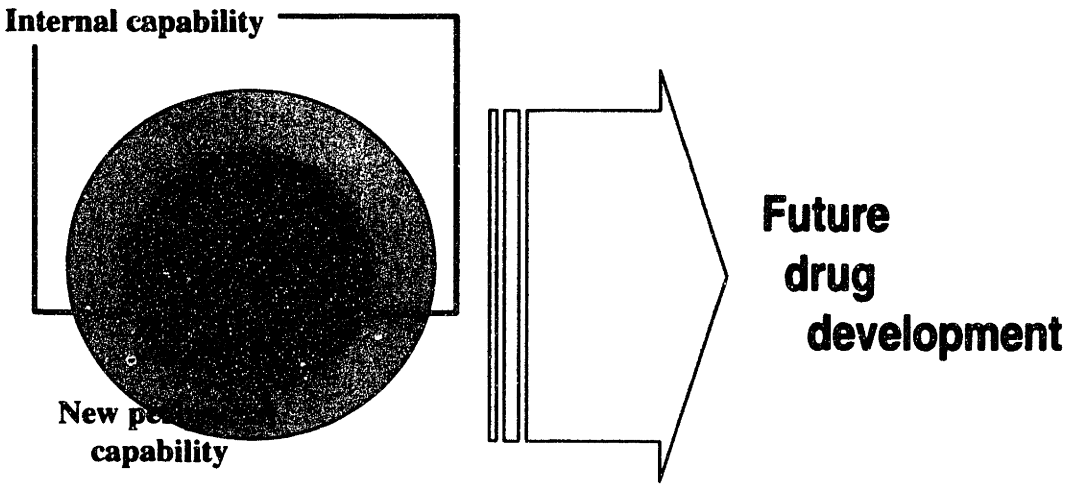


Fig. 26. Correlation between Ra and Rp





New core capability: Acquisition, Strategic alliance (long-term)
New peripheral capability: Transactional alliance (temporary)

Fig. 27. Concept of New Capability for Future Drug Development

Source: Muranishi (author)

