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# Customer Based Business Development

Strategic Challenges for a Small Research-Based  
Spin-Off Enterprise

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Viktor Rognås  
Hanna Stenberg



UPPSALA  
UNIVERSITET

**Teknisk- naturvetenskaplig fakultet  
UTH-enheten**

Besöksadress:  
Ångströmlaboratoriet  
Lägerhyddsvägen 1  
Hus 4, Plan 0

Postadress:  
Box 536  
751 21 Uppsala

Telefon:  
018 – 471 30 03

Telefax:  
018 – 471 30 00

Hemsida:  
<http://www.teknat.uu.se/student>

## Abstract

# Customer Based Business Development

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*Viktor Rognås and Hanna Stenberg*

The biotechnology industry is one of the fastest growing sectors of the western economy. The biotech industry is helping the world by creating significant societal and economic value in various sectors. However, as a result of the fast development of the biotech industry, the environment is constantly changing and doing so at a high pace. Hence, biotech companies are forced to always stay competitive and improve their business in order not to be outrivalled.

XYZ is a family-owned chemical company based in Europe. The company's main business is polysaccharide chemistry but specializes in fluorescent dextran derivatives for which XYZ offer different goods and services. Dextran is a polysaccharide that has been widely used as a research tool in various scientific fields. XYZ has been struggling with stagnating sales and wants to grow their business and find new customers.

The purpose of this master thesis is to suggest ways of business development for XYZ through customer and market understanding. Assessment of the company's current strategy, market and customers will aid in understanding the company's value proposition and identify opportunities for business development. Data was collected mainly through qualitative unstructured interviews.

In conclusion, based on the empirical results we recommend to assess the value propositions that the company is currently offering to customers. This should be done before reaching out to new customers. Further, this project aims to describe the factors a small research-based enterprise should consider when designing a business strategy.

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Ämnesgranskare: Göran Lindström  
Examinator: Curt Pettersson  
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## Populärvetenskaplig sammanfattning

Bioteknikbranschen är en av de snabbast växande branscherna i den västerländska ekonomin. Denna snabba tillväxt medför att industrin och marknaden förändras i snabb takt, och företag behöver strategier för att hänga med. I huvuddelen av arbetet, *Customer Based Business Development - Strategic Challenges for a Small Research-Based Spin-Off Enterprise*, så studerar vi, genom ett caseföretag, hur små forskningsbaserade teknikföretag kan utveckla sina affärer genom att använda kunskap om sina kunder. Det innehåller även, i appendix, en individuell teknisk fördjupning, *Introducing Lysine Into Dextran Using 4-Nitrophenyl Chloroformate Mediated Activation*, som utforskar en väg att framställa en potentiell framtida produkt (fluorescerande dextran, se nedan) hos caseföretaget.

Caseföretaget är ett litet familjeägt bioteknikföretag, där försäljningen inte når önskvärda nivåer. Företagets affärer är baserade på forskning inom kolhydratkemi som grundaren utfört. Forskningen har till största delen handlat om dextran, som är en kolhydrat. Dextran har många användningsområden, och man kan koppla på olika kemiska grupper för att ge det olika egenskaper. Ett användningsområde är att visualisera biologiska system, till exempel lymfsystemet, genom att koppla på fluorescerande grupper på dextran. Det fluorescerande dextranet kan sedan tillsättas till ett lymfsystem som då “lyser upp” och systemet synliggörs. Detta är användbart om man, exempelvis, vill mäta läckage i systemet.

Syftet med huvuddelen av detta arbetet är att föreslå affärsutvecklingsmöjligheter genom kund- och marknadsförståelse. Detta uppnås främst genom att intervjua kunder och personer på företaget, men även andra typer av information. Därefter analyserar vi informationen genom ett teoretisk ramverk som vi stödjer oss på, och diskuterar utifrån detta. Det vi föreslår i slutändan är att utvärdera vilka värden som nuvarande erbjudanden ger nuvarande kunder. När det finns en större förståelse för detta är det lättare att expandera sina affärer.



# Table of contents

<b>List of Figures</b>	<b>1</b>
<b>List of Tables</b>	<b>1</b>
<b>Key Words and Abbreviations</b>	<b>2</b>
<b>1 Introduction</b>	<b>4</b>
1.1 Background	4
1.1.1 The Case Company – XYZ	4
1.2 Problematization	7
1.3 Purpose of This Study	8
<b>2 Methods - Data Gathering and Research Process</b>	<b>10</b>
2.1 Data Collection	10
2.1.1 Secondary Data	11
2.1.2 Interviews: Unstructured and Semi-structured	12
2.1.3 Observations	13
2.2 Data Analysis	13
2.3 Method Evaluation	17
2.4 Research Ethics	18
<b>3 Theoretical Framework</b>	<b>20</b>
3.1 Research-Based Spin-Offs	20
3.2 Business Strategy	24
3.2.1 Generic Strategies	25
3.2.2 Core Competencies and the Hedgehog Concept	26
3.2.2 Growth Strategy	28
3.2.3 Value Creation Strategies	29
<b>4 Empirical Results</b>	<b>32</b>
4.1 The Market	32
4.1.1 Customers and Products	32
4.1.2 Competitors	36
4.2 Company Resources	38
<b>5 Analysis</b>	<b>42</b>
5.1 The Company Profile	42
5.2 Team Balance	43
5.3 Customer Understanding	44
5.4 The Market	47
5.4 Recommendations	48
<b>6 Conclusions</b>	<b>52</b>
<b>7 Discussion</b>	<b>54</b>
<b>8 Acknowledgements</b>	<b>58</b>
<b>9 References</b>	<b>60</b>
<b>10 Appendix</b>	<b>64</b>
10.1 Interviews with customers	64
10.2 Search queries on Google Scholar™	70
10.3 Introducing Lysine Into Dextran Using 4-Nitrophenyl Chloroformate Mediated Activation – Synthesis of FITC-alpha-Lys-Dextran	72

## List of Figures

- Figure 1.** The process of analytical induction.
- Figure 2.** Processes and outcomes in grounded theory.
- Figure 3.** Porter's Generic Strategies.
- Figure 4.** The Hedgehog concept.
- Figure 5.** Ansoff's growth strategy matrix.
- Figure 6.** Red Ocean Strategy vs. Blue Ocean Strategy.
- Figure 7.** Geographic location of customers.
- Figure 8.** Unique customers per invoice frequency.
- Figure 9.** Product purchase frequency.
- Figure 10.** Search queries on Google Scholar™ for article mentions since 2014.
- Figure 11.** Organizational structure of XYZ.
- Figure 12.** Current situation of XYZ summarized in an internal/external-matrix.
- Figure 13.** Stuck in the middle.

## List of Tables

- Table 1.** The criteria by which the 2014 – 2016 invoices were sorted.
- Table 2.** Sorting criterias for XYZ customers 2014 – 2016 to reflect the customer type/size.
- Table 3.** Three types of research-based spin-off enterprises.
- Table 4.** Email sent to authors in Sweden of scientific articles where dextrans were used.
- Table 5.** Google Scholar™ articles mentioning FITC-dextran since 2014.
- Table 6.** Competitors and their prices for FITC-dextran and DSS.
- Table 7.** Search queries on Google Scholar™ for company article mentions.

## Key Words and Abbreviations

BA	Business Angel
BHAG	Big Hairy Audacious Goal
CEO	Chief Executive Officer
CMO	Contract Manufacturing Organization
CRO	Contract Research Organization
DSS	Dextran Sodium Sulfate
GMP	Good Manufacturing Practice
GPC	Gel Permeation Chromatography
IBD	Inflammatory Bowel Diseases
IPO	Initial Public Offering
MW	Molecular Weight-average
OE	Operational Effectiveness
PRO	Public Research Organization
RBSO	Research-Based Spin-Off
SME	Small or Medium-sized Enterprise
XYZ	The Studied Case Company
VC	Venture Capitalist
USO	University Spinout Company



# 1 Introduction

*This chapter gives the background to the case company and what challenges they are facing. It also explains the purpose and aim of this study.*

The industry of biotechnology is one of the fastest growing sectors of the western economy (Li and Halal, 2002). The biotech industry is helping the world by creating significant societal and economic value in various sectors. However, as a result of the fast development of the industry, the environment is constantly changing and doing so at a high pace. As a result, many biotech companies are forced to try to stay competitive and improve their business in order not to be outrivaled.

The market for dextran products is no exception. As with any market, producers of dextran products face the challenges of competition in terms of being outrivaled by other businesses who may have better and cheaper products. Although the dextran market is not as recognized as other chemical products the market is dominated by a few large actors such as Sigma-Aldrich (Merck KGaA) and Thermo Fisher Scientific. Due to these large players, there are high barriers to entry to the market, making it harder for new actors to increase market share. The same applies to smaller companies operating within this market. Flexibility and innovation are, therefore, a necessity for such companies to stay alive. Hence, being able to create value and offer customers something more than their competitors are becomes a challenge that these companies need to consider.

## **1.1 Background**

### 1.1.1 The Case Company – XYZ

The case company (XYZ) is a family-owned chemical company based in Europe, with customers all over the world. The company's main business is polysaccharide chemistry but is specialized in fluorescent dextran derivatives for which XYZ offer different goods and services. Dextran is a polysaccharide that has been widely used as a research tool in various scientific

fields. XYZ was founded in 1991 by a researcher who has extensive experience of working with dextran.

The company began as a scientific consultancy firm where the founder also marketed a small range of products. Between the years 1991 and 2000, the founder managed the company all by himself. In 2009, his daughter took the role as CEO. The CEO has since earlier a background in physiotherapy and has also been teaching at a university. During the year of 2009, XYZ also expanded and hired a chemist and started to invest more in the production of the company's own line of products. The founder and the CEO together own 100 % of the company, where the founder owns 60 % of the shares and the CEO owns 40 %. They also comprise the board of the company. Since 2014, XYZ currently has 5 employees. XYZ is offering standardized dextran products, customized products and analysis services connected to polysaccharide chemistry.

### **The Main Business – Dextran Derivatives**

Dextran is a polysaccharide, comprised of many repeating units of glucose (Banerjee and Bandopadhyay, 2016). Due to the hydroxyl groups that are present in dextran, several sites of derivatization are possible which give rise to polysaccharides such as dextran sulfates (Cámara and Wilke, 2017). Even though the research and technology which dextran is built upon is non-disruptive, researchers have found diverse applications of dextran and its derivatives both industrially and clinically. The advantages of dextran lie within its high biocompatibility, high biodegradability, and low toxicity. Further, it is easy to modify and have a long shelf life. Moreover, the chemical and physical properties of dextran also conform to the principles of green chemistry, making it an environmentally friendly product.

One of the applications is to attach a fluorescent group, making the dextran fluoresce under the right conditions. Fluorescence is the emission of light by a substance that has absorbed light or radiation. Fluorescent dextran can, therefore, be used for visualizing different biological systems e.g. the lymphatic system, making it “light up” and you can see the actual lymph nodes and pathways. Dextran Sodium Sulfate (DSS), a dextran derivative, is a commonly used dextran product within cell biology and especially in the research of inflammatory bowel diseases (IBD). DSS can be used to induce colitis in animal models, which mimics IBD in humans very well.

(Solomon et al., 2010). Due to this, DSS is a very useful tool for this type of research.

### Customers and Competitors

XYZ is positioned as a global actor with customers from all over the world and the target market is industries within Life Science. The majority of XYZ's customers are research groups within universities, research institutes, international distributors, pharmaceutical-, biotech- and diagnostic companies. Most of XYZ's products go to public or academic research. The company has one large recurring customer for which the majority of company's sales are based upon.

The main competitors active in the market are the large global corporations Sigma-Aldrich (owned by Merck KGaA) and Molecular Probes (owned by Thermo Fisher Scientific). The company has also expressed worries regarding increased competition from Asia, especially China. The most prominent customer is a global distributor.

### Marketing Channels

Currently, XYZ does not have a devoted marketing section. The main marketing channel is through the company website. Here customers can information about XYZ and about the products and services the company offers. The customers can easily purchase standardized products directly from the website. For customers to buy XYZ's products, no personal contact with the company is needed. However, if they are interested in any analytical service or customizable product, XYZ encourages customers to make contact. In the current situation, XYZ mostly sells well-known and standardized dextran products. The company sells less of the customized products and analysis services. Thanks to the founder's good reputation within the field of dextran, a lot of their sales have been through word of mouth.

### Suppliers

XYZ gets their main raw dextran supplies from another company in Denmark. This company is the main supplier of dextran in Europe and is well recognized. They supply technical quality, but are at the same time very expensive when comparing to other suppliers in Asia, according to the CEO.

## The Company's Vision and Goals

XYZ has a company vision where the company wants to expand and reach all parts of the world and also increase the sales of their chemical analysis services. In the business plan, the company expresses a long term vision of being:

*“[...] a world class company with a leading position in polysaccharide products for the life science industries and research institutes”.*

(XYZ Business Plan, 2016)

XYZ has adopted a strategy where they grow organically, i.e. no external capital is used. The company's business plan states that their goal is an annual organic growth for turnover with 20%, and they want to grow the company staff to around 10 employees until 2018, and this includes a marketing employee at 50%. Financially the company has a 60% solidity and recurring revenues of about 1.2 million SEK per employee. Today the company's overall business idea and goal is to provide premium quality polysaccharide derivatives, especially fluorescent dextran derivatives for permeability studies. Due to this, the research is focused on developing novel products. The CEO has expressed a strategy where the focus is on fluorescent products.

## **1.2 Problematisation**

XYZ has been struggling with stagnating sales and wants to grow its business to find new customers. The company wants to gain more knowledge about the market it is operating in since this could aid in where to find new potential customers. Moreover, XYZ wants information regarding what the users of dextran products value when deciding what product to buy, where these users are located and how they search for information about dextran. All of these aspects are relatable to business development in regards of how a company can create value propositions for their customers.

The sales of a company can be seen as a receipt showing that a company is producing and selling something that customers value. Due to this, stagnating sales might be a consequence of other business aspects. XYZ is a small company currently operating in a competitive and niche

market, where there already are large global actors holding market shares. The company's product is based on non-disruptive research and technology, thus they are not presenting anything new to the market. Further, one of the company's existing and most frequent customer is also their distributor, and at the same time their competitor. A great challenge XYZ is facing is also facing is to phase out the founder but keep as much as possible of his know-how within the company. All of these aspects constitute strategic challenges that small companies such as XYZ must consider when trying to develop their business and stay competitive. The questions are, how and in what way do these strategic challenges affect XYZ's business development?

In order to investigate this, there is a need to observe XYZ's situation from different aspects. This is important since this information can aid in developing an optimal business strategy for the company which can help XYZ increase its sales. Due to this, an assessment of the company, the market, and the customers is needed. By understanding these factors, the company will achieve a higher understanding of their value propositions. This, in turn, can lead to an identification of business development opportunities.

### ***1.3 Purpose of This Study***

The purpose of this master thesis is to suggest ways of business development for XYZ through customer and market understanding. Assessment of the company's current strategy, market and customers will aid in understanding the company's value proposition and identify opportunities for business development. Further, this project aims to describe the factors a small research-based enterprise should consider when designing a business strategy. The work will start with understanding the strategic challenges of being a small research-based enterprise in a competitive and niche market.



## 2 Methods - Data Gathering and Research Process

*This chapter is about the methods by which empirical data were collected and analyzed, and why these methods were suitable for the study. It also contains assessments of the quality of the data collected using these methods.*

This study aims to, through a deeper understanding of this specific case, contribute to the understanding of the broader field of business strategy and value creation within small research-based spin-off companies. This type of study design is called an *instrumental case study* (Bryman and Bell, 2015, p. 68). Bryman and Bell (2013, p. 395) lay out the general system for qualitative research which was used while writing this thesis, illustrated in the enumerated list below.

1. General research questions.
2. Choice of relevant places and objects to study.
3. Data collection.
4. Data interpretation.
5. Theoretical work.
  - a. Redefine research questions.
  - b. Additional data collection. Go back to 4.
6. Report conclusions.

Using the systematic approach described above, an *abductive* method was continuously applied throughout the research process. An abductive approach is a combination of both inductive and deductive approaches. A deductive study starts with a theory, whereas in an inductive study the starting point is the collection of empirics (Bryman and Bell, 2012).

### 2.1 Data Collection

The methods used for the data collection aimed to gather information about the company's current business strategy. A qualitative research design was chosen since the information richness of qualitative data is preferred in order to capture the complexity of the content in this

study. The empirical data consists of primary data in the form of interviews and observations, and secondary data from online and offline sources.

An explorative research direction was established in order to determine the nature of the problem. When conducting exploratory research, a researcher must be willing to change his or her direction as a result of the discovery of new data and insights (Lekvall and Wahlbin, 2007, p.196). Hence, during this study, it was of great importance to be flexible and change directions in order to attain new and relevant information. This was done by performing personal interviews rather than surveys, where a set of questions are fixed.

### Triangulation and Crystallization

In order to more accurately examine the empirical phenomena of this study, and increase data validity, different types of data collection methods were favorable. A description of *triangulation*, which is “the combination of methodologies in the study of the same phenomena” (Jick, 1979), a concept coined by Denzin (1978, p.291) and later described by Bryman and Bell (2013). The idea is to, through the application of fundamentally different data collection methods (like interviews and observations), more accurately capture the essence of the studied phenomena. A synonymous concept is *crystallization*, where different methods are thought to dissect the phenomena of interest and reveal it (Alvehus, 2013, p.73). Via crystallization one can get a deepened and more complex understanding of a topic (Ellingson, 2009).

#### 2.1.1 Secondary Data

Secondary data was collected through desk research on the internet and also by examining paper copy invoices to customers between the fiscal years 2014 and 2016. This acted as a starting point in order to pivot the initial research questions. Further research of these companies could then be performed via the web, mainly using the social media platform LinkedIn (<http://www.linkedin.com>), but also via the web pages of the companies.

The data collected through this method was found to be sufficiently credible for the means, which was to get a rough picture of what type of customers XYZ has and how large those customers are in terms of employees. There was an awareness of the fact that there probably are

more potential customers that XYZ hasn't even reached yet, and that the current distribution of customer types can't be externally transferred to certainly depict the whole market distribution.

### 2.1.2 Interviews: Unstructured and Semi-structured

Interviews were one of the main methods used to collect data in this study (see Appendix 10.2). Six face-to-face interviews were conducted, along with complementary interviews via mail, and lastly one telephone interview. The first contact with customers was mainly made via email. Initially, 41 email contacts were made, selected from an existing contact list that the CEO had, but also contacts found from dextran-related articles published in Sweden. From there, local subjects were selected for face-to-face interviews for practical reasons. From there, a *snowball sampling* technique was used. Snowball sampling is a sampling technique where existing interviewees recommend other people of interest to the study in which the researchers could contact for future interviews (Alvehus, 2013; Goodman, 1961, pp.148–170). An assumption was made with respect to the transferability of this type of market. The transferability was deemed sufficiently high since the research methods within this market is somewhat standardized or at least similar.

Qualitative and unstructured interviews were used at the start and then shifted towards semi-structured interviews in order to define and narrow down the research questions. As interviews are quick and easy to perform, it is a great way to get the first insights of a complex study like this. The disadvantage of this method is that the interview answers might not reflect the reality of the behavior outside the interview setting (Osterwalder, 2014). Due to this, observations were used as a triangulating complement (see 2.1.3 *Observations*).

All interviews were conducted by a team of two persons (the authors of this thesis) with one assigned “leader”, doing most communication with the interviewee, and the other team member taking notes on a laptop. No recordings of any interviews were made due to the effect and implications it might have had on the interviewee's answers (Osterwalder, 2014). Directly after all interviews, the interview team sat down and went through the notes to fill in blanks, which heightened the authenticity of the notes.

### 2.1.3 Observations

An anthropological approach was adopted in terms of participatory observations. This method was used ethnographically with the company where the authors attended and observed weekly meetings, as well as simply being at the company and observing their everyday work tasks. Alvehus (2013) argues that this is a good method to validate data. The aim of the observations was to gather “natural” data from their daily working environment, which Alvehus puts in contrast to the “fabricated” data originating from interviews. The observations were always open, i.e. the observed always knew beforehand that they were being observed. This is preferable from an ethical viewpoint but might affect the reliability of the data negatively due to the *observer effect*. The observer effect states that the observer in one way or another have an impact on the observed environment and therefore makes the data less representative (Alvehus, 2013).

## 2.2 Data Analysis

One of the most common ways to analyze qualitative data is by using *thematic analysis* (Bryman and Bell, 2013). Fereday and Muir-Cochrane (2006) describe thematic analysis as “the search for themes that emerge as being important to the description of the phenomenon”. They state that the process involves the identification of themes through which is found by “careful reading and re-reading of the data”. By using this method, an identification of patterns or themes could be found within the collected data within this study. This was a suitable method since most of the collected data consisted of qualitative interviews. By using this approach, recurrent topics from when talking to interviewees could be identified.

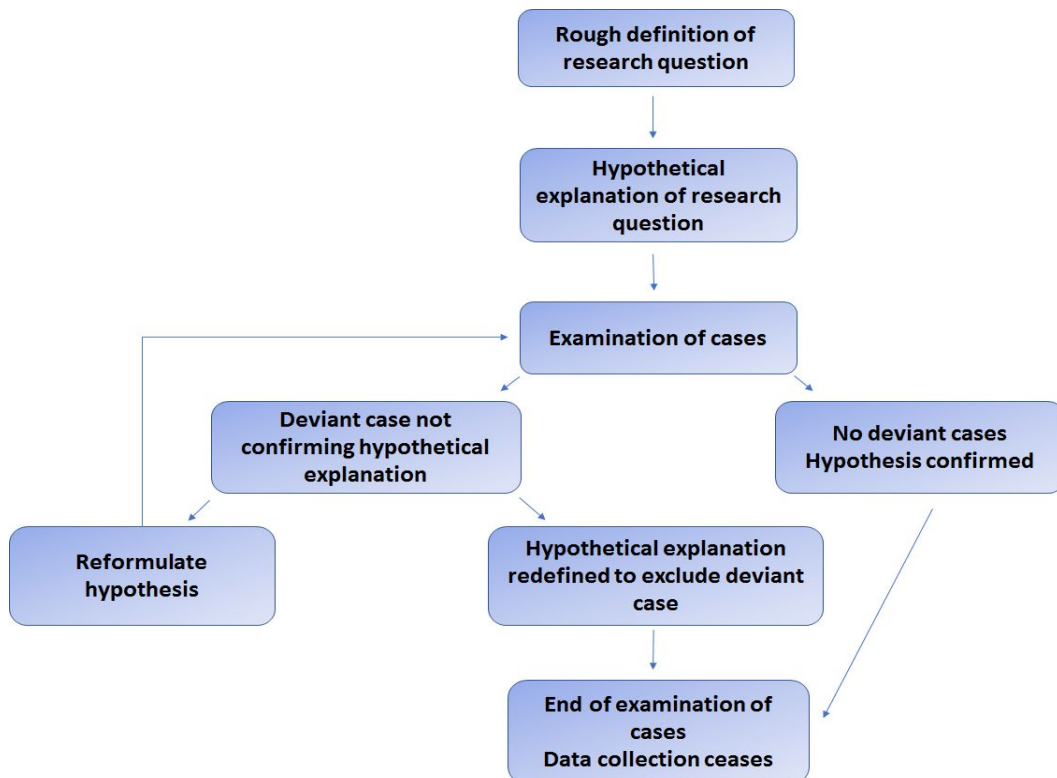
### Analytical Induction

Analytical induction is a research method used to search for a universal explanation of a specific phenomena (Bryman, 2016, pp. 566-567). According to Bryman, it can be summarized into five steps seen in Figure 1. This method was very suitable for this type of study since the range of the topics treated in this study is very broad. Hence, based on the data that was constantly collected throughout the study and the new information it contributed with, the research question could be

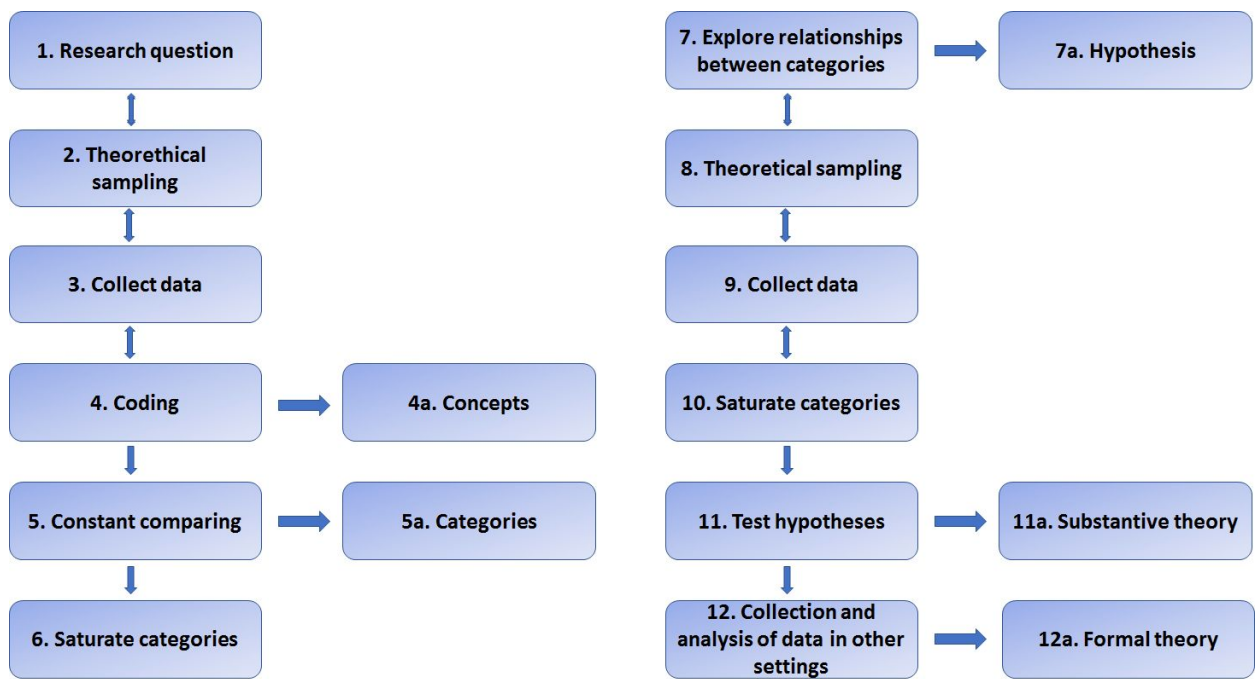
redefined until the hypothesis could be confirmed.

## Grounded Theory

Grounded theory explains how a theory is derived from gathered data, which are later systematically analyzed. The concept of grounded theory is that it is an iterative process, meaning that there is a “repetitive interplay between data collection and analysis/theory building” (Bryman, 2016, pp.567-568). Bryman provides a set of tools used for the process of grounded theory, but also describes the expected outcomes (see Figure 2) (Bryman, 2016, pp.568, 570-571). This tool allowed an iterative analysis approach for this study, which aided in a constant comparison of the collected data with the theoretical sampling and thereby enabling forming a theory suitable for the study.



**Figure 1.** The process of analytical induction. This method can be used to search, define and redefine the research question. Adapted from Bryman (2016, pp.566-567).



**Figure 2.** Processes and outcomes in Grounded theory. An iterative process that displays the interplay between data collection and analysis/theory building. Adapted from Bryman (2016, pp.568, 570-571)

### Analysis of Secondary Data

Data collected from the invoices were analyzed quantitatively. The invoices were sorted in an MS Excel 2015 spreadsheet using the format in Table 1 below, with criteria set by the authors. From the spreadsheet, an extraction of unique customers that had previously purchased products or services from XYZ can be done. Pivot tables were used to quantify and analyze frequencies within the data set.

**Table 1.** The criteria by which the 2014 – 2016 invoices were sorted. The criteria used was set by the authors of this thesis in order to try to describe XYZ’s customer base in terms of customer type and size.

<b>Order</b>	The chronological order in which the invoice was received.
<b>Customer ID</b>	A unique number assigned to customers for quantitative analysis reasons.
<b>Invoice Address</b>	The physical address to which to invoice was sent.
<b>Country</b>	The country to which the invoice was sent.
<b>Product</b>	What products the invoice contained.

<b>Volume [g]</b>	The volume in gram [g] for each product respectively.
<b>Invoice Date</b>	What day of the year the invoice was sent [YYYY-MM-DD].
<b>Comment</b>	Miscellaneous comments about the invoice or company, e.g. acquisitions.

The customers were categorized using the criteria outlined in Table 2. The criteria used was set by the authors of this thesis in order to describe the customer base in terms of customer type and size. Pivot tables in MS Excel 2015 were used to count the number of different customer types and their respective company size.

**Table 2.** Sorting criteria for XYZ customers 2014 – 2016 to reflect the customer type/size. The criteria used was set by the authors of this thesis in order to try to describe XYZ's customer base in terms of customer type and size.

<b>Customer ID</b>	A unique number assigned to customers for quantitative analysis reasons.
<b>Name</b>	The name of the customer/company/organization.
<b>Type</b>	Public/Private/Government University/Company/Organisation/Hospital.
<b>Company Size</b>	A rough number of employees.
<b>Budget</b>	Budget or endowment.
<b>Specialties</b>	In what area this customer specializes in.
<b>Industry</b>	What type of industry the customer exists in, e.g. biotech.
<b>Founded</b>	When the customer university/company was founded.
<b>Country</b>	What country the customer resides in.
<b>Website</b>	The customer university/company website.
<b>Comment</b>	Miscellaneous comments about the company, e.g. acquisitions.

## Narrative Analysis

Narrative analysis was used during the study and involves any type of storytelling or narration of a certain event or life experience. Examples of these are conversations and interviews (Bryman, 2016; Connelly and Clandinin, 1990). As the majority of the data collected was performed via

interviews or conversations, all this information could later be analyzed and contributed to creating a deeper understanding of how people think and reason.

## **2.3 Method Evaluation**

### **Validity**

According to Lekvall and Wahlbin (2007, p.304), it is impossible to determine the true validity of a method; since you would have to compare against a method which you know gives valid results, then you might as well use that method instead. The used methods aimed to gather information about XYZ's current business strategy, and as such, any information concerning this was considered as valid data. With the comparisons between interview respondents and also observations and secondary data, the validity of the method was considered high. Lekvall and Wahlbin (2007, p.305) further claim that predictive validity is the most decisive form of validity in market research; a high predictive validity is in place when the results accurately predict success. Since the theory used to analyze data in this study is well researched, a high predictive validity for these methods is arguably the case.