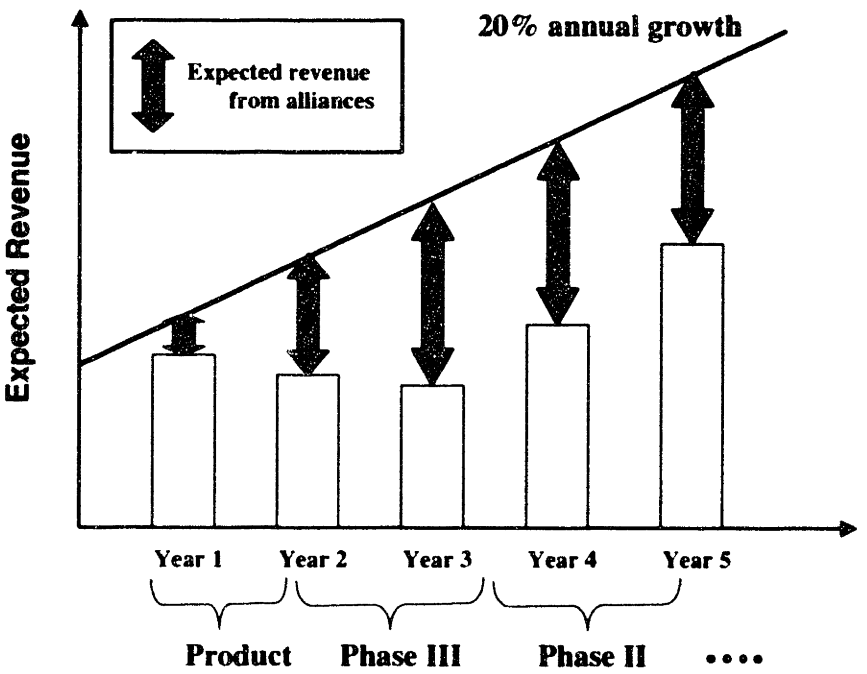


Fig. 28. Concept of Setting of Alliance Volumes

Source: Interview with Mr. Ransom

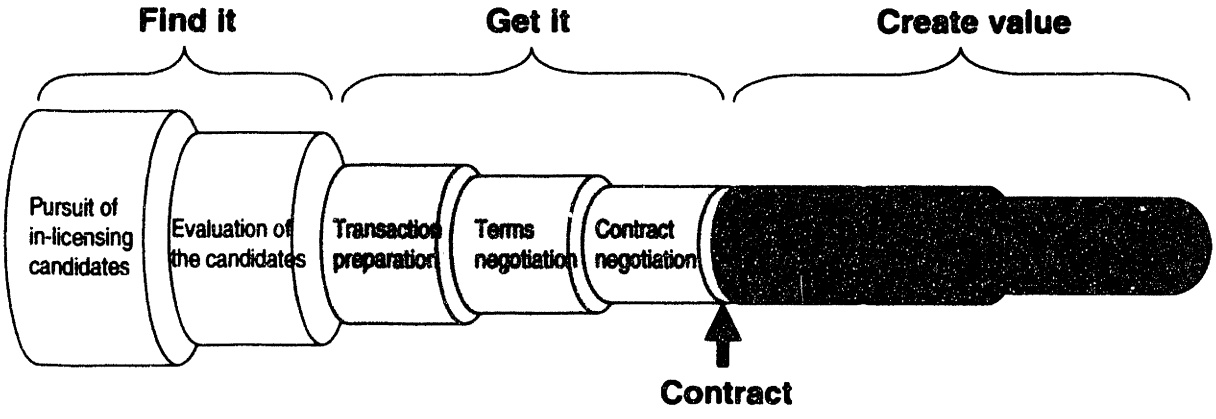


Fig. 29. Mapping of Step-integrated process of Alliance Management

Source: Gueth, Thompson

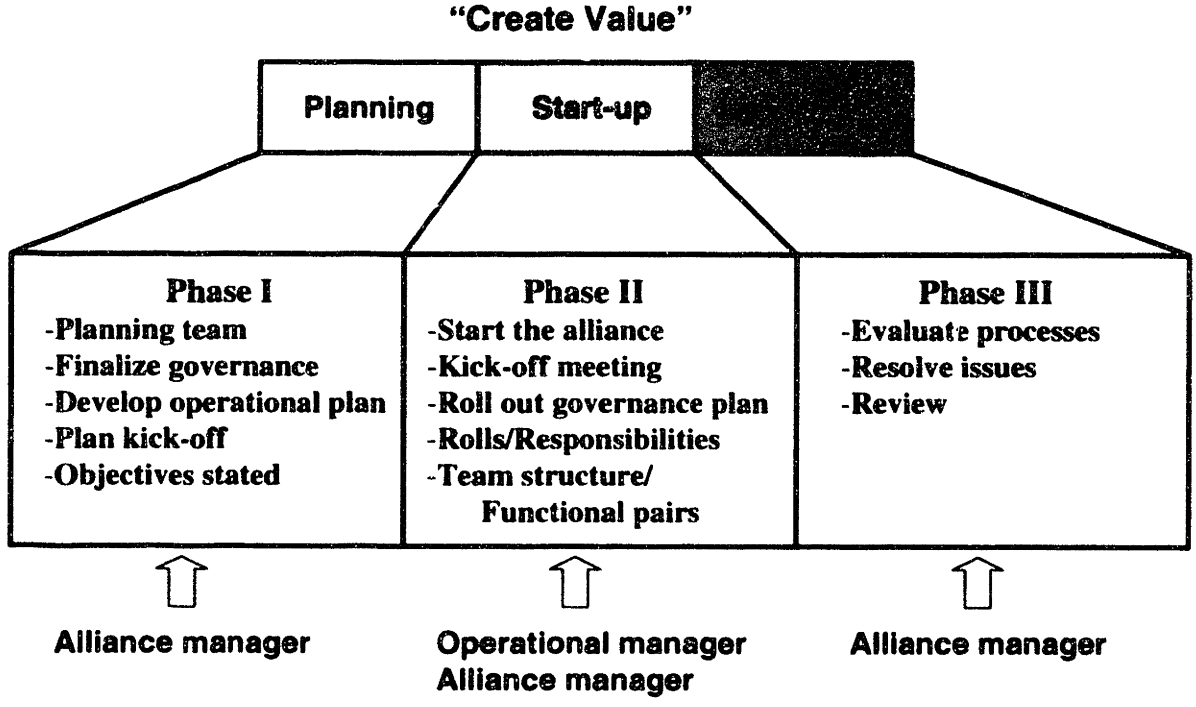


Fig. 30. Details of "Create Value" Process

Source: Interview with Mr. Ransom

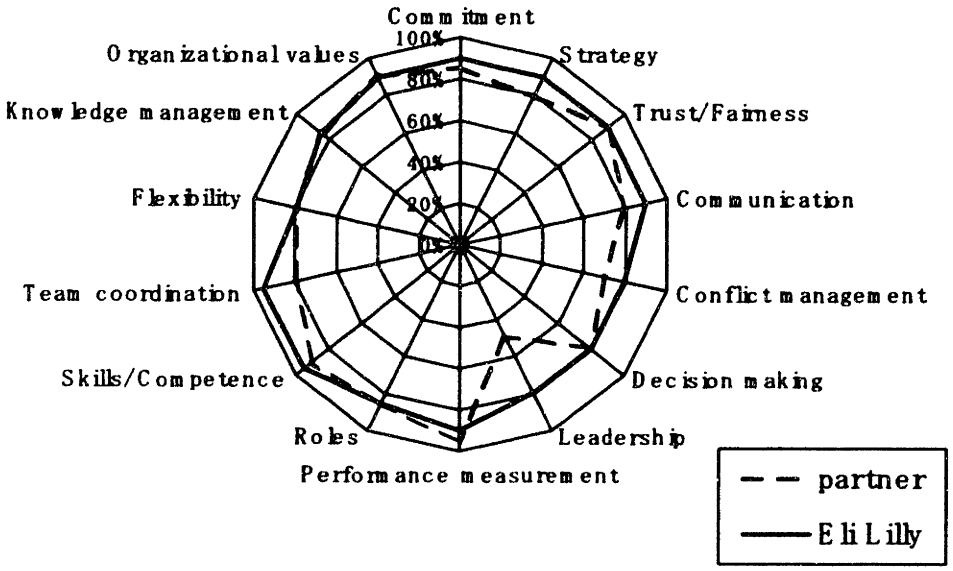


Fig. 31 (A). Assessment of Alliance Condition

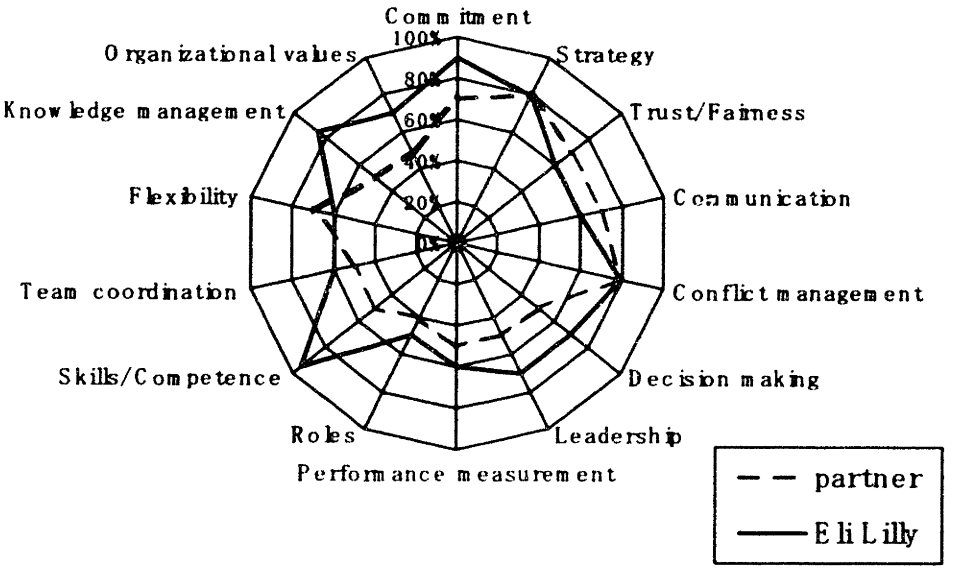


Fig. 31 (B). Assessment of Alliance Condition

Source: Gueth

APPENDICES

Appendix 1

Typical Differences between Biotech and Pharmaceutical Companies

Biotech company	Pharmaceutical company
Research oriented	Research, Development (clinical), marketing functions
Small sales	Large sales
Small number of employees (20-300)	Large number of employees (more than 5,000)
Stock or private ownership	Stock ownership
Zero or one product	25-100 products
Rapid and flexible decision-making	Slower decision-making
Short history (less than 15 years)	Long history (50-150)

Appendix 2

Familiarity analysis - criteria

	Technology	Market
1-	complete consistency with in-house technology	complete same market
1+	much overlap with in-house technology	same market logistic expansion
2-	some overlap and relatively supplementary	similar market
2+	some overlap but challenging	similar market but unpredictable market
3-	new technology	different domestic market, or similar foreign market
3+	new technology and challenging	different market foreign market

Familiarity

Appendix. 3. Technology deals in Abbott Laboratories (1996-2001)

Number of deals													
outwards	Inwards	Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
0	4	*Asset or business acquisition (AA)*	3/96		Medisense Inc	ES	T&M	Product Technology glucose self-testing systems		Diabetes	876	Tech (2+) Market (1+)	98% share
	Product 4		4/97		Sanofi Pharmaceuticals Inc	ES	T&M	Products Production R&D plant			200	Tech (2+) Market (1+)	a part of Sanofi
			11/99		Perclose	ES	T&M	Medical device Drug delivery		Cardiovascular	644	Tech (2+) Market (2-)	
			12/00		BASF AG	ES	T&M	Products R&D plant and force		Metabolic Autoimmune disease Pain relief	6900	Tech (2+) Market (2-)	Strengthen infrastructure 10,700 employees
2	16	*Product or Candidate acquisition (PCA)*	1/97		La Jolla Pharmaceutical Co	ST	D&M	Candidate Phase III	Marketing	Infection	50 (Up-front 10 Milestone 40)	Tech (2+) Market (1+)	
	Launched 0		4/97		BioTime	ST	D&M	Plasma expanding candidate Phase III	Marketing		Total 40 (initial 2 5 Royalty)	Tech (3-) Market (2-)	
	Pre 7 P I 1 P II 2 P III 4		7/97		Medicis Pharmaceutical Corp	ES	T	undisclosed	Development Manufacturing	Infection (Dermatitis)		Tech (2+) Market (2-)	
			10/97		Vanguard Medica Group plc	ST	D&M	Candidate Pre clinical	Marketing	Infection	3 + royalty	Tech (2+) Market (2-)	
			10/98		Nippon Shinyaku	ES	D&M	Candidate Phase II	Marketing	Genitourinary (incl sex hormones)	Royalty Milestone	Tech (1+) Market (1+)	
			11/98		Aronex Pharmaceuticals Inc	ES	D&M	Candidate Phase III	Marketing	Infection	Total 40 (Equity invest 3 Milestone 11 9)	Tech (1+) Market (1+)	
			6/99		Cephalon Inc	ST	M	undisclosed	Marketing	CNS		Tech (3-) Market (2-)	
			11/99		Antisoma Ltd	ST	D&M	Candidate Phase III	Marketing	Cancer	total 100 + Royalty	Tech (2-) Market (2-)	

			12/99		Wakunaga Pharmaceutical Co Ltd	ES	D&M	Candidate Pre clinical	Marketing	Infection	-	Tech (1+) Market (1-)	
			1/00		American Biogenetic Sciences Inc	ST	D&M	Candidate Pre clinical	Marketing	CNS	Equity and milestone	Tech (2-) Market (2-)	
			3/00		NPS Pharmaceuticals Inc	ES	D&M	Candidate Pre-clinical	Marketing	CNS	Royalty Milestone	Tech (2-) Market (2-)	
			4/00		Chrysalis Biotechnology Inc	ST	D&M	Candidate Phase II	Marketing	Diabetic wound care	-	Tech (2+) Market (2-)	
			7/00		Eisai Co Ltd	ES	D&M	Candidate Phase I	Marketing	Cancer	Royalty Milestone	Tech (2+) Market (2-)	
			11/00		Fujisawa Pharmaceutical Co Ltd	ES	D&M	Candidate Pre clinical	Marketing	Erectile dysfunction	-	Tech (3-) Market (2-)	
			Jun-01		Pharmacosmos A/S	ST	D&M	Candidate Pre clinical	Marketing	Anemia	-	Tech (3) Market (1+)	
			Jun-01		Ligand Pharmaceuticals Inc	ST	D&M	Candidate Pre-clinical	Marketing	Genitourinary (incl sex hormones)	Total 44 Funding Milestone	Tech (2+) Market (1+)	
1	3	*Technology licensing (TL)*	7/96		Arris Pharmaceutical Corp	ST	T	Drug discovery technologies	Research Development	-	-	Tech (3-) Market (1+)	not exclusive
			11/99		Biocompatibles Inc	ST	T&D	Drug delivery (coated stent)	Development	Cardiovascular	-	Tech (3-) Market (2-)	
			Jul-01	•	Weston Medical Group plc	ES	T	Intraject needlefree drug delivery technology	Development	multi	Royalty Milestone	Tech (3-) Market (1+)	
1	2	*Technology access (TA)*	9/96	•	Oxford Molecular Group Plc	ES	T	Basic Research / discovery. Bioinformatics Chemical structure	Research	multi		Tech (3-) Market (1+)	
			1/97	•	Incyte Pharmaceuticals, Inc	ST	T	Genomics / functional genomics Pharmacogenomics	Research	multi		Tech (3-) Market (1+)	in silico SNP programme
	9	*Contract research (ConR)*	1/97		Jago Pharma AG	ST	T	Drug delivery Respiratory	Development	Infection	Royalty 4 7%	Tech (3-) Market (1+)	
			1/97		ArQule Inc	ST	Seeds	Discovery Assay detection Seeds library	Development	multi		Tech (3-) Market (1+)	

		12/97		ICAgen Inc	ST	Seeds	Early stage candidates	Development	Genitourinary Neurological	Up-front 12 Milestone Royalty	Tech (2+) Market (1+)	
		1/99	*	Isis Pharmaceuticals Inc	ST	Seeds	Discovery High throughput screening (Gene target)	Development	multi	Royalty Milestone	Tech (3-) Market (1+)	Antisense Target Validation (ATV) technology
		9/99		Chiron Corporation	ES	T Seeds	Diagnostics Basic Research / discovery	Development	Infection (HCV)	Up front Milestone	Tech (2+) Market (1+)	
		4/00		Martek Biosciences Corp	ST	T	long chain polyunsaturated fatty acids technology	Research Development	Infant formulas	-	Tech (3-) Market (1+)	
		5/00		Abgenix Inc	ST	Evaluation	Animal model technology	Research Development	multi	Research fee Milestone Royalty	Tech (3-) Market (1+)	
		5/00	*	IPF PharmaCeuticals GmbH	ES	T Seeds	Basic Research / discovery (peptide)	Development	multi	Funding Milestone Royalty	Tech (3-) Market (2+)	First-refusal right
		6/00		Battelle Pulmonary Therapeutics	AC	T	Pulmonary drug delivery	Development	Respiratory diseases	-	Tech (3-) Market (1+)	
4	*Collaborative research (ColR)*	4/98		Becton Dickinson Immunocytometry Systems	ES	T&D	Immunological technology	Research Development	Diagnostics	-	Tech (2+) Market (1+)	
		11/99		Karo Bio AB	ST	Seeds Proprietary tech	Early stage candidates	Research Development	Diabetes	Funding Milestone Royalty	Tech (2) Market (1+)	
		1/00		Neurosearch AS	ST	Seeds	Early stage candidates	Research Development	CNS	Milestone 17 Royalty	Tech (3-) Market (1+)	
		11/00	*	Rosetta Inpharmatics, Inc	ST	Creat database	Bioinformatics Micro array	Research Development	multi	-	Tech (3-) Market (2-)	
0	*R&D joint venture (RDJV)*	-		-	-				-			
7	*Venture investment (VI)*	4/96		RiboGene Inc	ST	Seeds	High throughput screening Candidates	Development	Infection	Total 27 Equity Royalty Milestone	Tech (3-) Market (1+)	

		7/97	*	Genset SA	ST	T	Functional genomics Pharmacogenomics	.	multi	Maximum 42 5 (stock 20 up-front 10)	Tech (3-) Market (1+)	
		9/97		Metabolex Inc ,	ST	T	Seeds	.	Diabetes	4	Tech (3-) Market (.+)	
		10/97		Biorex Research & Development Rt	ST	T&M	Candidate (Phase II)		Diabetes	28	Tech (2+) Market (1+)	Phase II First-refusal right
		1/98		LocalMed	ST	T&M	Drug delivery Medical devices		Cardiovascular	milestone type	Tech (3-) Market (1+)	
		8/97		Procept Inc	ST	T	Discovery (High throughput screening)	.	.	.	Tech (2+) Market (1+)	
		Mar 01	*	Millennium Pharmaceuticals Inc	ST	T	Pharmacogenomics		Diabetes	250	Tech (2+) Market (1+)	
3	*Strategic development contract (SDC)*	10/97		Taisho Pharmaceutical Co Ltd	ES	M	Seeds	Co-development	Infection	Royalty	Tech (3-) Market (1+)	Discovery to marketing
		7/99		NaPro BioTherapeutics Inc	ST	M	Seeds	Co-development	Cancer	Funding Milestone	Tech (3-) Market (1+)	Drug delivery to marketing
		1/00		Neurosearch AS	ST	M	Seeds	Co development	CNS	17 (milestone)	Tech (3-) Market (1+)	Discovery to marketing
0	*Co-development Co-marketing (CDM)*	.		.	.							

Additional data: Bioinformatics, Gene technology (1992-1996)

Collaborative research (ColR)	7/93		Collaborative Research	ST	T	DNA Manupulation Gene cloning	Research Development	Cancer etc	.	Tech (2+) Market (1+)	
Venture investment (VI) Contract research (ConR)	7/94		Ligand Pharmaceuticals Inc	ST	T	Candidate Pre-clinical	Research Development	Infection Cancer	26 Equity investment Milestone	Tech (3-) Market (1+)	
Technology access (TA)	12/95		Incyte Pharmaceuticals, Inc	ST	T	Genomics / functional genomics Pharmacogenomics (Lifeseq)	discretionary	Infection	Subscribe fee Milestone Royalty	Tech (3-) Market (1+)	in silico SNP programme

Appendix. 4. Technology deals in Eli Lilly (1996-2001)

Number of deals													
outwards	inwards	Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
2	0	*Asset or business acquisition (AA)*											
11	10	*Product or Candidate acquisition (PCA)*	5/97		The Cancer Therapy and Research Center Research Foundation	AC	T&D	Candidate pre-clinical (two anticancer compounds)	Development Marketing	Cancer		Tech (2+) Market (1+)	
	Launched 0		9/98		Cerebrus	ST	M	Candidate pre clinical	Development Marketing	Cancer		Tech (2+) Market (2-)	
	Pre 2 P I 4 P II 4 P III 0		12/98		Sepracor Inc	ST	D&M	Candidate phase I	Development Marketing	CNS (depression)	90 (up front 20 milestone 70)	Tech (2+) Market (1+)	
			4/99		AutoImmune Inc	ST	D&M	Candidate phase II	Development Marketing	Diabetes		Tech (2+) Market (1+)	
			5/99		SIBIA Neurosciences Inc	ST	T	Candidate phase II	Development Marketing	CNS	20	Tech (2+) Market (1+)	
			4/00		Ono Pharmaceutical Co Ltd	ES	M	Candidate phase II	Marketing	Lung injury and acute respiratory distress syndrome	Up-front Milestone Royalty	Tech (2+) Market (1+)	
			12/00		Mitsubishi Tokyo Pharmaceuticals Inc	ES	D&M	Candidate phase I	Development Marketing	Infection (HBV)		Tech (2+) Market (1+)	
			12/00		Sankyo Co. Ltd	GL	D&M	Candidate phase I	Development Marketing	Cardiovascular	Up-front Milestone Royalty	Tech (2+) Market (1+)	
			Feb 01		IVAX Corporation	ST	T	Candidate phase II	Development Marketing	CNS		Tech (2+) Market (1+)	
			May 01		BioMerieux Pierre Fabre	ES	D&M	Candidate phase I	Development Marketing	Cardiovascular	Up-front Milestone Royalty	Tec.. (2+) Market (1+)	
	2	*Technology licensing (TL)*	12/97		SIBIA Neurosciences Inc	ST	T	High throughput screening	Research	multi		Tech (2+) Market (2-)	

			11/98	*	Peptide Therapeutics Group plc	ST	T	Discovery, Evaluation (Rational Approach to Protease Inhibitor Design)	Evaluation of technology	Cancer	-	Tech (3-) Market (2-)
2	9	*Technology access (TA)*	12/96	*	Incyte Pharmaceuticals Inc	ST	T	Discovery Gene Chip, Software	Research	multi	Access fee Mile stone Royalty	Tech (3-) Market (2-)
			5/97		Xoma Corp	ST	T	Recombinant pharmaceutical production	Research		-	Tech (3) Market (1+)
			8/97	*	Acacia Biosciences Inc	ST	T	Functional genomics	Research	basic	-	Tech (3-) Market (2+)
			7/98	*	Pangea Systems Inc	ST	T	Discovery Functional genomics Bioinformatics	Research	basic	-	Tech (3-) Market (2+)
			9/98	*	Affymetrix, Inc	ST	T	Discovery Gene Chip, Software	Research	multi	-	Tech (3-) Market (2-)
			10/00	*	BIOBASE	ST	T	Discovery Functional genomics	Research	basic	-	Tech (3-) Market (2-)
			10/00	*	Orchid BioSciences, Inc	ST	T	Pharmacogenomics (SNP genotyping)	Research	basic	-	Tech (3-) Market (2-)
			11/00		Lexicon Inc	ST	T	Drug discovery (knockout mouse)	Research	basic	-	Tech (3) Market (2+)
			Apr 01	*	Simulations Plus Inc	ST	T	ADME software (Gastroplus bioinformatics)	Research	basic	-	Tech (3-) Market (1+)
	16	*Contract research (ConR)*	11/96		EcoPharm	ST	T	Discovery Seeds(from plant)	Clinical development	infection	Milestone Royalty	Tech (3) Market (1+)
			1/97	*	TheraTech Inc	ST	T	Drug delivery (peptide, oral transmucosal delivery)	Clinical development	multi	Funding Milestone Royalty	Tech (3-) Market (1+)
			5/97		Scripgen Pharmaceuticals Inc	ST	T	Screening technology	Seeds	multi	Fund Milestone	Tech (2+) Market (2+)
			2/98		MetaXen LLC	ST	T	Seeds screening Preclinical development	Clinical development	Cardiovascular	35	Tech (2+) Market (1+)

		3/98		Ligand Pharmaceuticals Inc	ST	T	Seeds	development		20	Tech (2+) Market (2-)		
		6/98	•	Emisphere Technologies Inc	ST	T	Drug delivery (oral proteins delivery)	Development Marketing	Osteoporosis Endocrinology	2	Tech (3-) Market (1+)		
		7/98	•	Genzyme Transgenics Corp	ST	T&M	Discovery (novel therapeutic protein to be produced transgenically)	Development	multi	Maximum 22	Tech (3-) Market (2-)		
		9/98	•	Dura Pharmaceuticals Inc	ST	T	Drug delivery (Inhalation)	Development	Diabetes	Fund Milestone	Tech (3-) Market (1+)		
		1/99	•	Millennium Pharmaceuticals Inc	ST	T	Discovery Seeds	Development Marketing	Cancer	Milestone Royalty	Tech (2+) Market (1+)		
		2/00	•	Alkermes Inc	ST	T	Drug delivery (Inhalation)	Development Marketing	growth-related disorders	Funding Milestone	Tech (3-) Market (1+)		
		9/00		Ceptyr, Inc	ST	T	Discovery Seeds	Development	Diabetes	Funding Milestone	Tech (2+) Market (1+)		
		9/00	•	Generex Biotechnology Corp	ST	T	Drug delivery (buccal formulation of insulin)	Development Marketing	Diabetes	Initial payment Milestone Royalty	Tech (3-) Market (1+)		
		9/00		Protein Design Labs Inc	ST	T	Human antibody production	Development		Initial payment Royalty	Tech (2+) Market (1+)		
		9/00	•	Inhale Therapeutic Systems Inc	ST	T	Drug delivery (Inhalation)	Development	Osteoporosis		Tech (3-) Market (1+)	new application	
		11/00		Medarex Inc	ST	T	Discovery Seeds (antibody)	Development	Multi	Initial payment Milestone Royalty	Tech (2+) Market (2-)		
		Apr 01	•	Alkermes Inc	ST	T	Drug delivery (Inhalation)	Development Marketing	Diabetes	Funding Milestone	Tech (3-) Market (1+)	new application	
27	*Collaborative research (CoIR)*	7/96	•	Onyx Pharmaceuticals Inc	ST	T	Discovery Functional genomics	Research	Cancer	Funding	Tech (3-) Market (1+)	extension	

10/96		Neurocrine Biosciences Inc	ST	T	Discovery Seeds	Scientific support	CNS Diabetes	Maximum 74 (Up front 20)	Tech (3-) Market (1+)
11/96		Synaptic Pharmaceutical Corp	ST	T	Discovery Seeds	Research	CNS	Milestone Royalty	Tech (3-) Market (1+)
1/97		Cambridge Antibody Technology	ST	T	Human antibody libraries Research technologies	co development	[illegible]	Milestone Royalty	Tech (3-) Market (2+)
1/97		SIBIA Neurosciences Inc	ST	T	Discovery Seeds	Research	CNS	Milestone Royalty	Tech (3-) Market (1+)
1/97	•	Inhale Therapeutic Systems	ST	T	Drug delivery (Inhalation)	Research Development	Osteoporosis	maximum milestone 20	Tech (3-) Market (2)
1/97		Aurora Biosciences Corp	ST	T	High throughput screening	Research Co-development		Fund Milestone	Tech (2+) Market (2-)
2/97		Athena Neurosciences Inc	ST	T	Peptide/protein technology	Research	CNS (Alzheimer)		Tech (2+) Market (1+)
4/97	•	Eastern Virginia Medical School (EVMS)	AC	T	Technology of regeneration of islet liver cells	Research	Diabetes	Up-front Milestone Royalty	Tech (3-) Market (2-)
4/97		Scios Inc	ST	T	Screening technology Seeds	Research Development of technology	CNS (Alzheimer)	Fund Milestone	Tech (2+) Market (1+)
5/97	•	Megabios Corp	ST	T	Gene therapy Drug delivery	Clinical development	Cancer	Equity investment Milestone	Tech (3-) Market (2-)
1/98		Protein Design Labs Inc	ST	T	Seeds screening	Evaluation Development	Infection	Maximum 35	Tech (2+) Market (1+)
1/98	•	Inhale Therapeutic Systems	ST	T	Drug delivery (Inhalation)	Development	Diabetes	maximum milestone 20	Tech (3-) Market (1+)
1/98		Albany Molecular Research	ST	T	Seeds screening	Research (provide system access)		-	Tech (2+) Market (2-)
1/98		Alleks Biopharmaceuticals Inc	ST	T	Discovery Seeds	Research		30	Tech (2+) Market (2-)