### **Reliability**

The reliability concerns the accuracy of the methods, i.e. if the same measurement (question asked to interviewee) was done, would you get the same result (answer)? If yes, then the method has a high reliability. To increase reliability in interviews, the same measurement was done several times (when given the opportunity) to minimize impact from external factors such as environment, time of day, stress, the way the question was asked and by who, etc. This is called the "test-retest-method" (Lekvall and Wahlbin, 2007, p.307).

### **Bias**

As the study was not blinded it is not possible to get 100 % objective results. The final results of this study will consist of observations and collections of data that the authors have seen and interpreted. In this case, demographic factors such as personality, gender, age, and the academic background may play a part.

## **2.4 Research Ethics**

This study applied several data gathering techniques such as interviews and participatory observations. During the interviews, the researchers strived to be clear about whom they represented and what this research was about. Bryman and Bell (2013) state that there are five ethical principles that a researcher needs to consider:

1. The transparency of information
2. Consent of participation
3. Confidentiality and anonymity
4. Collected data utilization
5. The promise of not leading the participant to any false pretenses.

At the start of the project, the authors of this master thesis signed a non-disclosure agreement not to share any sensitive business information to any other external parties. In line with Bryman and Bell (2013, pp.136–137) ethical guidelines, before every interview, the interviewees were informed of the purpose of the research and why they were of interest for the study. As contact had been done beforehand via mail, the people interviewed were there on their own accord and was not forced to contact us if they did not want. Hence, they could end the interview at any time. Since none of the interviewees were under age, no parental consent was needed.

After the interview, they were told that all information and data collected will be handled in confidentiality, and if the material were to be used for the final report, they would be able to read it before hand and grant their permission. The subjects could also choose to be anonymous. Emphasis was placed on the last two principles since the aim was to collect as much information as possible but also receive the interviewee's honest opinions and thoughts. If for some reason their identity were to be revealed, they were informed of why and to whom.

The same principles, as stated above, were adopted when interviewing the CEO of the company and the employees. Here the ethical implications of being a small business could be seen. With only 5 employees, although anonymity was offered, this could not be guaranteed due to the size

of the staff. Due to the complexity of the situation, this could have affected the answers obtained during the interviews or to abstain from answering.

As the study involved participatory observations, the researchers of this study came in contact with the individuals working at the company. Bryman and Bell (2013, pp.148) discuss the impracticality in trying to get everyone's informed consent. The main aim with a participatory observation is to be a quiet observer in the background and see how people act in their natural environment. By asking everyone for their agreed consent every time could lead to a disturbance in that sense. There is also a risk of intrusion of an individual personal space when performing a participatory observation during a longer period. These may have been factors that the individuals of the company did not consider before agreeing to participate in the study. However, as researchers one tries to adopt a manner that will not cause any distress to the environment or the people that are being studied.

From a societal beneficial point of view, XYZ produces dextran derivatives which are mainly being used as a research tool within various Life Science areas. Dextran and its derivatives have become well known for its usefulness and its wide array of applications, both industrially and clinically. Due to this, XYZ is indirectly providing goods and services that contribute to an increased knowledge and understanding of various biological processes which in the end can lead to a better and improved health care.

## 3 Theoretical Framework

*This chapter contains theories about business strategy and commercialization of science to aid the final recommendation. First, a description of research-based spin-offs is presented. This is followed by theories dealing with core competencies, visions, and strategies.*

### 3.1 Research-Based Spin-Offs

Many high technological companies within the biotech industry or Life Science, like XYZ, are founded by experienced scientists (Mehta, n.d.; Vohora et al., 2004). It is not uncommon that scientists, employed by universities or research institutes, find new discoveries with potential for having applications they want to commercialize. This phenomenon is known as *academic entrepreneurship* (Barth and Schlegelmilch, 2013). Academic entrepreneurship often originates from so-called *spin-offs*. ‘Spin-offs’ is meant to describe companies that have received a formal transfer of intellectual property or technology from a mother institute; separating them from, or rather making them a subgroup of, start-ups. There are several types of spin-offs. Wright et al. (2007) talk about research-based spin-offs (RBSOs) as companies which commercialize some type of research. These spin-offs or start-ups have become an option for researchers and universities to generate profit. As shown in Table 3, RBSOs can be summarized into three categories: Venture Capitalist (VC)-backed, Prospectors and Lifestyle companies (Wright et al., 2007; Mustar et al., 2008). The information in Table 3 describes the similar and different characteristics of these types of RBSOs.

RBSOs tend to be mostly one-man enterprises with a limited ambition to grow and without a clear commercial strategy. Wright et al. (2007) argue that the growth ambition limitations might be explained partly due to lack of knowledge on how research can be commercialized. One approach to commercialization is to offer products/services that are quickly accepted by the market and thereby reach break-even revenue at a fast rate (Chesbrough and Rosenbloom, 2002; Bhide 2002). A reason why biotech companies start out as consultancy firms or contract research organizations (CROs) might be the long lead times to market, as described by Bower (2003).

As mentioned earlier, many RBSOs start up without a clear vision of how to create value to customers, this is especially true if the entrepreneurs are researchers without the knowledge of commercialization. These companies continue to develop the research for years and search for a viable business model. Lifestyle companies are often founded by individuals based on their personal knowledge (Wright et al., 2007). Usually, lifestyle companies are seeking market acceptance in favor over investor acceptance. Most of the time it is done without external capital. Prospector companies, on the other hand, are searching for a profitable business model, similar to a start-up. Wright et al. (2007) say that a prospector company either go for an exit or become profitable within a niche market. They further state that a typical lifestyle consultancy company usually has a hard time generating high profits since the concept is easily copied. At the same time, it is sufficiently profitable for lifestyle companies to make a living since customers are easy to reach, even though repetitive sales are difficult. Prospecting companies, on the other hand, have a harder time to reach customers and thereby find their position in the value chain. Additionally, their business idea is also easy to imitate (Wright et al, 2007).

### Research Base

The *disruptiveness* of the research, of which the RBSO is spun out of, is another factor. A disruptive innovation refers to an innovation that creates a whole new market and value network, disrupting the existing ones and finally displacing the established market's leading firms (Bower and Christensen, 1985). According to Wright et al. (2007), a VC-backed RBSO is usually based on disruptive research. These RBSOs are very early in their product/service development phase. In contrast, lifestyle companies start out very late in the product/service development phase, and consultancies might already have a first customer when they start out.

The other factor is the *broadness* of the research/concept. Broadness means in how many domains it can be applied, and the more domains the less risk since it can be diversified in many directions to potential customers. The drawback of a broad concept is that it usually takes a lot of resources to develop. For prospecting companies, they rather search for a specific product or niche than an entire technological or scientific concept, as do lifestyle companies. For consultancy firms (lifestyle), their know-how might be the core and not some sort of technology (Wright et al. 2007).

## Financial Resources

There is a great difference between VC-backed companies and the rest when it comes to financial resources. VC-backed have a substantially greater financing capability and they also have a different business model where the aim is to exit. VC-backed RBSOs also attract international capital to a greater extent. Prospectors do not attract the same amount of VC-capital but rather turn to local VCs or BAs in the area with different goals on exit. Non-financial motives could play a part here to a greater extent than with VC-backed RBSOs. As mentioned earlier, lifestyle companies very seldom take in external capital; if it happens it is usually through a BA who wants to play an active part in the company. Personal and family capital is also used to a greater extent in lifestyle companies (Wright et al., 2007). Since lifestyle companies do not really develop new products, their financial requirements are much more short-term oriented than it is for VC-backed and prospector companies.

## Human Resources

VC firms do not usually invest in firms where the team only consists of scientists with no prior business knowledge. For VC firms to do that, usually the RBSOs attract surrogate entrepreneurs to lead the way with the business. Or, the VC might hire their own manager as part of the deal. This is also true for many prospect companies where they might team up with a surrogate entrepreneur, but not really with managers since there usually is no money to hire a professional manager. The surrogate entrepreneur in the prospector companies are not even paid sometimes; they might get their pay from an incubator or some other source. For lifestyle companies, the founding team can be just one or two scientists, and a balanced team is not really an issue unless some type of product is to be marketed; then a more business oriented person usually joins in (Wright et al., 2007). Usually, sectoral experience in the founding team in both VC-backed and prospector RBSOs is quite limited. Even a potential surrogate entrepreneur/manager often lack the sectoral contacts and experience to ensure a fast launch. Wright et al. (2007) say that paradoxically, the lifestyle companies are founded by scientists that have substantial consulting experience within their field to customer companies; they are also usually very familiar with market segments they want to target with a potential product.

**Table 3.** The three types of research-based spin-off enterprises, as presented in '3.1 Research-Based Spin-Offs'. Here we can see the full list as adapted from Mustar et al. (2008).

		<b>VC-Backed</b>	<b>Prospector Type</b>	<b>Lifestyle Type</b>
<b>Institutional Link</b>	<b>Formal involvement</b>	Equity based on a complex IP system	Equity relations based on one patent or none	License, contract, informal relations
	<b>Prestige of Research Group</b>	Worldwide recognition over a broad domain	Worldwide recognition in a focused subdomain or local recognition	Various
<b>Business Model</b>	<b>Investor vs. Market Acceptance</b>	Investor acceptance	Both	Market acceptance
	<b>Mode of Value Capture</b>	Clear IP maximizing strategy or value chain acquisition. Strategy to prepare trade sale/IPO	Optimize time to break-even and future trade sale value, no clear exit yet	Optimize profit
<b>Research Base</b>	<b>Degree of innovativeness</b>	Disruptive technology or market	New product based on non-disruptive technology	New products/service addresses an unmet market need
	<b>Stage of Product/Service Development</b>	Early, sometimes not even defined	Early, alpha prototype	Almost market-ready product/service
	<b>Broadness of the Technology Concept</b>	Can be broad	Narrow	Not relevant
<b>Financial Resources</b>	<b>VC involvement</b>	Able to attract 1–5M€ in first 18 months after founding	Lower amount of BA's, baby VC or public fund investment	Usually no external equity, some BA involvement possible
	<b>Financing Mix</b>	High level of external equity, some debt financing, intensive use of subsidies	Mix of external capital, soft loans and subsidies	Internal funding, debt and some soft loans
<b>Human Resources</b>	<b>Balanced Team</b>	Surrogate entrepreneur or hired guns	Technical scientist act as entrepreneurs	Technical scientist
	<b>Sectorial Experience</b>	Management experience, research excellence	Little experience	Plenty of sector experience
<b>Social Resources</b>	<b>Partnership at Start-up</b>	Formal partnerships with stakeholders (VC, technology providers etc.)	None	Formal availability of lead users

## Social Resources

Wright et al. (2007) emphasize that it is often important for RBSOs to have solid networks and/or partnerships for increased growth potential, and that prospector companies often completely lack this. Often prospectors look to sell products downstream in the value chain, which is the area they are most unfamiliar with. Also, if local VCs (small-scale) invest, or a surrogate entrepreneur hops on, they very rarely can provide relevant contacts to the founders. The reality is very different for VC-backed companies since they do not initially search for market acceptance but rather investor acceptance and thus the VCs network is of greater relevance. Lifestyle companies that sell services usually have a customer contract from the start, and if they sell products it is usually co-created with a customer (Wright et al., 2007).

## **3.2 Business Strategy**

Strategy is a way to take your company from point A (current situation) towards point B (your vision). So before diving into strategy building, define where you are heading i.e. what is your point B? Collins and Porras (1996) describes three components of a vision:

1. Core Values: A company's essential tenets.
2. Core Purpose: A company's reason for being.
3. Envisioned future: Vividly described long-term (10-30 years) goals.

Core values and purpose makes up a company's *core ideology* and it is not something you can come up with or fake, it is something inherently true to the company and is discovered by looking inside you. The envisioned future is made up of big, hairy, audacious goals (BHAGs), which can be either quantitative or qualitative. In contrast to the core purpose which can never be fulfilled nor disregarded, the BHAGs are reachable (Collins and Porras, 1996). You reach for the stars by start climbing tree-tops.

Let's consider another article by Collins (2001) who makes a point when it comes to building great companies: Attend to people first. From studying 11 companies that skyrocketed in the market, one common factor Collins found was that the leaders of these companies did not

initially look at the strategy nor vision of the companies, but they attended to the people first. Collins says it best in his own words:

*“They got the right people on the bus, moved the wrong people off, ushered the right people to the right seats – and then they figured out how to drive it”*

(Collins, 2001, p.71)

### 3.2.1 Generic Strategies

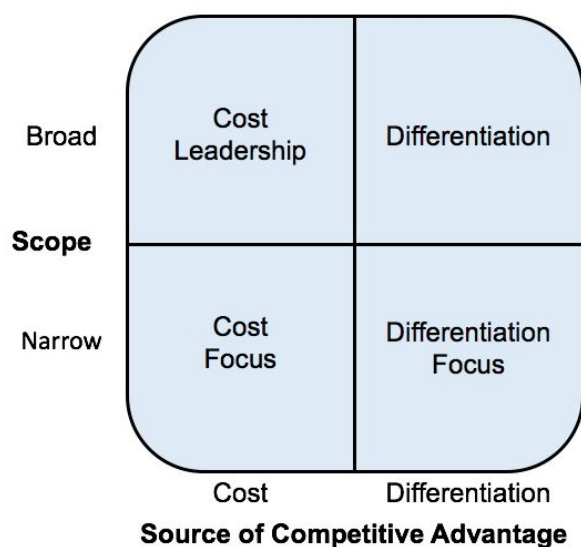
One of the front men of theory on business strategy is Michael E. Porter. His generic strategies (see Figure 3) are three concepts that many organizations have adopted to develop key strategies in order to outmaneuver competitors and create competitive advantage. These three strategies include *Cost Leadership*, *Differentiation* and *Focus* (Porter, 1980).

Cost Leadership is about creating a competitive edge by manipulating production costs. This can be done in two ways, either by charging lower prices and thereby increase market share or reduce one's costs in order to increase profits; fewer expenses means that money can be redirected elsewhere. Price is an important factor to consider when trying to attract customers. The Differentiation strategy looks to how a company can develop unique products and through this entice new customers. The concept is based on differentiating one's products from the competitors and offer something that they lack. Moreover, Porter (1980) claim that in order to implement a Differentiation strategy, a company needs the following:

- Marketing and promotion teams. These individuals are needed to constantly define a company's brand and to emphasize its uniqueness.
- Deliver high-quality products. It is harder to create a loyal relationship with a customer if the product does not meet the customer's expectations.
- Research and innovation. By continuously trying to develop and push the boundaries of a company's research and technology, the company will find it easier to stay relevant.

Cost Leadership and Differentiation are both strategies aiming to target the large masses. On the other hand, there is the Focus approach. Companies that use Focus strategies concentrate on

particular niche markets. By putting all their efforts into one market, they often understand the dynamics of that market and the unique wants and needs of the customers within it. As a result, they develop either uniquely low-cost or well-specified products for the market. Since they often also serve customers in their market well, they tend to build strong brand loyalty. This makes their particular market segment less attractive to competitors (Porter, 1980). However, by only serving a selected group of people might prove unattractive to those outside that group. Thus, these companies become almost solely dependent on the spending habits and behavior of a very small percentage of people. Porter subdivided this type of strategy into two: Cost Focus and Differentiation Focus. Cost Focus is about trying to find a cost advantage within their target market segments, while Differentiation Focus involves companies trying to find a unique market in which they can try to maximize profits in any possible way (Porter, 1980)



**Figure 3.** Porter's Generic Strategies. This model describes different strategies for competitive advantage.

Porter (1996) argues that a business strategy is the creation of a uniquely valuable position that is made up from a unique set of different activities in relation to competitors. A clear distinction is made from the differences between Strategy and Operational Effectiveness (OE), and that they are not the same thing. When talking about OE, it means performing *similar* activities *better* than the competition, and that strategy means performing different activities altogether and *combining* them. OE is necessary for the daily management but not the whole picture when it comes to valuable positions.

### 3.2.2 Core Competencies and the Hedgehog Concept

So what about these previously mentioned activities? Activities are everything you do that relate to your business. Prahalad and Hamel (1990) describe the concept of *Core Competencies* where

they argue that you should focus on what you are good at and try to do more of it, while doing less of what others do better. You also try and hone in on relevant areas which really matter to your customers. For a competence to be a true ‘Core Competence’, Prahalad and Hamel (1990, p. 83) gives a three-step test which the competence has to pass:

1. It should provide access to a wide variety of markets.
2. It should make a significant contribution to the perceived customer benefits of the end product.
3. It should be difficult for competitors to imitate.

A similar concept that Collins (2001) talks about is the Hedgehog Concept; three things that a company should be systematic and consistent with. The three things are: What a company can be best in the world at (competence), how its economics work best (is there a profitable market?), and what best ignites the passions of its people. Collins says you should more or less eliminate all activities that are not in the intersection of these three circles (Figure 4).



**Figure 4.** The Hedgehog concept adopted from “*The Hedgehog and the Fox*” by Isaiah Berlin, 1953; coined by Collins, 2001. In contrast to the fox, who knows many things; the hedgehog knows and focuses on one big thing. Thus the fox’s thinking is unfocused and its long-term achievements limited. The hedgehog, often overlooked, is focused and succeed against all odds.

Strategy guides your choices of activities when making tradeoffs and choosing what *not* to do. One of the keys to success is being consistent in what you do, something Collins (2001) calls the “Buildup-Breakthrough Flywheel”, and can be compared to kick-starting a motorcycle; it takes a few consistent kicks before the motor ignites. By being consistent with your strategy and company vision, and achieving *activity-fit* (when activities reinforce one another), it will also be

very hard for competitors to imitate. Porter (1996) argues that the probability that competitors can imitate one activity might be 90%, but imitating a strategy consisting of many activities is very unlikely. This gives that the more interlocked activities you have, which contribute to your overall strategy, the harder it would be for competitors to imitate

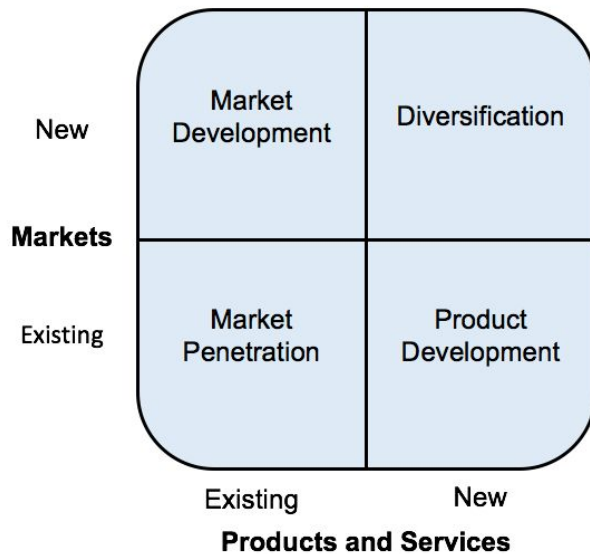
#### Notice

Strong know-how and expertise of the industry might be looked at as a core competence. But consider that if your competitors have equivalent skills, then it is not a true core competence. It just creates a higher barrier for new entrants the market. Further, it's not very viable when considering expanding into new markets, which will have their experts already (Prahalad and Hamel, 1990).

your position. Porter further emphasizes that continuity is key since it fosters activity improvement and that changes in strategy are very costly. Therefore it is wise to stay true to the strategy that once made the company successful. If the historical position is no longer viable, the challenge would be to start over, just like a startup would (Porter, 1996).

### 3.2.2 Growth Strategy

Porter (1996) mentions “The Growth Trap”, which is when the desire to grow dilutes the strategic position. This can cause managers to broaden their line of products or services outside their core and thus blur what the brand stands for. However, globalization can often allow companies to stay true to their strategy on a larger market instead of spreading out on a smaller local market. It is common for companies to turn to growth after decades of organizing and optimization, but it is a real threat to the business strategy. For growth to be profitable, a company should strive to *deepen* their position, not broaden it (Porter, 1996; Collins 2001). Ansoff (1957) talks about ways to increase sales and new reaching new customers. His growth strategies can be modeled in a product/market matrix, also known as the Ansoff Matrix (see Figure 5).



**Figure 5.** Ansoff's growth strategy matrix, showing four different approaches a company can take when growing their business.

Ansoff suggests that for a company to grow, it can apply new/existing products/services in new/existing markets. *Market development* strategies are about selling already existing products/services of the company but to new types of customers/markets. The *Diversification* strategies use new products/services altogether to create new demands. For *Product Development* strategies, the company is using existing customer types and giving them new value in terms of products/services. Meanwhile, the *Market Penetration* is about selling more of your existing offerings to more customers of the same type

### 3.2.3 Value Creation Strategies

Kim and Mauborgne (2004) talk about how a company can create a valuable profitable position through a type of strategy they've termed the *Blue Ocean Strategy*. Blue ocean strategy is a concept where you create uncontested market space where the competition is irrelevant, in contrast to a *Red Ocean Strategy* where the industry is overcrowded (and the water is colored red from the blood of fighting competitors), see summary in Figure 6 below. Blue ocean strategies are adopting some type of "new market strategy", inhabiting the Market Development and Diversification quadrants of Ansoff's matrix (Figure 5), while the Red Ocean strategies move in the lower quadrants Product Development, and mainly Market Penetration. The challenges with competing using a red ocean strategy as a small company are evident. Brands become more and more alike and customers are more likely to base their choice to purchase solely on price. A reason why companies face difficulties when trying to break free from the competition is that managers fail to see the difference between these two strategic views.

Red Ocean Strategy	Blue Ocean Strategy
Compete in existing market space	Create uncontested market space
Beat the competition	Make the competition irrelevant
Exploit existing demand	Create and capture new demand
Make the value/cost trade-off	Break the value/cost trade-off
Align the whole system of a company's activities in pursuit of differentiation <i>or</i> low cost	Align the whole system of a company's activities in pursuit of differentiation <i>and</i> low cost

**Figure 6.** Red Ocean Strategy vs. Blue Ocean Strategy. Red oceans represent all industries currently in existence, blue oceans those that are yet to come (Kim and Mauborgne, 2004).

A key insight to blue ocean strategy is that it often is created from within red oceans, i.e. it springs from existing markets using existing technologies linked to what customers really value. This is in line with the Market Development strategy in Ansoff's matrix (Figure 5). This is also something that Collins (2001) mention separates good companies from great companies; great companies carefully apply existing technology instead of hopping on new tech trends. To make this value-driven approach a reality, you need a fundamental understanding of what your customers value the most. Then you need to supply this while also aiming for reduced costs. Kim and Mauborgne (2004) argues that this is good news for existing companies since it means they can create blue oceans within their core business (which is how most blue oceans are created according to their research).

A blue ocean strategy never benchmarks against competitors, since the strategy makes the competition irrelevant. It is not a matter of beating the competition by offering a better solution to the same problem – it is a matter of redefining the problem itself. In a red ocean mindset, there is a notion that value and cost are positively related to some degree, whereas in a blue ocean mindset they are instead thought of as being negatively related. This means a critical change in thinking about strategy: the trade-off between value and cost is no longer necessary. Greater value for lesser costs is a possibility (Kim and Mauborgne, 2004).

When it comes to identifying how to create blue oceans one should look at the *strategic move*. They define this as “*the set of managerial actions and decisions involved in making a major market-creating business offering*” (Kim and Mauborgne, 2004, p. 75). Essentially it means that the creation of a blue ocean is a string of strategic moves, where the key is to make the right ones, and business strategy comes into play here for guidance (Kim and Mauborgne, 2004). While the Blue ocean strategy as described above is desirable, few companies actually manage to truly apply and execute this type of strategy. In reality, it is often a mix between the two that is being used. What this mindset really boils down to is to look for ways that you can create new types of customer values (Kim and Mauborgne, 2004). Ash Maurya (2012) and Osterwalder et al. (2014) have described stepwise models for value creation:

1. Problem/solution-fit: Is the problem worth solving, and is it solved in a satisfactory way?
2. Product/market-fit: When you have produced something people want.
3. Business model-fit: Capturing customer value in monetary terms.
4. Scale up: Accelerate the business model.

Maurya (2012) argues that before a product/market-fit is achieved, the company should focus on finding a plan that works via “learning and pivots” (step 1–2). Not until *after* product/market-fit should you move on to accelerating that plan via “growth and optimization” (step 3–4) (Maurya, 2012, p. 9; Osterwalder, 2014). A core part of achieving true problem/solution-fit is to verify that your products really addresses customer jobs and their accompanying pains and gains (Osterwalder, 2014).

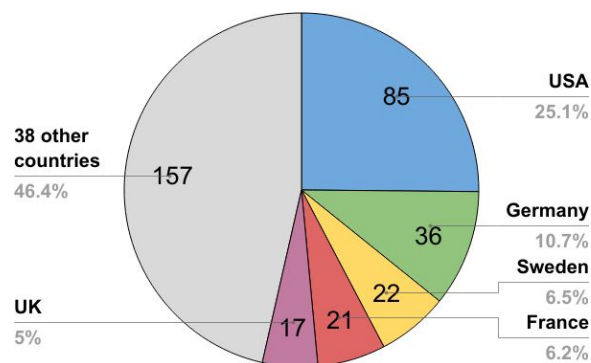
## 4 Empirical Results

Here the empirical data is presented, divided into “market” and “company” data. Market data relates to customers and offered products, as well as the current competition. Company data relates to resources currently available to XYZ. Finally, the data is summarized in a SWOT matrix (Figure 12).

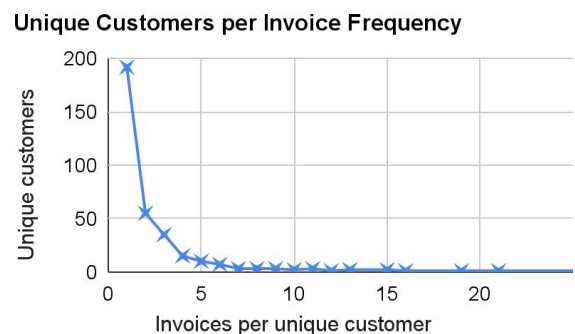
### 4.1 The Market

#### 4.1.1 Customers and Products

Identification of current customers and products sold were assessed from invoices dating back to the fiscal year of 2014 until 2016. As represented in Figure 7, a total of 338 unique customers were identified from these invoices and about 25 % of those residing in the US. Of these 338 customers, 192 were one-time buyers (see Figure 8) making up 56.8 % of the total customer base. 83.4 % of the customers purchased less than 3 times during this 2 year period. Two customers are excluded in Figure 8: the most prominent customer with 121 invoices, followed by second most prominent with 41 invoices, compared to the average frequency of 2.6 invoices.

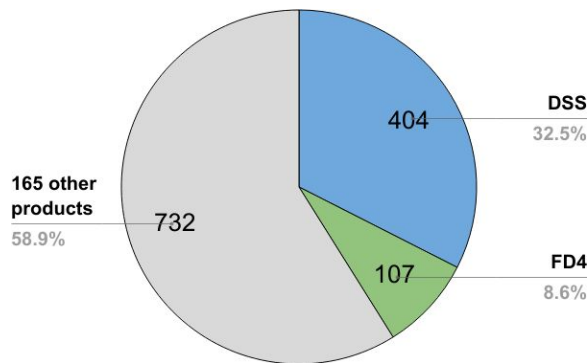


**Figure 7.** The geographic location of customers. On each slice is the number of customers from that country. The customer amount for that country relative to the total customer base is also given in percent.



**Figure 8.** Unique customers per invoice frequency. This graph illustrates the frequency of unique customers on the y-axis, and the frequency of unique invoices per customer on the x-axis (up to 25 invoices/unique customer). Data is collected from all invoices sent by XYZ between 2014 and 2016.

The most frequently sold product was DSS (Dextran Sodium Sulfate, MW 40 kDa) followed by FITC-dextran (MW 4 kDa), see Figure 9. 165 other unique products are split upon the 732 purchases.



**Figure 9.** Product purchase frequency. Purchase frequency stated in each slice. Contribution to the overall purchase frequency is also given in percent.

### Marketing Channels

A previous bachelor thesis conducted by Lundström et al. (2015) for XYZ showed that most of XYZ’s customers got into contact with the company via recommendations (word of mouth) or through internet search. They also found out that customers valued XYZ’s products mostly by their low price and the ability to create customized products, “Customer Specific Products”.

According to the CEO, the company does not usually follow up customers after a purchase to ask for feedback, due to lack of resources. At least one field visit to their largest customer has been done. The company has conducted a customer satisfaction survey recently in accordance with the ISO 9001 guidelines (ISO 9001 is a quality control program the company is using).

Through email contact with researchers in Sweden, it was found that 12 out of 41 respondents do not use dextran anymore in their research (see Table 4). Out of these 12 respondents, 5 said that they had previously used dextran products from XYZ, either fluorescent or DSS.

**Table 4.** Emails sent to researchers on the CEO's contact list and authors in Sweden of scientific articles where dextrans were used/mentioned.

Total Email Sent	Total Respondents	Total Respondents Who Previously Used Dextran
41 (100 %)	12 (29 %)	5 (12 %)

Based on the interviews with potential, current, and previous customers – it became clear that the reputation of a supplier can contribute to creating value in the sense of credibility.

*“I have heard of XYZ before, the founder is very well-known within the scientific field of dextran. Because of this, I know that XYZ has a very large know-how within the company.”*

(Scientist at a global dermatology company, 2017-03-31)

*“Since my research leader is acquainted with the founder of XYZ we knew about the company since before. We buy all of our DSS from XYZ.”*

(Postdoctoral Researcher within Medical Cell Biology, 2017-04-04)

Depending on the context of use between the customer types there are evident differences when it comes to e.g. regulations in respect to the quality of the product and/or specific demands regarding suppliers.

*“When buying material for an experiment from a supplier, even though it might be for a test experiment, it is important to consider questions such as: will this supplier be able to deliver/live up to our criteria IF we were to scale up? We have quite high demands on our suppliers and must follow certain regulations when choosing suppliers.”*

(Scientist at global dermatology company, 2017-03-31)

One interviewee said that the switching of a supplier would result in that they have to carry out tests in order to secure product quality. This, in turn, would result in higher switching cost for the customer. These do not solely relate to monetary switching costs but also time-based switching costs.

*“Even though there are other substitutes for certain products, this would require us to test the product ourselves first before making a decision to switch, and then it’s a matter of time again.”*

(Senior Research Engineer within Vascular Biology, 2017-03-31)

*“Although it might become more costly to buy a more expensive dextran in the short run, it’s better in the long run since we will save money by saving time. We just need our product to work as promised so we can perform our experiments the way we planned.”*

(Senior Research Engineer within Vascular Biology, 2017-03-31)

The majority of the customers are working on a very tight schedule regarding their planning of their experiments. Interviewees also expressed the importance of reproducibility and reliability of scientific results and that this is a determining factor. Other determining factors that customers consciously consider before a purchase include the price of the product, as well as service supplied by the selling company. In general, customers think that dextrans are expensive.