3/98	•	Columbia University	AC	T	Discovery Seeds (Genetic)	Research Development	Diabetes	Funding	Tech (3-) Market (1+)	
12/98	•	Allelix Biopharmaceuticals Inc	ST	T	Gene therapy	Research	Diabetes	-	Tech (2+) Market (1+)	extension
1/99		Scios Inc	ST	T	Seeds screening	Research Development	CNS (Alzheimer)	Fund Milestone	Tech (2+) Market (1+)	extension
3/99		Ribozyme Pharmaceuticals Inc	ST	T	Seeds screening Preclinical development	Research Development	Infection (HCV)	Funding Milestone Royalty	Tech (2+) Market (1+)	
10/99		Prokfix Ltd	ST	T	Basic research	Research	Cancer	Funding Milestone	Tech (3-) Market (1+)	
12/99	•	Prothenics plc	ST	T	Seeds screening Preclinical development (Computer Aided Molecular Design (CAMD) technology)	Research Development	Cardiovascular	5	Tech (2+) Market (1+)	
3/00	•	Array BioPharma	ST	T	Discovery High-throughput screening (Structural biology Information management)	Research Development			Tech (2+) Market (2-)	
4/00		Arena Pharmaceuticals, Inc	ST	T	Discovery Screening (Orphan G-protein coupled receptors)	Research Development	CNS Cardiovascular	Funding Milestone Royalty	Tech (2+) Market (1+)	
6/00		Millennium Pharmaceuticals Inc	ST	T	Discovery Seeds	Research Development	Cancer	Milestone Royalty	Tech (2+) Market (1+)	1-year extension
Jan 01		Biosite Diagnostics Inc	ST	T	Discovery Seeds (antibody)	Research Development		Funding Milestone Royalty	Tech (2+) Market (2-)	
Mar 01	•	D Pharm Ltd	ST	T	Drug delivery (lipid vector technologies)	Research Development	CNS	Funding Milestone	Tech (2+) Market (1+)	
Aug 01		Deltagen Inc	ST	T&D	Animal model Evaluation	Candidate supply Development		Right to co- promotion	Tech (2+) Market (2-)	

3	*R&D joint venture (RDJV)*	5/96		National University of Singapore	AC	T	Pharmacology	Research	basic	-	Tech (2+) Market (2+)
		10/98		ICOS Corp	ST	T&M	Candidate phase II	Development	Erectile dysfunction	50 50 JV + 75 Up-front	Tech (2+) Market (2)
		3/99		Chugai Pharmaceutical Co Ltd,	ES	D	Clinical Development	Development	-	-	Tech (1+) Market (3-)
4	*Venture investment (VI)*	4/97		Seragen Inc	ST	T	Protein technology Candidate Phase III	-	Cancer	-	Tech (2+) Market (1+)
		5/97	•	Millennium BioTherapeutics Inc	ST	T	Discovery Gene therapy	-	-	20	Tech (3-) Market(2-)
		8/98		Phytera Inc	ST	T	Basic Research / discovery	-	Infection	-	Tech (3-) Market (1+)
		Jan 01	•	Pharmaquest	ES	T	Information management (knowledge management)	-	-	-	Tech (3-) Market (1+)
3	*Strategic development contract (SDC)*	2/97	•	Emisphere Technologies Inc	ST	T	Drug delivery (oral protein delivery)	Research Development	multi	60 Funding Milestone Royalty	Tech (3-) Market (1+)
		6/97	•	Vertex Pharmaceutical Inc	ST	T	Drug design Process development Substance manufacturing	Clinical development Marketing	Infection (HCV)	50 Equity investment Milestone	Tech (3-) Market (1+)
		1/99		ILEX Oncology Inc	ST	T	Lilly's candidates Development of phase I candidate	Development Marketing	Cancer	Funding Milestone Royalty	Tech (1+) Market (2-)
5	*Co-development Co-marketing (CDM)*	5/96		Merck Medco Managed Care Inc	ES	D&M	Management programmes	Development Marketing	Diabetes	-	Tech (2-) Market (1+)
		6/97		Interneuron Pharmaceuticals, Inc	ST	D&M	new uses for Prozac	Development Marketing	CNS	Milestone	Tech (2-) Market (2-)
		1/99	•	Institute of Human Genetics (of University of Heidelberg)	AC	T&M	Gene / gene therapy Biological	Development	growth-related disorders	-	Tech (3-) Market (1+)
		Apr 01	•	1747 Inc	ST	T&D	Information system (clinical trial)	Development		Initial payment	Tech (3-) Market (1+)
		Jul 01		University of Pittsburgh	AC	D	Lilly provides compounds UP manages clinical trial	Development	Cancer	-	Tech (2+) Market (1+)

Additional data: Bioinformatics, Gene technology (1992-1996)

Contract research (ConR)	5/92	Sibia Inc	ST	T	Genetically engineered calcium channel	Research Development	CNS	Equity investment Milestone Royalty	Tech (3-) Market (1+)
Collaborative research (CoLR)	5/95	Onyx Pharmaceuticals Inc	ST	T	Discovery Functional genomics	Research	Cancer	Funding	Tech (3-) Market (1+)
Venture investment (VI)	10/95	Millennium Pharmaceuticals Inc	ST	T	Functional genomics Bioinformatics	Research Development	Cardiovascular	40 Equity investment Milestone Royalty	Tech (3-) Market (1+)

Appendix. 5. Technology deals in Scering Plough (1996 2001)

Number of deals		Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity	Others
...wards	...wards												
-	3	*Asset or business acquisition (AA)*											
3	9	*Product or Candidate acquisition (PCA)*	6/96		Apogepha	ES	M	Product (Mictonorm)	Marketing	Genitourinary	-	Tech (2-) Marketing (1+)	
	Launched 3		10/96		SciClone Pharmaceuticals	ST	D&M	Candidate phase I (interferon)	Development Marketing in Japan	Infection (HCV)	-	Tech (2-) Marketing (2-)	
	Pre 0 P I 3 P II 1 P III 2		6/97		Chiroscience Group plc	ST	D&M	Candidate phase I (phosphodiesterase inhibitors)	Development Marketing	Asthma Rheumatoid arthritis	Milstone (potential 38)	Tech (2-) Marketing (1+)	
			2/98		COR Therapeutics Inc	ST	D&M	Product (Integrin)	Development Marketing	Cardiovascular	Up-front Milestone (potential 32)	Tech (2-) Marketing (1+)	
			3/98		Chugai Pharmaceutical Co Ltd	ES	M	Candidate phase III (Maxacalcitol)	Marketing	Dermatological	Up front Milestone	Tech (2-) Marketing (2+)	
			6/98		Corvas International Inc	ES	D&M	Candidate phase I (antithrombotic drug)	Development Marketing	Cardiovascular	Milestone Royalty	Tech (2-) Marketing (1+)	
			7/98		ICN Pharmaceuticals Inc	ES	M	Product (HCV Ribavirin)	Marketing worldwide	Infection (HCV)	16 5	Tech (1+) Marketing (1+)	
			2/99		British Biotech plc	ST	D&M	Candidate phase III (matrix metalloprotenase inhibitors)	Development Marketing	Oncology	Up front 8 Milestone Royalty (potential 60)	Tech (2+) Marketing (1+)	
			1/99		AtheroGenics	ST	D&M	Candidate phase II (AGI 1067)	Development Marketing	Cardiovascular	Up-front Milestone Royalty	Tech (2+) Marketing (1+)	
3	9	*Technology licensing (TL)*	7/96	•	Human Genome Sciences Inc	ST	T	Bioinformatics Functional genomics	Research		55	Tech (3-) Marketing (2-)	
			10/96		Enzon Inc	ES	T	Drug delivery (PEG) tech Manufacturing tech	Manufacturing Marketing	Infection Oncology	Total 3 Milestone Royalty	Tech (2+) Market (1+)	

			10/97	•	Inex Pharmaceuticals Corp	ST	T	Drug delivery tech (Gene delivery)	Development (Use SP's p53 tomor suppressor gene)	Oncology	1 3		Tech (3-) Market (1+)
			12/97		Sepracor Inc	ST	Patent	Product patent (Claritin)	Development (SP will develop active metabolite of Claritin) Marketing	SP will develop active metabolite of Claritin	Up front 5 Royalty		Tech (1+) Market (1+)
			2/98	•	Transgene SA	ST	T	Drug delivery tech (Adenoviral gene delivery)	Development (Use SP's p53 tomor suppressor gene)	Oncology	Up-front Milestone Royalty (potential 88)		Tech (3) Market (1+)
			4/98	•	Sparta Pharmaceuticals Inc	ST	T	Drug delivery tech (Spartaject(TM) technology)	Development (combination with SP's anticancer)	Oncology	Up-front Milestone Royalty		Tech (3-) Market (2-)
			7/98	•	Immune Response Corp	ST	T	Drug delivery tech (Gene delivery)	Development (Use interferon alpha 2b gene)	Infection (HBV, HCV)	Up-front 5 Milestone Royalty (potential 75)		Tech (3-) Market (2-)
			10/98	•	Genzyme Molecular Oncology	ST	T	Tech patent (p53 gene therapy) Gene delivery tech	Development (Use interferon alpha-2b gene)	Oncology	Up-front 5 Milestone Royalty (potential 135)		Tech (3) Market (2)
			11/98		IGEN International Inc	ST	T	High throughput screening system	Research		-		Tech (3) Market (1+)
3	4	*Technology access (TA)*	9/97	•	Genome Therapeutics Corp	ST	T	Functional genomics database	Research	Infection	Up-front Milestone Royalty		Tech (3) Market (1+)
			10/98	•	Incyte Pharmaceuticals, Inc	ST	T	Functional genomics database (LifeSeq)	Research	-			Tech (3-) Market (2-)
			10/00	•	Genometrix Inc	ST	T	High-throughput sample analysis (Micro array) Functional genomics database	Research	-	-		Tech (3-) Market (2-)
			10/01	•	BIOBASE	ST	T	Functional genomics database	Research	-	-		Tech (3) Market (2-)