*“The decision where to buy dextran is not solely based on the price. In our work, reproducible and reliable results are of high importance. Due to this, we want products that deliver the properties and quality promised in the product sheets.”*

(Senior Research Engineer within Vascular Biology, 2017-03-31)

*“Our research group depend on reliable and reproducible results. Due to this we need a trustworthy supplier.”*

(Postdoctoral Researcher within Medical Cell Biology, 2017-04-04)

*“What we need is reliable suppliers that deliver the high quality dextran. Dextran is expensive, but we are willing to pay a higher price for high-quality since our work is dependent on reproducible research results. High-quality dextran would mean low variability, non-toxic or harmful. Narrow fractions are nothing that we consider, rather, a low batch-to-batch variability is preferred. We don’t have any demands for ISO- or GMP certified suppliers.”*

(Professor in Vascular Biology, 2017-03-09)

*“When deciding on what products to purchase, factors such as price, service and others experience play in.”*

(Research Engineer within Vascular Biology, 2017-03-30)

It became clear when talking to the interviewees that no one in this customer segment was interested in the analysis service that XYZ currently offers. Neither was there a clear interest in some of the product properties that the company highlights in their current sales argument. All of the interviewees said that they had no need for it. Meanwhile, it was found that the standardized products that XYZ offers were of interest among potential customers. Further, one customer who had previously bought from XYZ was satisfied with their purchase.

*“We have no interest or need for determining molecular weights. We mainly used standardized products, so the batch variability is of higher importance to us than properties such as narrow fractions.”*

(Professor in Vascular Biology,

2017-03-09)

*“I was happy with my purchase at XYZ. I prefer doing business with smaller companies in comparison to larger ones, they are much more rigid and difficult to handle.”*

(Scientist at a large dermatology company, 2017-03-31)

*“I have never heard of XYZ before but I am positive toward support local companies.”*

(Professor in Vascular Biology, 2017-03-09)

#### 4.1.2 Competitors

The main competitors active in this market are the large global corporations Sigma-Aldrich (owned by Merck KGaA) and Molecular Probes (owned by Thermo Fisher Scientific), who are currently holding the majority of the market shares for FITC-dextran products (see Figure 10 and Table 5). These companies have a long history and good reputation within the scientific community, which is of great importance to the customers. Hence, their credibility is high.

“XYZ developed a product that we needed for a certain experiment which we got to try. We compared it to another dextran product from Molecular Probes (Thermo Fisher Scientific). Unfortunately, XYZ’s product performed worse than the other dextran product. The difference between the two was almost ten-fold.”

(Senior Research Engineer within Vascular Biology, 2017-04-03)

“We have bought all our dextran products from Molecular Probes (Thermo Fisher Scientific).”

(Research Engineer within Vascular Biology, 2017-03-30)

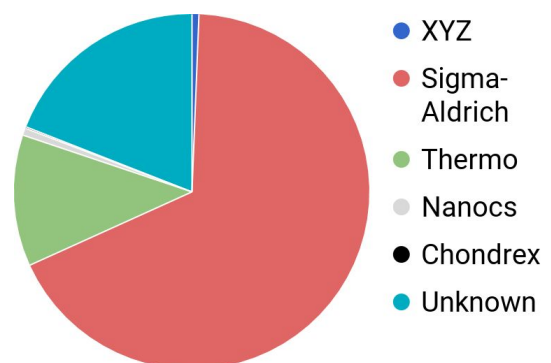
“DSS is expensive. As it is a standardized product, we don’t need to know more about it. ”

(Postdoctoral Researcher within Medical Cell Biology, 2017-04-04)

In comparison to the large competitors, XYZ offers dextran products at a lower price (see Table 6). According to the CEO, there are companies in the Asian regions that provide dextran products at much lower prices, but XYZ believes that the current European quality standard is higher than the Asian and thereby make up for the price difference. However, the company feels that the Asian countries could pose a threat due to resource advantages e.g. cheaper labor.

**Table 5.** Google Scholar™ articles mentioning FITC-dextran since 2014 (see Appendix 10.4).

Company	Number of Results
<i>Entire market</i>	11700
<i>XYZ</i>	77
<i>Sigma-Aldrich</i>	7990
<i>Thermo Fisher Scientific</i>	1400
<i>Nanocs</i>	73
<i>Chondrex Inc.</i>	17



**Figure 10.** Search queries on Google Scholar™ for article mentions since 2014. Not including patents (from Table 5).

**Table 6.** Competitors and their prices for FITC-dextran (4 kDa or similar) and DSS (40 kDa). The color coding in the rightmost column: Green = the three lowest, Red = the three highest; Yellow = Others.

Competitor	Product	MW [kDa]	Quantity	Price [SEK]	Price per gram [SEK/g]
<b>Chondrex Inc.</b>	FITC-Dextran	4	25 mg/mL x 5 mL	561.6	4132.8
	DSS	40	20 g	2160	108
<b>Nanocs</b>	FITC-Dextran	3	0.01 g	3326.4	332640
		5	0.01 g	2462.4	246240
<b>XYZ</b>	FITC-Dextran	4	0.1 g	512	5120
		4	1 g	2405	2405
		4	5 g	7973	1594.6
	DSS	40	50 g	1740	34.8
		40	100 g	2486	24.86
		40	500 g	9340	18.68
<b>Sigma-Aldrich</b>	FITC-Dextran	4	0.1 g	1148.85	11488.5
		4	0.5 g	2742.75	5485.5
	DSS	40	5 g	758.66	151.73
			25 g	2877.3	115.09
			100 g	8714.7	87.15
<b>Thermo Fisher</b>	FITC-Dextran	3	0.01 g	3040.00	304000

## 4.2 Company Resources

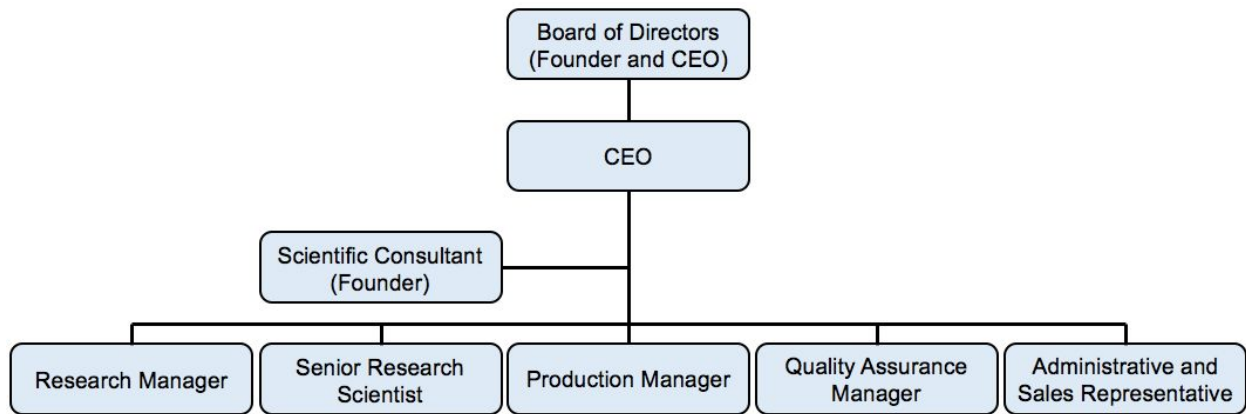
### Human Resources

Currently, XYZ has 5 employees and their organizational structure is represented in Figure 11. The CEO has expressed that, being a small company, they feel vulnerable when someone is absent. Due to this, XYZ would like to expand their number of employees, which the company also states in the business plan. XYZ mentions that one of the most important resources for the company would have to be their human capital. The company has a worldwide recognition within the field of carbohydrate chemistry, specifically dextran and dextran derivatives. This is many thanks to the founder of XYZ. Based on interviews with the CEO and employees of the

company, the founder’s know-how have also been seen as one of their greatest strength. The fact that the founder has been active in the market for almost over 30 years contributes to the credibility of the company and has presumably also helped to generate customers.

*“We are a large global company, due to this we have our own in-house knowledge. Thanks to this we don’t have to rely on others expertise”*

(Scientist at global dermatology company, 2017-03-31)



**Figure 11.** The organizational structure of XYZ..

As previously mentioned, a great challenge XYZ is facing is to phase out the founder but keep as much as possible of his know-how within the company. Due to this, the recruiting process has mainly been focused on the retainment of in-house skills, e.g. theoretical knowledge, practical laboratory excellence and communication skills. The employees are hired with this in mind and the idea is that they should complement each other. This gives the company a high level of expertise and enables them to solve several of their customer’s problems in respect to dextran and dextran derivatives.

### Financial Resources and Physical Assets

Earlier on, XYZ reached a point that was related to some of their most sold products, where the revenue generated was not sufficiently greater than the effort it took to produce them. XYZ then decided to outsource this production to a CMO in Denmark. Now XYZ has invested in a chemical reactor enabling them to increase their production output, and the company says that it would be able to double the production volume with its current resources.

<p style="text-align: center;"><b>Internal Strengths</b></p> <ul style="list-style-type: none"> <li>● The goal of 20 % annual growth of sales.</li> <li>● The goal of 10 employees until 2018.</li> <li>● Customers worldwide.</li> <li>● Easy to purchase standardized products on their website.</li> <li>● Founders network and reputation.</li> <li>● Relevant scientific expertise.</li> <li>● Capacity to double their production.</li> <li>● Quality control program.</li> <li>● Healthy finances.</li> </ul>	<p style="text-align: center;"><b>Internal Weaknesses</b></p> <ul style="list-style-type: none"> <li>● Non-disruptive research and technology.</li> <li>● Difficulties defining their uniqueness.</li> <li>● Each employee is a key player.</li> <li>● Unbalanced team (no marketer).</li> <li>● Limited communication with customers.</li> <li>● Sales consist of many one-time purchases.</li> <li>● Most sales are based on one product (DSS).</li> <li>● Dependent on one large customer.</li> <li>● One customer is also a competitor.</li> </ul>
<p style="text-align: center;"><b>External Opportunities</b></p> <ul style="list-style-type: none"> <li>● Customers value low price, customized products, supplier reputation, service.</li> <li>● A determining purchasing factor for customers is the reproducibility and reliability of scientific results.</li> <li>● Main channels customers use to reach XYZ is via recommendations or internet search.</li> </ul>	<p style="text-align: center;"><b>External Threats</b></p> <ul style="list-style-type: none"> <li>● Customers against switching supplier.</li> <li>● Customers think dextrans are expensive.</li> <li>● Large global competitors with high market share and good reputation.</li> <li>● Emerging competition from Asia.</li> <li>● Few raw dextran suppliers.</li> <li>● Distributors of XYZ products compete on the same market as XYZ.</li> </ul>

**Figure 12.** Current situation of XYZ summarized in an internal/external-matrix (also known as a SWOT-matrix).



## 5 Analysis

*In this chapter, the empirical data from chapter 4 is analyzed and interpreted. Finally, a recommendation on how to move forward using this data analysis is presented.*

### 5.1 The Company Profile

XYZ shows many similarities to RBSOs in terms of being a company trying to commercialize some type of research or knowledge-base. As mentioned, the founder of XYZ is a well known and experienced researcher who started his own consultancy business. Hence, the way the company initially started could be regarded as a lifestyle company (see Table 3). Lifestyle companies often consist of technical scientists who have extensive sector experience (Wright et al. 2007), which is similar to XYZ in the early stages. Further, lifestyle companies seldom take in external capital. However, when the founder decided to pass on the role as CEO, the company profile warped to more of a prospector company (see Table 3). In line with the prospector type, XYZ has world recognition in a focused subdomain through the founder. Although the founder has plenty of sector experience, the rest of the team does not. A prospector company is seeking valuable business using a knowledge-base of some sort. This could be through e.g. developing new products (Wright et al. 2007). This is in line with what XYZ is currently doing, and what the CEO wishes to expand as the company has expressed that it would like to develop more new products, especially fluorescent products.

#### Vision and Goals

According to Collins and Porras (1996), a company vision should be inspiring and motivating. Also, it should state the organizational values and direction in a clear manner. It could include human values e.g. how the company improves people's lives. Currently, the stated vision of XYZ (p. 34) is more similar to a mission statement, which is just a part of a vision. The pronounced vision does not seem to include the elements that Collins and Porras talk about when it comes to building a company's vision. A vision should reflect the soul of the company and its core values. It should also contain a core purpose, which is the mission statement. The core purpose of a company should express how the company creates value for its customers. Finally

to tie it all together the vision should express a visionary goal. In short, the vision can be seen as how to pitch your company in a concise way.

The goal of annual organic growth of sales with 20 % is a great financial goal that is achievable and motivating. But the vision and mission could also to be motivating in themselves. This is an important part for strategy-setting since it is the company's guiding star.

## **5.2 Team Balance**

Collins (2001) says that the team is the first thing that should be properly assembled. The company has a very homogenous staff in terms of knowledge. As mentioned earlier, XYZ mainly consists of technical scientists, which is line with both lifestyle and prospector companies (Table 3). Thus, it is not uncommon that knowledge intensive companies such as XYZ has a staff that looks like this. However, as a result, there is an imbalance between scientific and business knowledge within the company. For example, XYZ does currently not have a devoted marketing section. This is a weakness for the company, and it could be more profitable for the company to invest in developing a marketing section. Porter (1980) mentions the importance of having a marketing and promotion team. These people are needed to constantly define a company's brand and to emphasize its uniqueness. Hence, it is essential that the people who are in charge of the market research have adequate skills and can identify what needs to be done and how it should be done. Wright et al. (2007) say that it is often a common problem for RBSOs to lack commercialization knowledge. This is something that usually is solved through the attainment of a surrogate entrepreneur, who takes on the role of leading the business forward, and not a manager (since it is too expensive). A third option might be to hire business coaches for the researchers themselves.

In XYZ's case, the CEO could also be seen as a surrogate entrepreneur. Becoming the CEO of the company, along with that position also came the role develop the company and lead the way. Something that is characteristic for what surrogate entrepreneurs do. An example of entrepreneurship at XYZ is the participation in different business development programs as an opportunity for their business to grow and develop. The help the company has received has taken shape both in fundings but also mentorship for the CEO. This has resulted in the company's expansion into Asia.

However, as Wright et al. (2007) point out, these entrepreneurs usually do not have the sectoral experience or the network required to make the company take off. According to Wright et al., a paradox is that the founder of lifestyle companies often already have customers within their network, but at the same time does not really need them. This is often due to that the growth ambitions of lifestyle companies are limited (Wright et al., 2007). Based on the case of XYZ, the growth ambitions may have changed when the current CEO took over the company, in comparison to how it was from the beginning when the founder managed the company. The current CEO shows higher growth ambition and wants to develop the company further. This can be seen in the company's current vision statement (1.1.1 The Case Company – XYZ), where the company says it want to become a world leading company within dextran. So lifestyle-company founders are usually very familiar with who their target customer is.

### ***5.3 Customer Understanding***

The market of dextran derivatives is complex and therefore it is a big challenge to operate in, especially as a small company. Not only is there a need to understand your own products as a producing company, but also understand your customers and how they value your product.

There are high barriers of entry since it takes experts on both ends. The manufacturer needs to have a certain expertise to develop and produce the product, as well as the customers who often are experts within their field.