0	9	*Contract research (ConR)*	10/96		Pharmacopeia Inc	ST	T Seeds	Seeds (Pharmacopeia discovery library)	Research Development	Asthma	Milestone	Tech (2-) Market (1+)
			8/97		CIMA Labs Inc	ES	T	Drug delivery (fast dissolving formulation)	Development Marketing	-	Up-front Milestone	Tech (2+) Market (1+)
			1/98	•	OncorMed Inc	ST	T	Sequencing services to assess the status of possible clinical trial candidates (p53 tumor suppressor gene)	Research Development	Oncology	-	Tech (2+) Market (2)
			2/98		Abgenix Inc	ST	T Seeds	Seeds (human monoclonal antibody)	Development Marketing	-	Up-front Milestone Royalty	Tech (2+) Market (2-)
			3/98	•	Medi Ject Corporation	ST	T	Drug delivery (needle-free injection)	Development Marketing	Infection	License fee Purchase order	Tech (3-) Market (1+)
			12/98	•	TerraGen Diversity Inc	ST	T	Recombinant genetics technology (anti bacterial)	Development Marketing	Infection	Up-front Milestone Royalty	Tech (2+) Market (1-)
			6/00		Cetek Corp	ST	T	Drug discovery (High throughput screening)	Development Marketing	-	-	Tech (2+) Market (2-)
			6/00	•	GeneFormatics Incorporated	ST	T Seeds (protein)	Drug discovery (functional genomics)	Development Marketing	-	-	Tech (3-) Market (2-)
			10/00	•	Human Genome Sciences Inc	ST	T Seeds	Drug discovery (Interferon)	Development Marketing	Infection Oncology	Milestone Royalty	Tech (2+) Market (1+)
	8	*Collaborative research (ColR)*	12/96	•	Genome Therapeutics Corp	ST	T Seeds	Seeds (High throughput screening Bioinformatics)	Research Development (long term)	Asthma	Up-front 22 5 Milestone Royalty (potential 76)	Tech (3) Market (1+)
			1/97	•	University of Toronto	AC	T Seeds	Seeds (Gene technology)	Research Development	CNS (Alzheimer)	Up-front Milestone Royalty (potential 34 5)	Tech (2+) Market (1+)
			6/97		Corvas International Inc	ES	T Seeds	Seeds	Research Development	Infection (HCV)	Up-front Milestone Royalty	Tech (2+) Market (1+)

		7/98	*	Immune Response Corp	ST	T	Drug delivery tech (Gene delivery)	Research Development	Infection	Up-front Milestone Royalty (potential 75)	Tech (3-) Market (1+)
		11/99		Genentech Inc	ES	T	Study on Integhn	Research	Cardiovascular	-	Tech (2+) Market (1+)
		7/00		Texas Biotechnology Corp	ST	T Seeds	Drug discovery (VLA-4 antagonists)	Research Development Marketing	Asthma	Up-front Milestone Royalty (potential 87)	Tech (3-) Market (1+)
		Mar-01		Medarex Inc	ST	T Seeds	Human antibody development tech	Research (provise target infoamation) Development Marketing	-	Up-front Milestone Royalty	Tech (2+) Market (1+)
		Aug-01		NeoGenesis Inc	ST	T Seeds	Drug discovery (small molecule)	Research Development	-	Equity investment Milestone Royalty	Tech (2+) Market (2-)
0	*R&D joint venture (RDJV)*	-		-	-						
0	*Venture investment (VI)*	-		-	-						
2	*Strategic development contract (SDC)*	3/97		Novopharm Biotech	ST	Development (15 years)	Development of generic drugs	Marketing	generic	-	Tech (1+) Market (1+)
		11/00		ICN Pharmaceuticals Inc	ES	Seeds (long-term)	Candidates clinical Seeds	Development Marketing	Infection (HCV)	-	Tech (2-) Market (1+)
1	*Co-development Co-marketing (CDM)*	4/98		Taro Pharmaceutical Industries Ltd.	ES	D&M	Candidates	Co-development Co-marketing	-	-	-

Additional data: Bioinformatics, Gene technology (1992-1996)

	Collaborative research (ColR)	11/94		Cana Inc	ST	T Seeds	Gene therapy (p-53 gene)	Research Development	Cancer	Up-front & Milestone Royalty	Tech (3+) Market (2-)
	Collaborative research (ColR)	12/95		Genome Therapeutics Corp	ST	T Seeds	Drug discovery (Functional genomics)	Research Development	Infection	-	Tech (3-) Market (1+)

Appendix. 6. Technology deals in Takeda (1996-2001)

Number of deals													
outwards	Inwards	Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
0	0	*Asset or business acquisition (AA)*											
1 (Actos)	11	*Product or Candidate acquisition (PCA)*	9/96		Gedeon Richter	ES	D&M	Candidate pre-clinical (TDN 345)	Development	CNS		Tech (2-) Market (1+)	
	Launched 1		12/96		Synsorb Biotech Inc	ST	M	Candidate phase II	clinical development	Kidney disease	3	Tech (2-) Market (2-)	
	Pre 3 P I 3 P II 3 P III 1		12/97		Meiji Seika Kaisha Ltd	ES	M	Product antibiotic (Cefditoren pivoxil)	Development in US Production Marketing in US	Infection		Tech (1+) Market (2-)	TAP
			2/98		Human Genome Sciences Inc	ST	D&M	Candidate phase I (MPIF-1)	Marketing in Japan	Cancer	option fee	Tech (2+) Market (2-)	
			4/98		Novo-Nordisk	ES	D&M	Candidate phase I (Leormeloxifene)	Development Marketing in Japan	Osteoporosis		Tech (2+) Market (1-)	
			9/99		Dainippon Pharmaceutical Co Ltd	ES	D&M	Candidate phase I (TAK-677)	Development Marketing	Diabetes		Tech (2+) Market (2-)	
			10/99		Tejin Ltd	ES	D&M	Candidate phase II		Urinary		Tech (2+) Market (2-)	TAP
			12/99		Interneuron Pharmaceuticals, Inc	ST	M	Candidate phase III (citicoline)	Marketing in US	Cardiovascular	Max 73 (initial 13 milestone 60)	Tech (2+) Market (2-)	
			11/00		Fujisawa Pharmaceutical Co Ltd	ES	D&M	Candidate pre-clinical (FR229934)	Development Marketing	erectile dysfunction		Tech (2+) Market (2-)	TAP
			Feb 01		Welfide	ES	D&M	Candidate pre-clinical (Y 128)	Development Marketing	Diabetes CNS		Tech (2+) Market (2-)	

			Jul-01		Mitsubishi-Tokyo Pharmaceuticals Inc	ES	D&M	Candidate phase II (MCC-135)	Development Marketing	Cardiovascular	-	Tech (2+) Market (2-)	
0	0	*Technology licensing (TL)*	-		-	-							
0	3	*Technology access (TA)*	6/99	*	Affymetrix, Inc	ST	T	DNA array tech Gene expression	Research	basic	Initial payment Royalty	Tech (3-) Market (1+)	
			8/99	*	Amersham Pharmacia Biotech	ES	T	Microarray (High throughput Functional genomics)	Research	basic	-	Tech (3-) Market (1+)	
			3/00	*	Celera Genomics Inc (of PE Corporation)	ST	T	Bioinformatics Functional genomics	Research	basic	-	Tech (3-) Market (1+)	
0	3	*Contract research (ConR)*	5/00		IPF PharmaCeuticals GmbH	ES	T Seeds	Basic Research / discovery (peptide)	Development	multi	Funding Milestone Royalty	Tech (3-) Market (2+)	First-refusal right
			Mar-01	*	Human Genome Sciences Inc	ST	T	Screening using genome technology	Takeda selects 100 coumpounds	multi	Milestone Royalty	Tech (3-) Market (1+)	Expansion of contract of 6/95
			Jun-01		Ligand Pharmaceuticals Inc	ST	T Seeds	Early-stage candidate (LGD2226) Dicovery	Development Marketing	Osteoporosis Sexual dydfunction	Max 44 (Initial milestone)	Tech (2+) Market (1+)	TAP
0	5	*Collavorative research (ColR)*	10/96		Novo Nordisk A/S	ES	T	Cell receptors tech	Research (chemical library)	Diabetes	shared	Tech (2+) Market (1+)	
			2/97		BS Laboratories	ST	T	Study on the causes of Alzheimer	Research Development	CNS (Alzheimer)	33 (shared with 6 companies)	Tech (3-) Market (1+)	with other 5 Japanese companies
			6/99	*	Institute of Medicinal Molecular Design (Iyaku Bunshi Seikkei Kenkyusho)	AC	T	DNA chip (long-length DNA) Compound screening support system	Co-development	multi	3 3	Tech (3-) Market (1+)	
			6/99		Gedeon Richter (Hungary)	ES	Seeds T	Chemical seeds	Research Development (High Throughput Screening)	-	-	Tech (2+) Market (2-)	
			11/99		Japan Pharmaceutical Ministry of Health	GV	T&D	Malarial infection study	Research (chemical screening)	Infection	-	Tech (1+) Market (7+)	with other 11 Japanese companies
	1	*R&D joint venture (RDJV)*	Mar-01		BioNumerik Pharmaceuticals	ST	D&M	Anticancer compounds	Development Marketing	Cancer	-	Tech (2+) Market (1+)	

0	*Venture investment (VI)*	2/00	establishing bioventure investment consortium	-	T	Building a consortium for venture investment	Investment	-	20 (total)	-	with 60 companies in Kansai district of Japan
1	*Strategic development contract (SDC)*	1/00	Taisho Pharmaceutical Co Ltd	ES	D&M	Drug candidate	Development and marketing in US and Europe	-	-	Tech (2+) Market (2+)	
0	*Co-development Co-marketing (CDM)*	-	-	-	-						

Additional data: Bioinformatics, Gene technology (1992-1996)

	Technology access (TA)	5/95	Human Genome Sciences Inc	ST	T	Genome database (human cDNA)	Research Development	multi	Milestone Royalty	Tech (3-) Market (1+)	Expansion of contract of 6/95

Appendix. 7. Technology deals in Sankyo (1996-2001)

Number of deals		Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
outwards	Inwards												
	0	*Asset or business acquisition (AA)*											
1	4	*Product or Candidate acquisition (PCA)*	10/97		Vanguard Medica Group plc	ST	M	Candidate phase II	Marketing	Cardiovascular	-	Tech (2+) Market (1-)	
	Launched 0		5/98		ImmuLogic Pharmaceutical Corp	ST	D&M	Candidate pre-clinical (proteins)	Development Marketing	Allergy	Up-front Milestone Royalty	Tech (2+) Market (1+)	
	Pre 2 P I 0 P II 2 P III 0		11/99		GelTex Pharmaceuticals, Inc	ST	M	Candidate phase II	Marketing	Cardiovascular	Up-front 13 Milestone (potential 33)	Tech (2+) Market (2+)	
			Apr-01		Kureha Chemical	ES	M	Candidate pre-clinical	Marketing	Infection (AIDS)	-	Tech (2+) Market (2-)	
0	4	*Technology licensing (TL)*	10/97		TheraTech	ST	T	Drug delivery tech (transdermal patch)	Research Development	Genitourinary	-	Tech (2+) Market (2-)	
			10/97		ProteinDesign Labs	ST	T	Human antibody tech	Research Development	-	-	Tech (2+) Market (2-)	
			11/97	*	ArQule Inc	ST	T	Seeds identifying tech (Mapping array)	Research Development	-	Milestone Royalty	Tech (3-) Market (2-)	
			6/98		RP Scherer Corp	ES	T	Drug delivery tech (fast-dissolving formulation)	Development	Cardiovascular	-	Tech (2+) Market (1-)	
0	4	*Technology access (TA)*	3/99	*	Genetics Institute Inc	ST	T	Drug discovery program Functional genomics	Research	-	-	Tech (3-) Market (1+)	
			11/99	*	Affymetrix, Inc	ST	T	Functional genomics Micro array	Research	-	-	Tech (3-) Market (2-)	

		11/00	*	Incyte Genomics, Inc	ST	T	Genomic database (human genome, animal model)	Research	-	-	Tech (3-) Market (2-)	
		Apr-01	*	Gene Logic Inc	ST	T	Functional genomics database	Research	-	-	Tech (3-) Market (2-)	
4	*Contract research (ConR)*	3/97		Oncogene Science Inc	ST	T Seeds	Drug discovery (anti-infection)	Research Development	Infection (Influenza)	-	Tech (2+) Market (1-)	
		4/97		Metabasis Therapeutics Inc	ES	T Seeds	Drug discovery (anti-diabetes)	Research Development	Diabetes	Up-front Equity investment Milestone Royalty	Tech (2+) Market (1+)	
		3/99	*	Quark Biotech Inc	ST	T	Gene response tech Gene discovery tech	Research	Diabetes	21 5	Tech (3-) Market (1+)	
		4/99	*	Tekk Inc	ST	T	Chemoinformatic discovery tech	Research Development	-	License fee	Tech (3-) Market (2-)	
5	*Collaborative research (CoIR)*	2/97		BS Laboratories	ST	T	Study on the causes of Alzheimer	Research Development	CNS (Alzheimer)	33 (shared with 6 companies)	Tech (3-) Market (1+)	with other 5 Japanese companies
		6/97		Genesis Sicor	ST	T	Study on Diabetes	Research Development	Diabetes	-	Tech (2+) Market (1+)	
		11/99		Japan Pharmaceutical Ministry of Health	GV	T&D	Malarial infection study	Research (chemical screening)	Infection	-	Tech (1+) Market (2+)	with other 11 Japanese companies
		9/99	*	Quark Biotech Inc	ST	Discovery of gene	Gene response tech Gene discovery tech	Research Development	Autoimmune	-	Tech (3-) Market (1+)	
		Apr-01		X-Ceptor Therapeutics, Inc	ST	T Seeds	Drug discovery (discovery of modulator of orphan receptor)	Research Development	Diabetes	Royalty	Tech (2+) Market (1+)	
0	*R&D joint venture (RDJV)*											

0	*Venture investment (VI)*									
0	*Strategic development contract (SDC)*									
3	*Co-development Co-marketing (CDM)*	4/98	Snow Brand Milk Products	ES	D	Candidate pre-clinical	Co-development	Osteoporosis		Tech (2+) Market (1+)
		5/99	Warner-Lambert Co	GL	D	Candidate pre-clinical	Co-development	Diabetes		Tech (2+) Market (1+)
		12/00	Eli Lilly	GL	D&M	Candidate phase I	Co-development Co-marketing	Cardiovascular		Tech (1-) Market (2+)

Appendix. 8. Technology deals in Yamanouchi (1996-2001)

Number of deals													
outwards	inwards	Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
	0	*Asset or business acquisition (AA)*	.		.	.							
4	8	*Product or Candidate acquisition (PCA)*	6/96		Amgen Inc	ES	M	Product (Infegen)	Manufacturing Marketing excluding US and Canada	Infection	Up-front 15 Milestone Royalty	Tech (2+) Market (2-)	
	Launched 5		11/96		Warner-Lambert KK	ES	Development Marketing	Candidate late phase II	Clinical development Marketing	Cardiovascular	.	Tech (2+) Market (1-)	
	Pre 0 P I 0 P II 1 P III 1		7/97		Zuellig Pharma Corp	ES	M	Product (Harnal)	Marketing in Philippines	Genitourinary	.	Tech (2+) Market (2-)	
	Clinical 10 compounds		11/97		Takeda Chemical Industries Ltd	GL	M	Product	Co-promotion in Germany	Prostate cancer Dysuria	.	Tech (2+) Market (2-)	
			1/98		GD Searle & Co	ES	Development Marketing	Candidates in clinical study (10 candidates)	Clinical development Marketing	several	Milestone	Tech (2+) Market (2-)	
			12/98		Mitsubishi Chemical Corp	ES	M	Product	Marketing	Cardiovascular	.	Tech (2-) Market (1-)	
			2/99		Glaxo Wellcome plc	GL	M	Candidate (phase III)	Co-promotion	Cardiovascular	.	Tech (2+) Market (1+)	Yamanouchi promotes Glaxo candidate Glaxo promotes Yamanouchi product
			Mar-01		Pharmacia KK	ES	M	Product (Celecoxib/YM177)	Manufacturing Marketing	Osteoarthritis Rheumatoid arthritis	.	Tech (3-) Market (1+)	
3 (WOWTA B)	1	*Technology licensing (TL)*	May-01	*	Hitachi Chemical Co Ltd	ES	T	Gene screening and protein function analysis computer systems	Research (genomics and proteomics)	.	.	Tech (3-) Market (1+)	

	1	*Technology access (TA)*	Jun-01	*	Celera Genomics	ST	T	Functional genomics Bioinformatics	Research	-	-	Tech (3-) Market (1+)	
0	1	*Contract research (ConR)*	4/98	*	Structural Bioinformatics Inc	ST	Seeds	Discovery (Bioinformatics High throughput screening Combinatorial chemistry)	Development	-	Milestone	Tech (3-) Market (2-)	
	6	*Collaborative research (ColR)*	2/98		University of Leiden, Utrecht University, Groningen University	AC	T (technology right)	Drug delivery	Research Development	Asthma Rheumatoid arthritis Arteriosclerosis Intestinal and liver inflammation Psoriasis Cancer	Funding Royalty	Tech (2+) Market (1+)	
			11/99		Japan Pharmaceutical Ministry of Health	GV	T&D	Malarial infection study	Research (chemical screening)	Infection	-	Tech (1+) Market (2+)	with other 11 Japanese companies
			3/00		ICAgen Inc	ST	T&D	Ion channel technologies	Research Development	CNS	Up-front Milestone Royalty	Tech (3-) Market (1+)	
			6/00		Glaxo Wellcome	GL	T&D	DNA chip tech	Research (disease gene detection)	-	-	Tech (2+) Market (1+)	
			7/00		NY Univ Medical Center	AC	T&D	Disease gene identification	Research Development	Osteoarthritis	-	Tech (3-) Market (1+)	
			Aug-01		Taisho Pharmaceutical Co Ltd	ES	T&D	Drug discovery (compound library)	Research Development	Diabetes etc	-	Tech (2+) Market (1+)	Exchanging ideas
	0	*R&D joint venture (RDJV)*											
	0	*Venture investment (VI)*											

0	*Strategic development contract (SDC)*	-	-	-								
1	*Co-development Co-marketing (CDM)*	5/98	Merck KGaA	GL	Co-development	Candidate	Phase I	Co-development	Cardiovascular	-	Tech (2+) Market (1+)	Yamanouchi develops Merk KGaA candidate Merk KGaA develops Yamanouchi candidate

Additional data: Bioinformatics, Gene technology (1992-1996)

	Collaborative research (CoIR)	11/93	Tularik Inc	ST	T Seeds	Target gene identification	Research Development	Infection	Funding Equity investment	Tech (3-) Market (1+)	

Appendix. 9. Technology deals in Bayer (1996-2001)

Number of deals													
outwards	inwards	Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
	0	*Asset or business acquisition (AA)*											
7	9	*Product or Candidate acquisition (PCA)*	5/96		CV Therapeutics Inc	ST	D&M	Candidates pre-clinical	Development Marketing	Diagnostics Infection	Up-front Milestone Royalty	Tech (2-) Market (1+)	
	Launched 2		12/97		Nihon Noyaku	ES	D&M	Candidates pre-clinical	Development Marketing	Infection (skin)		Tech (2-) Market (1+)	
	Pre 4 P I 2 P II 1 P III 0		3/98		NuCOx	ST	D&M	Candidates phase I	Marketing	Inflammatory	Licensing fee	Tech (1+) Market (1+)	
			12/98		Cambridge NeuroScience Inc	ST	D&M	Candidates pre-clinical (recombinant Glial Growth Factor 2)	Development Marketing	Neurological (Multiple sclerosis)	26 Up-front Milestone Royalty	Tech (3-) Market (2-)	
			7/99		Suntory Pharmaceuticals	ES	D&M	Candidates phase I	Development Marketing	Infection		Tech (2-) Market (1+)	
			12/99		SmithKline Beecham plc	GL	M	Product Antiseptic ointment	Marketing	Infection		Tech (2-) Market (1+)	
			3/00		Indena	ES	D&M	Candidates pre-clinical	Development Marketing	Oncology		Tech (2-) Market (1+)	
			9/00		Yamanouchi Pharmaceutical	GL	M	Product Infection	Marketing	Infection		Tech (1+) Market (1+)	
			11/00		Avigen Inc	ST	D&M	Candidates phase II (gene therapy treatment)	Development Marketing	Blood&Clotting (haemophilia B)	60 Up-front Milestone Royalty	Tech (3-) Market (2-)	
0	6	*Technology licensing (TL)*	9/97	*	Immune Response Corp	ST	T	Gene delivery technology	Research Development Marketing	Blood&Clotting (haemophilia A)		Tech (3-) Market (1+)	

			7/98		F Hoffmann-La Roche AG	GL	T	PCR technology	Research	-	-	Tech (2-) Market (1+)
			3/00	*	Oxford GlycoSciences Plc	ST	T	Proteomics	Research	Respiratory (Asthma)	10/developed compound	Tech (3-) Market (1+)
			9/00	*	EraGen Biosciences	ST	T	DNA / protein chip	Research Development Marketing	Diagnostics (HIV)	-	Tech (2+) Market (1+)
			Jan-01	*	Zymark Corporation	ST	T	High Throughput screening (Staccato(TM) mRNA expression)	Research	-	-	Tech (3-) Market (1+)
			Mar-01	*	Innogenetics Inc	ST	T	Nucleic acid based viral diagnostics	Research Development Marketing	Infection (HCV)	19 2 Up-front Equity investment	Tech (3-) Market (1+)
0	9	*Technology access (TA)*	5/97	*	Genome Therapeutics Corp	ST	T	Genome database (bacterial genome)	Research	Infection	Subscription fees Royalty	Tech (3-) Market (1+)
			8/97	*	Genetics Institute Inc	ST	T	Database for proteomics and discovery (DiscoverEase)	Research	-	Up-front Co-development Co-marketing	Tech (3-) Market (1+)
			4/98	*	Incyte Pharmaceuticals, Inc	ST	T	Functional genomics (LifeSeq) Bioinformatics (LifeTools)	Research	Infection Obesity Osteoporosis Cardiovascular Respiratory	-	Tech (3-) Market (1+)
			8/98	*	Genzyme Molecular Oncology	ST	T	Functional genomics (gene target) Discovery	Research	-	-	Tech (3-) Market (1+)
			12/98	*	Sangamo BioSciences, Inc	ST	T	Functional genomics (SAGE) Discovery	Research	-	-	Tech (3-) Market (1+)
			1/00	*	Pharmagene plc	ST	T	Discovery database (PhasaZero) mRNA expression profile database (Pathfinder)	Research	-	1 65	Tech (3-) Market (1+)