Osterwalder et al. (2014) describe the importance of knowing your customer and how a company only can benefit from taking the time to do this. By understanding what the customers are trying to perform, the problems they are trying to solve, or the needs they have, it will be easier for the company to design the right product/service for the right customer. Customer value is the value that a customer places on specific good or service, which is dependent on how beneficial the customer finds that specific product or service. Customer value is therefore not only related to monetary terms but could also be emotional ones. Brand loyalty is an example of this. If the customer value exceeds the market value, the customer will find it worth the while to buy that product. Further, if a producer can increase the customer value without increasing the production costs, there is room to increase the price. Due to this, it is very important for

companies to understand their customer in order to increase profit. Through the concept of customer value proposition, XYZ could thereby increase their sales. The sales of a company could be seen as a receipt that a company is producing something that their customers want. As XYZ is struggling with stagnating sales, the customer understanding is worth assessing.

A large majority of the invoices were one-time purchases (see Figure 8). This also became clear when talking to the interviewees, where half of the interviewees were one-time purchases. A reason for this might be that the customers purchase larger amounts at one time so that it lasts for several years. This could mean that the purchases are several years apart, but only one purchase fits into our data range of two fiscal years. Another reason might be that they simply were not sufficiently satisfied with their purchase to return. In either case, it is something that should be investigated further. Based on Figure 9, it became clear that the most frequently sold product is DSS (MW 40 kDa) followed by FITC-dextran (MW 4 kDa). This could thereby act as an indication of which products the customers are most in need of. Investigating if there is an opportunity to increase the value propositions for these product could therefore be an alternative for XYZ to look into.

Most customers are working against a very tight schedule, and as the saying goes: “Time is money”. Due to this, the interviewees identified the need for a high quality product that delivers the properties and quality expected. In line with this, interviewees expressed the need for a trustworthy suppliers. All of them expressed the importance of reliable and reproducible results in their work. Although price seemed to be a contributing factor, it was not necessarily a determining one. This could hereby mean an opportunity for XYZ for a new pricing strategy. As shown in Table 6, in comparison to the large competitors, XYZ offers dextran products at lower prices. Hence, if XYZ can prove to potential customers that the products the company is offering is of the same quality as its competitors, if not better, XYZ could have a chance to increase market share. Another approach would be to adopt another pricing strategy. Based on the interviews, customers seem willing to pay for high quality thus if XYZ can provide this the company could increase its profit by raising the product prices.

The market that XYZ is operating in is quite narrow and also dominated by larger actors. One way to increase market share is to take market shares from their competitors. However, since the

researchers in the interviews all stated that reproducibility and reliability is key, those who already have a reliable dextran derivative supplier might not be that willing to switch. The change of supplier might result in higher switching costs, both in monetary terms but also in time. Thus, the switching costs is something that must be considered when trying to attract new customers that already have a dextran supplier.

Based on the interviews performed in this study, where all of the interviewees were researchers within a research group at a company or university, it can be argued that some of the product properties that XYZ is highlighting as sales argument is not creating value for their customers directly. The interviewees instead emphasized how the indirect properties that led to reproducible and reliable results were of value to them. Due to this, XYZ could instead adopt market development strategy, which is mentioned in Ansoff's matrix (see Figure 5). Market development strategies is about selling already existing products/services, but to new types of customers/markets. For instance, XYZ's analytical service might be needed in another customer segment. Another possibility is that the interviewees in this study might not be aware nor understand the value propositions XYZ is offering. Because of this, XYZ might have to inform and convince this customer segment how they can benefit from the company's products or services.

It does not seem like people in general know what dextran is or what it can be used for. This was also the case when talking to colleagues of the authors who are educated within biomedicine and chemical engineering. Therefore the assumption that the knowledge of this type of polymer is very limited and presumably only known among people operating within that exact market. Further, this led to the speculation that dextran is a product that people in general have a hard time to relate to. Due to this, it is important for a company like XYZ to find their USP and create a profile where they distinguish themselves and communicate to the world what they are doing and in what way they are creating value. Further, a clear company profile could also make it easier to try to relate to the company rather than the product itself. As mentioned earlier, the chemical and physical properties of dextran conform to the principles of green chemistry, making it an environmentally friendly product. This could offer an opportunity for XYZ to profile themselves as an environmentally conscious company, thus attracting customer/partners who find this aspect important.

## 5.4 The Market

XYZ are competing on similar conditions as the other players in this market, resembling a “Red Ocean” strategy (see Figure 6) as described by Kim and Mauborgne (2004). As the market is dominated by big actors such as Sigma-Aldrich (Merck KGaA) and Molecular Probes (Thermo Fisher Scientific), these hold the majority of the market shares as supported by customer interviews and internet based searches (see Table 5 and Figure 10). Based on this, XYZ is currently holding approximately 0.7% of the market share for FITC-Dextran (their second largest product). This means that there is much room for XYZ to increase their market share in.

As mentioned in 1.2 Problematization, the company has a large customer that is both their distributor but also a competitor. Based on the the company’s invoices, this customer is the most frequent occurring customer and is therefore very profitable for XYZ. This triggered the questions: what are the risks of being dependent on one customer? What would happen if this customer were to stop purchasing their products from XYZ? Due to this, the authors of this study assessed this as being a weakness of the company. On the other hand, this customer has been recurring for several years and has been also appointed XYZ as a quality supplier. Since they are a large global distributor, and XYZ probably won’t be able to outcompete them either way, one opportunity for XYZ could be to become a permanent subcontractor for them.

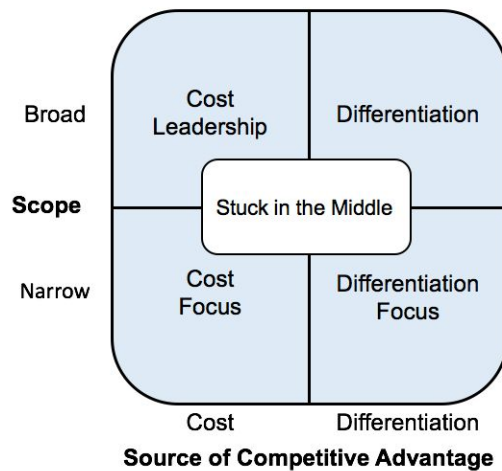
In XYZ’s current business plan, they state:

*“We provide premium quality polysaccharide derivatives, especially fluorescent dextran derivatives for permeability studies”*

(XYZ Business Plan, 2016)

This makes for a very narrow customer segment target, as well as a narrow line of product. According to Porter’s generic strategies (Figure 3), a company can choose to adopt a Cost Focus or a Differentiation Focus when creating competitive advantage within a customer segment (Porter, 1985). As XYZ is operating in a focused market dominated by strong competitors, it is of high importance to stay competitive. Currently, XYZ is both trying to adopt a Differentiation

Focus strategy (through customer specific products), as well as going with the Cost Focus strategy. Although Porter never mentions that this approach is wrong, the concept with one or the other strategy is to gain a competitive advantage. Either by offering goods that are uniquely desirable in comparison to your competitors or by simply offering similar products to a lower price (Porter, 1985). As it looks now, XYZ is attempting to do both in order to increase



**Figure 13.** Stuck in the middle. Showing how one can be “stuck” between Porter’s generic strategies.

the company profits. For the standard product line, XYZ is performing a “Cost Focus” strategy, while with the Customer Specific Products performing a “Differentiation Focus” strategy. This is making the company strategically “stuck in the middle” (Figure 13). Porter (1996) defines that a business strategy is the “*creation of a unique valuable position*” made from “*a unique set of different activities in relation to competitors*”.

Today XYZ has three different types of business units (production, consultancy and analytical services). This may increase the risk of failure to communicate “*Who are we, and what makes us stand out?*” (Sveningsson and Alvesson, 2010, p.62) to the customers, which is not in line with a competitive strategy (Porter, 1996).

## 5.4 Recommendations

The main suggestion we would like to give to XYZ is to assess what jobs the customers are trying to perform. It is recommended that the company go out to their customers and strive to create a good relationship and perhaps a partnership, with recurring customers. This could mean that someone at the company visits one customer and gets a insight into how that customer work and what that customer needs to perform their work. Another example could be that the company have an employee that will deliver the product, especially if it is within the local area. This could contribute to showing how service minded the company is and also get a chance to

create a personal contact with the customers.

Since the market of dextran derivatives is so complex and narrow, it could be advantageous for XYZ to have someone who is close and familiar with the customer type, who often are biologists. This could aid in a better communication between the company and the customers. Due to this, the recruitment of a biologist who has previous experience of dextran derivatives could help to complement the existing team of the company. The biologist can contribute by increasing the know-how of the company by creating a better understanding of the current use of dextran, while also being able to predict future applications. The same goes for the recruitment of a devoted marketer. By hiring someone who has previous experience from this type of business, or a good customer understanding, XYZ would be able to market themselves more efficiently. As XYZ is a small company, their human resources become one of the most valuable resources. Hence, it is of great importance to create a well functioning, socially integrated team, that can complement and support each other towards a common goal.

The use of internet to search for information but also for purchase has come to dominate today's way of commerce. Due to this, it is important to realize its potential and recognize its use as an effective communication tool. As XYZ's current marketing channel today is the website, which is also the channel that most of their customers find them, an easily navigated website that emphasizes the company profile and express in what way they create value for their customers is important. As XYZ's website also acts as a marketing tool for the company, it should be designed to catch the eye of the customers and create an instant interest. It should convey the purpose of the business, what they do and why they do it so well. By linking to publications where XYZ has been mentioned, or previous collaborations with known companies/organizations, the company could increase their credibility (something that customers value). Further, by including a short online questionnaire on the website or in the checkout for customers to answer after purchase, they can easily collect customer insights, to aid in improving their business.

XYZ should also find out what core competencies they have and try to identify their USP, and further assess how these can contribute to producing customer value within their market. Based on the theories generated by Collins and Porras (1996), another recommendation to XYZ is to

specify their vision for the company, along with the company mission. The vision should be formulated together as a company and reflect their common visions of where they want to be in the future. Below are examples of how a vision and mission can be formulated. It is emphasized that these are only suggestion that may act as inspiration.

***Examples of Core Purpose (Mission)***

“To provide affordable premium quality polysaccharide derivatives for the Life Science industries with high customer satisfaction.”

***Examples of Core Values***

- ★ High customer service.
- ★ Affordable products.
- ★ Scientific excellence.

***Example of a Visionary Goal***

To be the leading provider of fluorescent dextrans.

***Articulating a Vision***

“We shall personally provide the life-science industry with affordable and reliable products.”

The growth strategy we recommend is most in line with a Market Penetration strategy (see Figure 5), similar to a Red Ocean strategy (see Figure 6). The challenges with these strategies are discussed in section 3 “Theoretical Framework”. This is more of a short term solution against the stagnating sales, and for long term a strategy resembling a Blue Ocean strategy (see Figure 6) would be preferred. Other strategies that have been suggested in this study have involved e.g. focusing on a new customer segment for their existing goods and services, adopting another pricing strategy in order to increase profit or trying to become a subcontractor for their existing customer who is a large global distributor. However, we believe that a good starting point for XYZ would be to first understand what kind of value proposition they are offering and use this information for further strategy development. We strongly believe that XYZ have a good chance to increase their market share and thereby increase their sales. Based on Figure 10, they have a lot of room to try to do this since they only hold 0.7 % of the current FITC-dextran market. Further, as the company already has an established customer base along with established products the company have a good conditions to carry out the recommendations that we have suggested. We further hope that this study will be able to provide valuable information in regards of the provided theories found in this report.



## 6 Conclusions

In this report, various strategic implementations has been suggested for XYZ on how to increase their sales. Emphasis is on the importance of customer understanding. The company can gain a lot of valuable information of going out and talking to their customers, asking them about their jobs and pains/gains that go along with it. We believe that this recommendation will not only aid them in the short run, but more importantly, rather in the long run.

Furthermore it is suggested that they utilize the company's website, as this is the company's main marketing channel. The website should be easily navigated, convey in a short and concise way who they are and what they can do for the customers. Additionally, the website could also act as a tool to collect customer opinions in an cheap but very effective way. Lastly, by linking to relevant publications and mentioning collaborations the company could further strengthen its credibility.

Future recommendations would be to hire a marketing employee in order to establish a marketing section within the company. The company should consider taking in an biologist whose knowledge could aid the company in understanding more about their product applications, both current but also future application. Not only could this employee's knowledge lead to increased know-how for the company but could also facilitate the communication with a lot of their customers who operates within the field of biology.

Further, the report has via its theoretical framework emphasized several factors that are regarded as important when designing a business strategy. These factors include everything from stating a mission and vision to having a well functioning team that can complement each other. Additionally, the report has also described the value of identifying the core competencies within a company and understanding how these can be used to create value propositions for customers. Moreover, the report has underlined the importance of defining yourself as a company and creating a clear profile.



## 7 Discussion

Based on the theoretical framework that has been established in this report, it is of great importance to have a well-defined business strategy. As mentioned, Collins (2001) talks about the Hedgehog concept, where a company should be systematic and consistent with that they are doing. The three things that the Hedgehog concept is built around are: What a company can be best in the world at, how its economics work best and what best ignites the passions of its people. Collins further says that you should more or less eliminate all activities not in the intersection of these three circles. One of the keys to success of being systematic and consistent in what you do (Collins, 2001). Porter (1996), further emphasizes that continuity is key since it fosters activity improvement, and that changes in strategy is very costly.

In line with what Osterwalder et al. (2014) earlier stated about the importance of knowing your customer, this is something a small company operating in a competitive and niche market really should take into consideration. By understanding what your customers are trying to perform and complete, the problems they are trying to solve, or the needs they have, it will be easier for a company to design the right product/service for the right customer. Hence, a company can create a unique position, a competitive advantage and will be able to create a better positioning to claim more market shares. Further, if you have not uncovered the jobs that your customer are trying to perform and identified the most important ones, it is of risk that your current product just addresses a few not so important jobs. This means that you might have a product that sells, and is profitable, but is very limited and becomes a mediocre product.

Further, two types of RBSOs were identified: lifestyle companies and prospector companies. As with anything, the world is seldom black or white but more a shade of grey. Hence, there is a big chance that RBSOs can be a mix of the two. Similar to the case, there might exist companies that have shifted from a lifestyle company to become more of a prospector one. Furthermore, the transition might not even be a deliberate choice but rather a consequence of trying to stay more flexible and perhaps become more competitive. It might also be due to the current lifestyle business model declining in profits. For example, starting to produce new products in order to entice new customers.

If the business model changes e.g. by producing new goods and services, one must consider that the customer base might change as well. This could potentially make the current network irrelevant. What made the network uniquely valuable to begin with for that type of business might not be relevant for the new business. In a prospector company, there is most probably scientific experts on board, with contacts within their field. But what is special with a lifestyle consultancy type of company is that these contacts are usually also your customers. This is not necessarily the case in prospector companies where you are still searching for your product and thus searching for customers as well.

We would argue that a prospecting company has many similarities to a start-up company, in that they both search for a profitable business model. The difference might be that prospectors not necessarily search for a scalable model, depending on their ambitions. Further, a start-up is not a smaller version of a large company, it is something else entirely. So for these two types of businesses, it takes different skills to develop them. Usually, when a start-up finds their unique value proposition that is profitable and scalable, the entrepreneur(s) leave to make place for a manager. Sometime entrepreneurs have the capabilities to go from searching to executing (Steve Jobs is an example of this), but we would argue that this is not always the case. According to Lekvall and Wahlbin (2007, p. 28), a too common of a cause for business development projects to fail is that it has not been understood, or the company is not prepared to, carry out the organizational consequences required for a change in business operations.

One of the aims with this report has been to try to describe the different strategic challenges that companies such as XYZ may face during their development. By providing different theories related to business development we have hoped to cover the topic by mentioning different factors that play in when managing a company. However, although our work is mainly based on literature and theories regarding on how a business should be managed, we are aware of the fact that it is not as easy as it may sound. Models such as Porter's Generic Strategies and Ansoff Matrix may be used frequently when talking about different strategies that companies can adopt, along with theories such as The Hedgehog concept and Blue Ocean etc. However, neither of these models or theories give concrete examples of what companies such as XYZ should do in practice in order to develop their companies. Hence, it is up to the companies themselves to find a way or a strategy that works for them.

With that being said, much valuable information and knowledge can still be obtained from the literature. One insight that the authors of this study have realized is that within the topic of business development is that the majority of the authors that have written something about it often emphasizes the same factors. These factors are furthermore often very basic and logic when looking into them. Hence, it might be that companies are making business development harder than it really is? One questions that one could ask is therefore: to what extent do companies promote alternatively inhibit themselves regarding their own development?

Lastly, business development is a complicated process in many aspects, which many companies probably have experienced. Furthermore, the word “business development” is quite ambiguous and depending on whom you ask for the definition of what business development really is, you will probably receive various answers. In the end, it comes down to how companies themselves define the word “business development” and what it means to them. This will then act as guide to where they want to go in the future. As a natural consequence they will create a business strategy in order to reach those goals. In the end it is all about having the courage to take action and do something, but also be prepared to fail and then have the strength to get back at it again.

*“If you aren’t failing, you aren’t learning, and if you aren’t learning, you aren’t improving”*

(Janelle Maiocco, CEO of Barn2Door)



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## 9 References

- Alvehus, J. (2013), *Skriva uppsats med kvalitativ metod: En handbok*, Liber, Stockholm  
ISBN: 978-91-47-09915-3
- Ansoff, I. (1957) Strategies for Diversification, *Harvard Business Review*, Vol. 35 Issue 5, Sep-Oct 1957, pp. 113-124
- Banerjee, A., Bandopadhyay, R. (2016) Use of dextran nanoparticle: A paradigm shift in bacterial exopolysaccharide based biomedical applications. *Int. J. Biol. Macromol.* 87, 295–301. doi:10.1016/j.ijbiomac.2016.02.059
- Barth, T.D. and Schlegelmilch, W., (2013) *Academic Entrepreneur, Academic Entrepreneurship in: Carayannis, E.G. (Ed.)*, Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship. Springer New York, New York, 1–8.
- Bhide, A. (1992), Bootstrap finance: the art of start-ups, *Harvard Business Review*, November–December, 109–17.
- Bower, D. (2003), *Business Model Fashion and the Academic Spinout Firm*, *R&D Management*, **33** (2), 97–105.
- Bower, J.L., Christensen, C.M. (1995) Disruptive Technologies: Catching the Wave [WWW Document]. *Harv. Bus. Rev.* URL <https://hbr.org/1995/01/disruptive-technologies-catching-the-wave> (accessed 5.25.17).
- Bryman, A. and Bell, E. (2013), *Företagsekonomiska forskningsmetoder*, Liber, Stockholm
- Bryman, A. (2016), *Social research methods, Fifth Edition. ed.*, Oxford University Press, Oxford ; New York.
- Cámara, C.I., Wilke, N., 2017. Interaction of dextran derivatives with lipid monolayers and the consequential modulation of the film properties. *Chem. Phys. Lipids* 204, 34–42. doi:10.1016/j.chemphyslip.2017.03.005
- Chesbrough, H. and Rosenbloom, R.S. (2002), *The Role of Business Model in Capturing Value from Innovation*, *Industrial and Corporate Change*, **11** (3), 529–44
- Collins, J. (2001), Level 5 Leadership: The Triumph of Humility and Fierce Resolve, *Harvard Business Review*, 66–76
- Collins, J.C. and Porras J.I. (1996) Building Your Company’s Vision, HBR’s 10 must reads on strategy, 2011, *Harvard Business Review Press*, Boston, Mass

- Ellingson, L.L. (2009), *Engaging Crystallization in Qualitative Research: An Introduction*. SAGE.
- Fereday, J. and Muir-Cochrane, E. (2006), Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development, *Int. J. Qual. Methods*, **5**, 80–92. doi:10.1177/160940690600500107
- Jick, T.D. (1979), Mixing Qualitative and Quantitative Methods: Triangulation in Action, *Adm. Sci. Q.*, **24**, 602–611. doi:10.2307/2392366
- Kim, W.C. and Mauborgne, R. (2004), Blue Ocean Strategy, HBR's 10 must reads on strategy, 2011, *Harvard Business Review Press*, Boston, Mass
- Lekvall, P. and Wahlbin, C. (2007), *Information för marknadsföringsbeslut, 4:e upplagan*, Studentlitteratur AB, ISBN: 9789186460853
- Lundström, A., Sarkisjan, A., Isgård, C., Brorsson, G., Rashyna, M. and Jillefors-Olsson S., (2015), *Att sälja fluorescerande dextraner - var, hur och varför?*, www.diva-portal.org
- Maurya, A. (2012), *Running Lean: Iterate from Plan A to a Plan That Works, 2nd ed.*, O'Reilly Media, Inc., ISBN: 878-1-449-30517-8
- Mehta, S. *Paths to Entrepreneurship in the Life Sciences*. Bioentrepreneur 2004. doi:10.1038/bioent831
- Mustar, P., Wright, M. and Clarysse, B. (2008), University spin-off firms: lessons from ten years of experience in Europe, *Sci. Public Policy*, **35**, 67–80. doi:10.3152/030234208X282862
- Osterwalder, A. and Pigneur, Y. (2014), *Value Proposition Design*, John Wiley & Sons, Hoboken, New Jersey
- Porter, M.E. (1996), What Is Strategy?, HBR's 10 must reads on strategy, 2011, *Harvard Business Review Press*, Boston, Mass
- Porter, M.E. (1980) *Competitive strategy: Techniques for analyzing industries and companies*, The Free Press, New York.
- Prahalad, C.K. and Hamel, G. (1990), The Core Competence of the Corporation, HBR's 10 must reads on strategy, 2011, *Harvard Business Review Press*, Boston, Mass
- Solomon, L., Mansor, S., Mallon, P., Donnelly, E., Hoper, M., Loughrey, M., Kirk, S., Gardiner, K., 2010. The dextran sulphate sodium (DSS) model of colitis: an overview. *Comp. Clin. Pathol.* **19**, 235–239. doi:10.1007/s00580-010-0979-4

Sveningsson, S. and Alvensson, M. (2010) *Ledarskap*. Liber, Stockholm

ISBN: 978-91-47-09492-9

Vohora, A., Wright, M. and Lockett, A. (2004), Critical Junctures in the Development of University High-Tech Spinout Companies, *Res. Policy*, **33**, 147–75.

doi:10.1016/S0048-7333(03)00107-0

Wright, M., Clarysse, B., Mustar, P. and Lockett, A., (2007), *Academic Entrepreneurship in Europe*, Edward Edgar Publishing, ISBN: 978-1-84542-648-4



## 10 Appendix

### 10.1 Interviews with customers

*The purpose with these interviews was to depict XYZ's customer base and get more insight into what their customers' main business is and how they use dextran..*

#### **Questions asked during the interviews:**

What is your main activity/core business?

Why do you use dextran?

Which products do you use?

What type? Fluorescent or not?

How do you use it? (specific application of a specific product)

Which molecular weights (MW) do you use?

How much product do you use (kg, g, mg)?

From where do you buy your dextran products from?

Who decides what and from where you buy your research material?

Do you use any other polysaccharides in your research?

Do you have a need for determining molecular weights? If you do, how does this work?

Do you have any specific quality requirements e.g. GMP, ISO?

Do you know any other substitutes that you can use for your research instead of fluorescent dextran?

20170308, Interview 1

The interview was conducted over the phone. Interviewee was a male researcher that have been working at a university. He had working in a research group that performed research on diabetes (type 1). In a collaboration with a pharmaceutical company, they tried to develop a treatment that would increase the survival of the pancreatic island with the hope to make diabetes treatments more efficient.

The interviewee told us that this took place almost 10 years ago. During that time, research had been indicating that dextran sulfate could be used to affect the immune system and that this

could be of interest when it came to trying to develop a treatment for diabetes. They used dextran sulfate and injected it into animal models to investigate its effects.

As they were going to use the dextran sulfate in a drug formulation and eventually go into clinical studies, they needed dextran that conformed to the guidelines of GMP (Good Manufacturing Practice). However, the experiment with dextran sulfate did not work. They also tried with heparin (which is structurally similar to dextran sulfate), but it didn't work either. "Today there are specific inhibitors for this system" so the use of dextran is no longer needed for this kind of diabetes studies.

20170309, Interview 2

The interviewee was a female professor at a university. She is in charge of a research group at the unit of vascular biology. Vascular biology involves the study of how blood vessels are formed and which factors control the process, positively or negatively. Tells us that in general, dextran can be used within the biomedical field, for example when looking at animal models (mainly mouse), cell imaging or affinity studies.

The main activity of her research group is to study angiogenesis in cancer, they do this by investigating the cell permeability of vessels. In order to look at how molecules and cells pass from the blood to the surrounding tissues they use fluorescent dextran as a visualizing tool. Have further used dextran in order to separate proteins. As cell permeability is their main focus, they have a constant need of dextran in their research. They have been using different fluorescent dextran of different molecular weights ranging from 40 kDa to 2000 kDa. The use of a specific MW is dependent on what they are investigating.

She mentions that she was not certain of where they were buying their dextran products from currently. As they are a group, everyone is allowed to make purchases. The choice of material is often based on previous or similar research to their own or if they had heard good things about a product during a conference/exhibition. She expresses that: "It is expensive". She however states that she is willing to pay a higher price for a product if they are of good quality and also can generate reproducible results. As they do not perform any quality checks of their purchased dextran products, she emphasized that what they need is trustworthy suppliers that delivers what

they promise. Moreover, she expressed that she was very willing to change supplier if she could find anyone who can deliver this.

She had never heard of XYZ before but had a positive attitude towards using local suppliers.

\*Note from authors: After some research looking at the research group's published articles, earlier purchases of dextran had been made from Sigma/Merck.

20170331, Interview 3

The interviewee was a male scientist working at a large global company whose main business is within aesthetics & correctives. One of their main products are based on hyaluronic acid, a glycosaminoglycan, which is structurally were similar to dextran derivatives. Due to this, the interviewee had a lot of knowledge about carbohydrate chemistry.

The interviewee tells about the history of the company and mentions how the company had been working with dextran before. Some time around the start of the company, a collaboration with a physician was started in order to try to find a treatment for the disease vesicoureteral reflux (VUR), a disease characterized by a retrograde flow of urine from the bladder to the kidneys. In this drug formulation, they used dextran in the form of dextranomers. As they moved to scale up the production of the drug later, they bought large volumes of dextranomer. However, this was almost 10 years ago. The dextranomers they bought at that time was not from XYZ but “an established manufacturer of cross-linked dextran”.

As this company has bought products from XYZ in the past the interviewee knew about the company but had also had personal contact with the founder of XYZ and the current CEO. He stated that the founder of XYZ is well known within the scientific field of dextran. He said that he himself had purchased and tried XYZ's product when he was trying to find new material for his research. He tells us that everyone on the company are allowed purchase material for their work.

Moreover, when talking about suppliers he tells us that the employees working at the company prefer to stick to the same suppliers if they can, since it is such a tiresome process to change. As it is a large company they have many regulations and can only have suppliers which they have

approved due to economic reasons amongst other things. In order to become a supplier, one must fill in a formulary and be able to live up to their criterias they have set. For example, suppliers need to accept a payment term of 45 days or more. This is very important according to the owner of the company. However, exceptions are made, for example when paying directly on a website with a credit card.

The interviewee continued and said that he was satisfied with the product that XYZ supplied. He bought dextran sulphate. After they have purchase such a product they also do their own quality controls to assure that the product is what the suppliers says it is. His personal view is that he prefers to deal with smaller companies when purchasing material for his research. He feels that larger companies are often more “difficult to deal with” in comparison to smaller.

Moreover, he stresses the importance of how one needs to consider purchases of new material. Assume one buys a product from a supplier, although it is for a smaller experiment, “will this supplier be able to deliver/live up to our criteria IF we were to scale up?”

Lastly, we asked him if he would consider to purchase products or needs any consultancy from XYZ again. He replies that since they are a very large company, they have their own in house expertise. Due to this, consultancy is probably not needed. However, if they were to contact XYZ again it would be in regard of “producing something new and with a very high purity.”

20170403, Interview 4

The interviewee was a male research engineer at a university. He is working at the unit of vascular biology and performing research where they look at the lymphatic system; everything from its formation to the the regulation of it. Have also been investigating how cancer affect the lymph system in terms of metastasis.

He has been using fluorescent dextran, specifically FITC-dextran 40 and 2000, in order to visualize the lymph system in mouse models. When asked why he used FITC instead of TRITC, he responded: “FITC was the only one that was available at that time.” The interviewee expresses that he finds dextran very usefully and that it is a well -recognized research tool within his research field, especially in respect to visualizing different biological systems. He

expresses that it is advantageous in respect to its chemical properties such as its water solubility, but also that it is easy to modify.

When performing one of his experiments, he has also tried to use polyethylene glycol (a polymer). However, he found that the use of dextran was much better. After purchase of a product such as dextran, they never perform a quality control. They don't have any need for determining molecular weights either.

He had heard of XYZ before via his research leader who had established a contact with one of the employees of XYZ. During one project, the interviewee experienced a problem that he needed help with. In order to solve this problem, he contacted XYZ and asked them if it was possible for them to develop a new kind of product, which he could use. The product was a TRITC-dextran and the research group wanted a lower molecular weight than those available on the market. XYZ developed the product which the interviewee got to test and that they also compared to another similar product from a competitor of XYZ. The results that the interviewee obtained showed that the product provided by XYZ had a much lower signal in comparison to the other, which probably was due to the degree of substitution. Since the interviewee are working under a very time pressed schedule they did not have the time to continue with the project and it was cancelled. Had discussion with his research leader, during the fall 2016, about starting a new project with XYZ. However, due to difficulties regarding the chemistry that project was also cancelled.

The interviewee stresses how important it is for them to receive products of good quality and that the product can deliver what the supplier says it can. Due to this "everything is not about the price" since they have to "consider the time they need to invest" also. Although it might become costlier to buy a more expensive dextran, it is better in the long run since they will save money by saving time. "Then we can perform our experiments the way we planned".

The choice of material that they choose to buy is often based on earlier research. He said that this is a strong "motivation" to use a certain product. The price is not always the determining factor. When it comes to trying substitutes the interviewee is a bit reluctant. In such cases they

often want to try the product themselves before making a decision and then it is a matter of time again.

When asking what he values in respect to the purchase of dextran he said: “Information regarding the solubility, emission and excitation” are factors that are important for him to know.