			10/00		Entelos, Inc	ST	T	Disease simulation system (PhysioLab ™ Asthma)	Research Development (animal model data)	Respiratory (Asthma)	-		Tech (3-) Market (1+)
			Apr-01	*	Phase-1 Molecular Technology Inc	ST	T	Toxicogenomics database (TOXbank(TM))	Research Development (animal model data)	-	-		Tech (3-) Market (1+)
			Aug-01	*	QIAGEN N V	ST	T	Functional genomics (ZeptoGene Workstation ultra-sensitive gene expression)	Research	-	-		Tech (3-) Market (1+)
0	9	*Contract research (ConR)*	12/96		Fuisz Technologies Ltd	ES	T	Drug delivery (rapid-dissolve)	Compounds	New formula	Up-front Milestone Royalty		Tech (2+) Market (1-)
			7/97	*	Sequus Pharmaceuticals Inc	ST	T	Drug delivery (Stealth liposome)	Compound (Ciprofloxacin)	Infection	Milestone Royalty		Tech (3-) Market (1+)
			3/98		Oxford Diversity	ST	T	Drug discovery (seeds library)	Research Development	-	26 2 Up-front Milestone		Tech (2+) Market (1+)
			12/98		Genzyme Corp	ST	T	Drug discovery (seeds library)	Research Development	-	35 Up-front Milestone		Tech (2+) Market (1+)
			1/99		ComGenex Inc	ST	T	Drug discovery (seeds library)	Research	-	6 9 Up-front Milestone Royalty		Tech (3-) Market (1+)
			3/99		Andrx Corp	ES	T	Drug delivery (controlled release)	Compounds	New formula	-		Tech (2+) Market (1+)
			9/99		Ranbaxy Laboratories Ltd	ES	T	Drug delivery (controlled release)	Compounds (Ciprofloxacin)	Infection	Milestone Royalty		Tech (2+) Market (1+)
			3/00		PharmaNetics, Inc	ST	T	New platelet function test	Research Development	Blood & clotting (Diagnostics)	Milestone Royalty		Tech (2+) Market (1-)
			8/00	*	GPC Biotech AG	ST	T	Drug discovery (functional genomics) Evaluation	Research Development	Infection	-		Tech (3-) Market (1-)
	21	*Collaborative research (ColR)*	10/96		Aims Pharmaceutical Corp	ST	T	Collaborative R&D of pre-clinical drugs (BAY17-1998 APC-366)	Research Development	Respiratory (Asthma)	Milestone		Tech (2-) Market (1+)

11/96		Shemakin Inst (Russian scientific center)	AC	T	Chemistry	Research	-	-	Tech (2+) Market (1+)	
11/96		Ronald & Nancy Reagan Research Institute	AC	T	-	Research Development	CNS	-	Tech (2+) Market (1+)	
12/96		Oncogene Science Inc	ST	T	Antibodies Immunoassays	Research Development	Oncology (diagnostics)	Fund	Tech (2+) Market (1+)	
11/97	*	Myriad Genetics Inc	ST	T	Drug discovery (ProNet(TM) database gene targeting)	Research Development	CNS (dementia, depression)	Milestone 54	Tech (3-) Market (1+)	This deal follows a 1995 alliance
9/98	*	Novalon Pharmaceutical Corp	ST	T	Drug discovery (BioKey™ drug target identification, surrogate ligand))	Selection of target High-Throughput screening	Infection	Fund Milestone Royalty	Tech (3-) Market (1+)	
9/98	*	Proteomix	ST	T	Drug discovery (gene targeting)	Research Development	Musculoskeletal (Osteoporosis)	Milestone 3	Tech (3-) Market (1+)	
9/98	*	Millennium Pharmaceuticals Inc	ST	T	**Strategic R&D** Target discovery (Functional genomics)	Research Development	-	**465** Up-front 368 4 Equity investment 96 6 Royalty	Tech (3-) Market (1+)	5-year contract Millennium will have rights to develop a large number of targets Corporate venture fund of Bayer AG
11/98		Molecular Simulations Inc	ST	T	Drug formulation Polymer technology	Research Development	-	-	Tech (2+) Market (1+)	
12/98	*	Myriad Genetics Inc	ST	T	Drug discovery (gene targeting)	Research Development	Asthma Osteoporosis Obesity	12 2 Up-front Milestone	Tech (3-) Market (1+)	Expansion of contract
12/98		Symyx Technologies	ST	T	Combinatorial chemistry	Research Development (development of system)	-	13 4 Up-front Equity investment 5 Royalty	Tech (2+) Market (1-)	Corporate venture fund of Bayer AG
3/99	*	Biovector Therapeutics SA	ST	T	DNA vector delivery technology (Neutraplex(TM))	Evaluation	-	-	Tech (3-) Market (2-)	

8/99		Max Planck Society Flemish Institute for Biotechnology University of Zurich University of Cologne Centre for Molecular Biology Institute for Psychiatric Research	AC	T	New therapeutic approaches for Alzheimer's disease	Research	CNS (Alzheimer's disease)	4	Tech (3-) Market (1+)	formed BARN (Bayer Alzheimer Research Network)
10/99	*	ArQule Inc	ST	T	Array screening technology	Compounds synthesis	-	30	Tech (2+) Market (1+)	
12/99		MorphoSys GmbH	ST	T	Antibody generation technology (HuCAL (Human Combinatorial Antibody Library))	Target supply Development	-	Up-front Milestone Royalty	Tech (2+) Market (1+)	
1/00		Artemis Pharmaceuticals	ST	T	Toxicological testing	Research	-	-	Tech (2+) Market (1+)	
2/00	*	Zen-Bio Inc	ST	T	Drug discovery (Proteomics hormones, cytokines)	Research (form a database)	Obesity & Diabetes Cardiovascular	Fund Milestone	Tech (3-) Market (1+)	
9/00	*	Atugen AG	ST	T	Drug delivery (Gene delivery)	Research Development	-	-	Tech (3-) Market (1+)	
Mar-01	*	Pharmagene plc	ST	T	Drug discovery (Human tissue, gene expression)	Research Development	Oncology	-	Tech (3-) Market (1+)	
May-01	*	EPIDAUROS Biotechnologie AG	ST	T	Drug disposition & Metabolism (Enzyme induction)	Research (Evaluation drug-drug interaction)	-	-	Tech (2+) Market (1+)	
Jun-01	*	Galapagos Genomics NV	ST	T	Gene delivery (recombinant adenoviruses)	Research (Evaluation model)	Respiratory	-	Tech (2+) Market (2-)	

2	*R&D joint venture (RDJV)*	7/99	*	Lion Bioscience Ltd	ST	T	Functional genomics Bioinformatics	setting "Lion Bioscience Research" that will utilise Lion's technologies as part of Bayer's research activities	-	100	Tech (3-) Market (1+)	
		Jan-01	*	CuraGen Corp	ST	T	**Strategic R, D &M** Evaluation of Bayer's pipeline (Functional genomics, Pharmacogenomics)	Co-research Co-development Co-marketing	Obesity & Diabetes	**1340** Bayer 56% CuraGen 44% + Equity investment 85	Tech (3-) Market (1+)	15-year contract
2	*Venture investment (VI)*	7/96	*	The Immune Response Corporation	ST	T	Gene therapy	Development Marketing	Blood&Clotting (haemophilia A)	10 Equity investment Milestone	Tech (3-) Market (2-)	Bayer Innovation, the corporate venture fund of Bayer AG
		4/98		Synyx Technologies	ST	T	Drug discovery (Combinatorial chemistry)	Research Development	-	Equity investment 5 Milestone 42 1	Tech (3-) Market (1+)	Bayer Innovation, the corporate venture fund of Bayer AG
0	*Strategic development contract (SDC)*	-		-								
1	*Co-development Co-marketing (CDM)*	8/00		PPL Therapeutics plc	ST	Candidate Drug delivery	Candidate Manufacturing	Development Marketing	Respiratory	40 Equity investment Milestone	Tech (2+) Market (1+)	

Additional data: Bioinformatics, Gene technology (1991-1996)

Collaborative research (CoR)	5/94	Onyx Pharmaceuticals Inc	ST	T	Discovery (Genetic biology)	Research Development	Cancer	Equity investment Up-front Milestone	Tech (3) Market (1+)	5-year partnership
Collaborative research (CoR)	9/95	Myriad Genetics Inc	ST	T	Drug discovery (gene targeting)	Research Development	Asthma Osteoporosis Obesity	Up-front Milestone	Tech (3-) Market (1+)	5-year partnership

Appendix. 10. Technology deals in Boehringer Ingelheim (1996-2001)

Number of deals													
outwards	inwards	Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
	0	*Asset or business acquisition (AA)*											
4	9	*Product or Candidate acquisition (PCA)*	8/96		CollaGenex Pharmaceuticals Inc	ST	M	Product registration pending	Marketing in Italy	Infection (dental)	Up-front Milestone Royalty	Tech (2-) Market (2-)	
	Launched 3		9/96		Ethical Holdings plc	ST	M	Candidate phase III (morphine tablet)	Marketing in Europe	Pain	-	Tech (2-) Market (1-)	
	Pre 0 P I 0 P II 2 P III 4		10/96		Ins Pharmaceuticals Inc	ES	M	Candidate phase II (Crohn disease)	Marketing	Autoimmune	40	Tech (2-) Market (1+)	
			11/96		Fujisawa USA Inc	ES	M	Product	Marketing (acquire all rights)	Pain	-	Tech (2+) Market (1+)	
			12/96		Biomatrix Inc	ST	M	Product (Synvisc)	Marketing in France	Osteoarthritis	8 Up-front Milestone	Tech (3-) Market (2+)	
			9/97		Scotia Holdings plc	ST	M	Candidate phase III (photosensitising drug)	Marketing in US and Europe	Cancer	54 Up-front Milestone	Tech (2+) Market (2-)	
			12/97		Transcend Therapeutics	ST	M	Candidate phase III	Marketing	Respiratory	46	Tech (2+) Market (1+)	
			12/99		Vion Pharmaceuticals Inc	ST	M	Candidate phase III (orphan drug)	Development Marketing	Cancer (neck and head)	Milestone Royalty	Tech (2+) Market (1+)	
			2/00		Pharmacia	GL	M	Candidate phase II	-	Infection (AIDS)	-	Tech (2-) Market (1+)	use in combination with Viramune
1	5	*Technology licensing (TL)*	8/96	*	Scriptgen Pharmaceuticals Inc	ES	Seeds	Drug discovery technology (gene expression)	Research Development	Infection	Up-front Milestone Royalty	Tech (3-) Market (2-)	
			1/97	*	IDEC Pharmaceuticals Corp	ES	T	Gene delivery (gene vector)	Research	-	Up-front Royalty	Tech (3-) Market (2+)	

			8/97		Ontogen Corp	ES	T	Software and hardware technology	Development	-	41 6	Tech (2-) Market (2-)
			1/00	*	Trega Biosciences Inc	ST	Seeds	Discovery seeds (Solution phase compound synthesis)	Research Development	basic	-	Tech (3-) Market (2-)
			2/00	*	Electrofect	ST	T	Electroporation technology (delivery of drugs or genes into cells)	Research	Cancer	-	Tech (2-) Market (1+)
0	5	*Technology access (TA)*	7/99	*	Affymetrix Inc	ST	T	DNA array tech Gene expression	Research	basic	Initial payment Royalty	Tech (3-) Market (1+)
			2/00	*	Lexicon Genetics Inc	ST	T	Gene sequence database	Research	Basic	Access fee Royalty	Tech (3-) Market (1+)
			6/00	*	DoubleTwist Inc	ST	T	Gene sequence database	Research	Basic	-	Tech (3-) Market (1+)
			12/00	*	Gene Logic Inc	ST	T	Gene sequence database (Functional genomics)	Research	Basic	-	Tech (3-) Market (1+)
			Aug-01	*	Cellomics Inc	ST	T	Discovery (target identification)	Research Development	Basic	-	Tech (3-) Market (2-)
0	6	*Contract research (ConR)*	6/96		Ansan Inc	ST	Seeds	Candidate dicovery	Development	Acute pancreatitis	-	Tech (2-) Market (2-)
			2/98	*	NanoSystems LLC	ST	T	Drug delivery (Nanosystem)	Development Compound supply	Respiratory	Up-front Milestone Royalty	Tech (3-) Market (1-)
			4/98		Tripos Inc	ST	T	Software development technology	Development	-	-	Tech (2+) Market (1+)
			6/98	*	Fusz Technologies Ltd	ES	T	Drug delivery (Enhanced Absorption)	Development	-	-	Tech (3-) Market (1-)
			6/99	*	Genome Pharmaceutical Corporation (GPC) AG	ST	Seeds	Discovery (ExpressCode technology)	Supply target information Development	Cancer	-	Tech (3-) Market (1+)

		11/99	*	Genetronics Biomedical Ltd	ST	T	Gene therapy Gene delivery	Development	Cancer	-	Tech (3+) Market (1-)	
10	*Collaborative research (CoIR)*	8/96		Praecis Pharmaceuticals Inc	ST	T	High throughput screening	Research Development	CNS (Diagnostics)	shared revenue	Tech (2+) Market (2-)	
		10/96	*	FCAR Fund	GV	T	combinatorial chemistry project	Research Development	basic	1	Tech (2+) Market (2-)	with 3 other companies
		11/96		Novo Nordisk A/S	ES	research into obesity treatments	collaborative research	collaborative research	basic	-	Tech (2+) Market (1+)	
		5/97	*	Sequana Therapeutics Inc	ST	T	Gene identification tech	collaborative research	basic	21	Tech (3-) Market (1+)	
		9/99	*	Valentis Inc	ST	Seeds	Gene therapy Drug delivery	Research Development	Rheumatoid arthritis	-	Tech (3-) Market (1+)	
		1/00	*	PHASE 1 Molecular Technology Inc	ST	T Seeds	Screening tech (molecular and cellular toxicology)	Research Development	-	-	Tech (2+) Market (1+)	
		2/00	*	BioFocus plc	ST	Seeds	Discovery (Synthesis, Design)	Research (compound design, evaluation) development	-	-	Tech (2+) Market (2-)	
		3/00	*	3-Dimensional Pharmaceuticals Inc	ST	Seeds	Sophisticated combinatorial chemistry	Research (compounds, skill) development	-	-	Tech (3-) Market (1+)	
		4/00	*	Atugen Biotechnology GmbH	ST	T	Gene target validation tech	Research (cell lines) development	-	-	Tech (3-) Market (2-)	
		9/00	*	Variagenics Inc	ST	T (SNPS detection)	Discovery (SNP detection)	Research Development	-	-	Tech (3-) Market (2-)	
0	*R&D joint venture (RDJV)*											
1	*Venture investment (VI)*	8/96		Cambridge NeuroScience Inc	ST	Seeds	Discovery Candidate phase III	Development Marketing	Stroke	10	Tech (2-) Market (1+)	

0	*Strategic development contract (SDC)*										
1	*Co-development Co-marketing (CDM)*	9/99	Biacore International AB	ST	T	Biopharmaceutical quality control tech			0 5	Tech (2+) Market (1-)	

Additional data: Bioinformatics, Gene technology (1992-1996)

Contract research (ConR)	6/95	Sequana Therapeutics	ST	T Seeds	Gene target identification	Research Development	Asthma	Up-front Royalty	Tech (3-) Market (1+)	
Contract research (ConR)	4/96	Ludwig Institute for Cancer Research	AC	T Seeds	Biochemical and genetic study	Research Development	Cancer	Royalty Milestone	Tech (3-) Market (1+)	

Appendix. 11. Technology deals in Merck KGaA (1996-2001)

Number of deals outwards	Number of deals inwards	Deal	Date	Emerging tech	Company	Company level	Aim	Acquired	Commitment	Field	Deal value ($ million)	Familiarity (ratings)	Others
	0	*Asset or business acquisition (AA)*	10/00		Biovation Ltd (UK)	ST	T	Antibody and protein engineering technologies (eliminating immunogenicity in antibodies)	Research Development	Immunology	-	Tech (2-) Marketing (1+)	
2	4	*Product or Candidate acquisition (PCA)*	9/96		Shaman Pharmaceuticals	ST	D&M	Candidate pre-clinical (plant extract)	Development Marketing in Asia	Diabetes	19 5 Equity investment Up-front Milestone	Tech (2-) Marketing (2-)	Lipha SA
	Launched 1		12/96		Etex	ST	M	Product (Bone filler)	Development in Europe Marketing	Musculoskeletal	-	Tech (2+) Marketing (2-)	
	Pre 1 P I 0 P II 2 P III 0		12/98		Medarex Inc	ST	M	Candidate phase II (MDX-447)	Development Marketing in Europe	Oncology	1 5 (Phase II cost)	Tech (2-) Marketing (1-)	
			3/99		Norsk Hydro	ES	M	Candidate phase II	Development Marketing	Oncology (pancreatic)	-	Tech (2+) Marketing (1-)	
1	3	*Technology licensing (TL)*	11/99	*	Sangamo BioSciences, Inc	ST	T	Functional genomics (GeneTools™)	Research	-	-	Tech (3-) Marketing (1+)	
			4/00		Protein Design Labs Inc	ST	T	Antibody to epidermal growth factor receptor (patent)	Research Development	Oncology	Up-front Milestone Royalty	Tech (3-) Marketing (1-)	
			10/00		Techniclone Corporation	ST	T	Antibody to necrotic regions of solid tumours	Research Development	Oncology	Up-front Royalty	Tech (3-) Marketing (1-)	
	1	*Technology access (TA)*	7/96	*	Human Genome Sciences Inc	ST	T	Functional Genomics Bioinformatics	Research		50 Up-front Milestone Royalty	Tech (3-) Marketing (1+)	
	3	*Contract research (ConR)*	1/98	*	Autogen (Australia)	ST	T	Gene therapy ("Beacon" gene)	Research Development	Obesity	-	Tech (3-) Marketing (1+)	Lipha
			5/00		SkyePharma plc	ST	T	Drug delivery (GEOMATRIX oral controlled release technology) Manufacture	Research Development Marketing	-	Royalty (10-15% of sales)	Tech (3-) Marketing (1+)	

		6/00		Trypos Inc (UK)	ST	T	General screening library (LeadQuest(TM), ChemSpace(TM))	Research Development	-	License fee	Tech (2+) Marketing (1+)	Lipha
2	*Collaborative research (CoIR)*	2/98		Ono Pharmaceutical Co Ltd	ES	T	Screening technology	Research (Lipha's insulin sensitiser products and beta-cell glucose sensitisers)	Diabetes	-	Tech (2+) Marketing (1+)	Lipha
		9/00	*	Gedeon Richter Ltd	ES	T	Cell-based high-throughput screening technology	Research (Evaluation)	CNS	-	Tech (2+) Marketing (1+)	
2	*R&D joint venture (RDJV)*	5/96		Novasep SA Institut du Petrole	ST, AC	T	Development and selling systems, software and cleansing processes for pharmaceuticals	Research Development	-	-	Tech (2-) Marketing (1+)	
		10/96		3-Dimensional Pharmaceuticals Inc	ST	T	Combinatorial chemistry	Research Development	Cardiovascular	10 Equity investment Up-front Milestone Royalty	Tech (2+) Marketing (1-)	
0	*Venture investment (VI)*	-	-	-	-							
0	*Strategic development contract (SDC)*	-	-	-	-							
3	*Co-development Co-marketing (CDM)*	5/96		ImClone Systems Inc	ST	D&M	Anticancer vaccines	Development Marketing	Oncology	11 7	Tech (3-) Marketing (1+)	
		5/98		Yamanouchi Pharmaceutical Co Ltd	GL	D&M	Development force	Candidate Phase I (EMD96785 EMD122347)	Cardiovascular	-	Tech (1-) Marketing (1+)	
		May-01		Biomira Inc	ST	D&M	Anticancer vaccines (Phase III THERATOPE, Phase II BLP25)	Development Marketing	Oncology	150 Equity investment Up-front Milestone Royalty	Tech (3-) Marketing (1+)	
Additional data: Bioinformatics, Gene technology (1992-1996)												
	Technology access (TA)	4/96		Human Genome Sciences Inc	ST	T	Gene database	Research Development	-	Up-front Milestone Royalty	Tech (3-) Marketing (1+)	

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