20170404, Interview 5

The interviewee is female postdoctoral researcher at a university. She is working at the department of medical cell biology. Their research involves investigation of intestinal diseases, specifically the gastro-intestinal protection mechanisms. In order to look at how the disease develops and the underlying mechanisms, the research leader have developed a colitis model in mouse and rat using dextran sodium sulfate (DSS). DSS can change the microbiota which causes the development of colitis. The research group finds this model very useful since they want a model that mimics inflammatory bowel diseases (IBD). There are other knock-out models that can be used to induce colitis but the interviewee said that they prefer DSS since it targets the gut specifically, and also that it is cheaper and milder than knock-out models. They induce colitis by adding DSS to the drinking water of the animals.

Since the research leader is acquainted with the founder of XYZ they knew about the company since before. They buy all of their DSS from XYZ. The interviewee tells us of one time when she experienced a problem with their purchased DSS as it did not have the wanted effect on the animals. Due to this she contacted XYZ and told them about their problem. The CEO arranged so that they received a new batch, which worked better. The interviewee emphasize that reproducibility and reliability are of high importance for them and due to this they needs trustworthy suppliers.

The interviewee thinks that DSS is an expensive product. They usually purchase DSS in larger quantities (buckets of 500 g) so they can store it. Everyone in the group are allowed to order and purchase material for their research. They are not in need of any further consultancy since DSS is such a standardized product and they do not have a need to determine molecular weights.

Except for their research on IBD, their department works with bio-imaging and therefore also uses fluorescent dextran. For this, they buy labelling kits and make their fluorescent dextrans themselves. The interviewee says that it is cheaper.

20170328, Email contact

Mail contact with a male researcher working at a university. He is working in a research group who investigates how virus bind to their host cells and cause infections. He says that they use a lot of different glycosaminoglycans (GAGs) for their research, but have also used dextran sulfate. Moreover, they use hyaluronic acid, polysialic acid and mono- and oligosaccharides. Mentioned that they have used dextran sulfate as a substitute for sulfated GAGs. They usually use smaller quantities of dextran sulfate (mg) for each experiment. They have high demands on the quality when the purchase material for their research. Their research group does not have need for determining molecular weights.

20170306, Email contact

Mail contact with a female researcher that have been working at the department of medical biochemistry and microbiology at a university. Tells us she has been using blue dextran as a size benchmark to evaluate size exclusion columns. Sometimes they've used dextran sulfates as non-specific control in affinity studies between proteins and polysaccharide chains, e.g. GAGs.

## 10.2 Search queries on Google Scholar™

In Table 7 below are the search queries that serve as underlying data for Table 5. It is intended to reflect the market for FITC-dextrans during 2014–2017, excluding patents.

**Table 7.** Search queries on Google Scholar™ for article mentions together with FITC-dextran since 2014, excluding patents. This data is used in Table 5 and Figure 10.

Company	Search	Number of Results
<i>Entire market</i>	Fluorescein*Dextran OR FITC*Dextran	11700
<i>XYZ</i>	Fluorescein*Dextran*XYZ OR FITC*Dextran*XYZ	77

<b><i>Sigma-Aldrich</i></b>	Fluorescein*Dextran*Sigma OR FITC*Dextran*Sigma	7990
<b><i>Thermo Fisher Scientific</i></b>	Fluorescein*Dextran*"Thermo Fisher*" OR FITC*Dextran*"Thermo Fisher*"	1400
<b><i>Nanocs</i></b>	Fluorescein*Dextran*Nanocs OR FITC*Dextran*Nanocs	73
<b><i>Chondrex</i></b>	Fluorescein*Dextran*Chondrex OR FITC*Dextran*Chondrex	17



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# Introducing Lysine Into Dextran Using 4-Nitrophenyl Chloroformate Mediated Activation

## Synthesis of FITC-alpha-Lys-Dextran

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Viktor Rognås



UPPSALA  
UNIVERSITET

**Teknisk- naturvetenskaplig fakultet  
UTH-enheten**

Besöksadress:  
Ångströmlaboratoriet  
Lägerhyddsvägen 1  
Hus 4, Plan 0

Postadress:  
Box 536  
751 21 Uppsala

Telefon:  
018 – 471 30 03

Telefax:  
018 – 471 30 00

Hemsida:  
<http://www.teknat.uu.se/student>

## Abstract

### **Introducing Lysine Into Dextran Using 4-Nitrophenyl Chloroformate Mediated Activation**

*Viktor Rognås*

In this paper, a synthetic method for fixable FITC-alpha-Lys-dextran is examined and evaluated.

Starting dextran molecular weight average was 70 kDa. One application of dextran is to attach some fluorescent group in order to visualize biological systems.

Fluorescent dextrans have been proven useful as a macromolecular tracer when studying for example permeability of blood vessels and the lymphatic system. In some biological applications, fluorescent dextrans need to be fixed. This means that you can follow parts of the cell more easily as they move around. These so-called 'fixable dextrans' are susceptible to cross-linking by aldehyde-treatment. It can then bind covalently to biomolecules. These fixed fluorescent dextrans can then be detected by ultrastructural and immunohistochemical techniques.

This four step synthesis resulted in 59 % yield of FITC-alpha-Lys-dextran with a degree of substitution at 0.12 % Molecular weight average of the final product was approximately 72 kDa with a polydispersity of approximately 1.45. Emission maxima occurred at 519 nm.

Handledare: Alexander Paptchikhine  
Ämnesgranskare: Jonas Sävmarker  
Examinator: Curt Pettersson  
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# Table of Contents

<b>Keywords and Abbreviations</b>	<b>75</b>
<b>1 Introduction</b>	<b>76</b>
1.1 Dextran	76
1.2 Fluorophores	77
1.2 Fixability	78
<b>2 Results</b>	<b>78</b>
<b>3 Experimental</b>	<b>80</b>
3.1 Synthesis	80
<b>4 Discussion</b>	<b>83</b>
<b>5 Conclusion</b>	<b>84</b>
<b>6 Acknowledgement</b>	<b>84</b>
<b>7 References</b>	<b>84</b>
<b>8 Appendix</b>	<b>85</b>
8.1 Analytical Results for Boc-Lys-D70	5 85
8.2 Analytical Results for $\alpha$ -Lys-D70	6 86
8.3 Analytical Results for FITC- $\alpha$ -Lys-D70	8 87
8.4 Calculations	89

## Keywords and Abbreviations

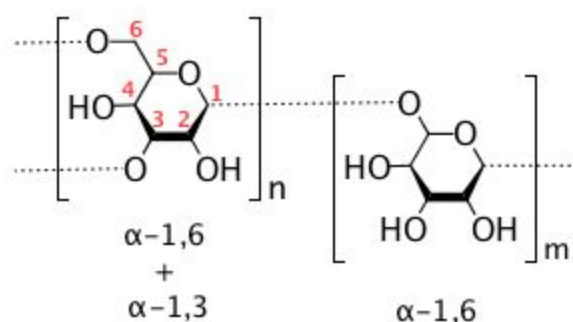
Abs	Absorbance
D70	Dextran ( $M_w = 70$ kDa)
DMAP	4-Dimethylaminopyridine
DMSO	Dimethyl sulfoxide
DS	Degree of substitution
FITC	Fluorescein isothiocyanate
GPC	Gel permeation chromatography
Lys	Lysine
MWCO	Molecular weight cut-off
$M_n$	Number average molecular weight
$M_w$	Weight average molecular weight
NPC	Nitrophenyl chloroformate
PD	Polydispersity
TLC	Thin layer chromatography
UV	Ultraviolet

# 1 Introduction

## 1.1 Dextran

Dextran (Figure 1.1.1) is a carbohydrate polymer, made up of glucose monomers, which has been used for a long time within biological research. It has many desirable properties, including low toxicity, being biocompatible, stable to autoclaving, essentially neutral and readily solvable in water even at large molecular weights (millions of Da). It is also interesting from an environmental point of view since it can be produced through fermentation of sucrose by the bacterium *Leuconostoc mesenteroides B512F* (Lm B512F).

As can be seen in Figure 1 below, dextran forms polymeric chains via  $\alpha(1\rightarrow6)$  glycosidic bonds primarily, and about 5% of the glucose branches off via additional  $\alpha(1\rightarrow3)$  glycosidic bonds; which is due to the Lm B512F fermentation process. Branches are usually 1 to 2 units in length when  $M_w < 500$  kDa ( $M_w$  = weight average molecular weight). For this work, a dextran with  $M_w = 70$  kDa is used, abbreviated as *D70*.



**Figure 1.** Dextran chain with carbon numbering in red.

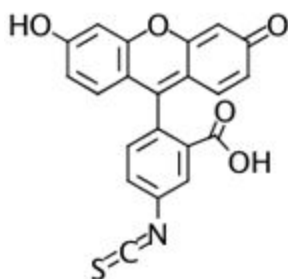
To the glucose one can attach different substituents. Mainly these are attached to the hydroxyl groups on C2–4, with C2 being most common. The reason C2 is more prevalent to undergo substitution is because of the C2–4 hydroxyl groups relative reactivity;  $k_2:k_3:k_4, 8:1:3.5$  [3].

These relative reactivities do not change much with pH; apart from  $k_4$  which is lower under basic conditions. The higher relative reactivity of hydroxyl group on C2 can be explained through its more acid nature due to proximity to the anomeric center C1 [4].

When adding substituents to dextran, its apparent  $M_w$  can increase significantly by up to 50%, depending on the type of substituent and DS (degree of substitution). For example if one starts with a dextran of  $M_w = 100$  kDa, the final derivative might have a  $M_w$  of 150 kDa. This has to be accounted for when choosing starting material to achieve the desired  $M_w$  of the final product.

## 1.2 Fluorophores

One application of dextran is to attach a fluorophore in order to visualize biological systems. Fluorescent dextrans have been proven useful as a macromolecular tracer when studying for example permeability of blood vessels and the lymphatic system (Figure 2). Fluorophores are functional groups that can be electromagnetically excited at one wavelength and then fluoresce at another longer wavelength. Fluorophores can be described by the wavelengths, in nanometers, where excitation is best performed (absorption maxima) and where fluorescence is best measured (emission maxima):  $\lambda_{\text{abs}}/\lambda_{\text{emission}}$ ; e.g. for Fluorescein (Figure 3): 493 nm/518 nm. The intensity of the fluorescent signal recorded is in relation to DS. This is of importance since the reason fluorophores are used is to visualize biological systems and the more intense the fluorescent signal, the clearer the visualization. DS reflects the amount of substituents per dextran monomer (glucose); a DS of 0.5 means 1 of 2 monomers has a substituent attached to it.



**Figure 3.** Fluorescein functionalized with isothiocyanate.

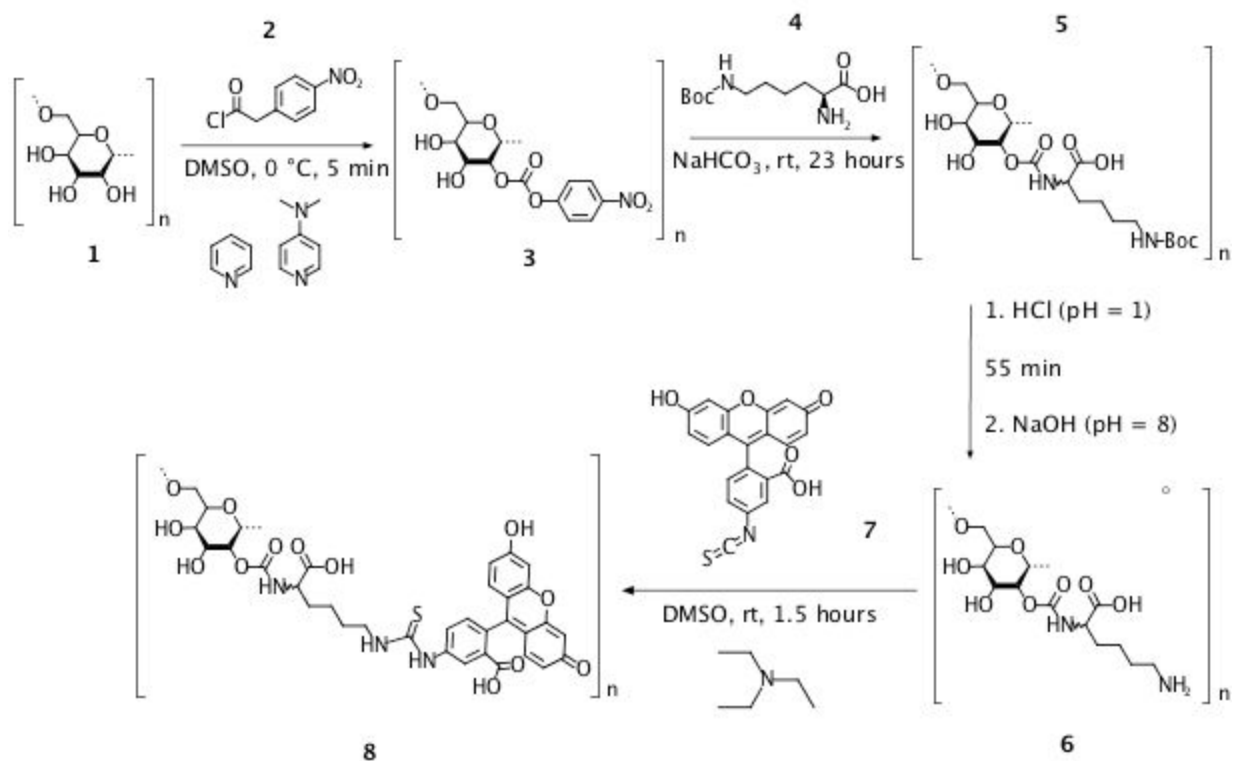
## 1.2 Fixability

In some biological applications, fluorescent dextrans need to be fixed [1, 2]. This means that the dextrans bind covalently to what is to be studied, in contrast to conventional non-fixable dextrans that solely interact through noncovalent bindings. This means that you can follow parts of the cell more easily as they move around. These so-called ‘fixable dextrans’ contain free amino groups through lysine that is susceptible to cross-linking by aldehyde-treatment. It can then bind covalently to biomolecules in cell membranes.

Fixable dextrans is a product that is already available on the market and XYZ have experienced a demand for such products from their customers. Thus it lies in the company’s interest to make such products available in their catalog. This work examines and evaluates one possible synthetic route for a fixable FITC dextran using a L-lysine as a linker.

## 2 Results

This synthetic pathway was carried out in four steps, as outlined in Figure 4, with precipitation in ethanol and drying in between each step. In the first step, hydroxyl group of the dextran **1** at C-2 (see Figure 1) is activated through the addition of 4-nitrophenyl chloroformate **2** in a basic environment using a combination of pyridine and DMAP, yielding  $\alpha$ -[4-NPC]-D70 **3**. Second step involved condensation of  $\omega$ -Boc-L-Lysine **4** with activated carbonate of **3**, yielding **5**. Boc-protection was removed in step 3 using hydrochloric acid and then neutralisation by NaOH, ending up with  $\alpha$ -Lys-D70 **6**. Finally, **6** and triethylamine was dissolved in DMSO and mixed with FITC **7**, yielding FITC- $\alpha$ -Lys-D70 **8**.



**Figure 4.** The four step synthesis carried out during this work.

The following analytical results was obtained for the final product **8**:

**GPC:** Mn = 49 580 Da; Mw = 71 979 Da; PD = 1.4518

**UV:**  $\lambda_{\text{abs, max}}$  = 493 nm; Abs = 0.111;

**Fluorescence:**  $\lambda_{\text{emission, max}}$  = 519 nm; DS = 0.0012

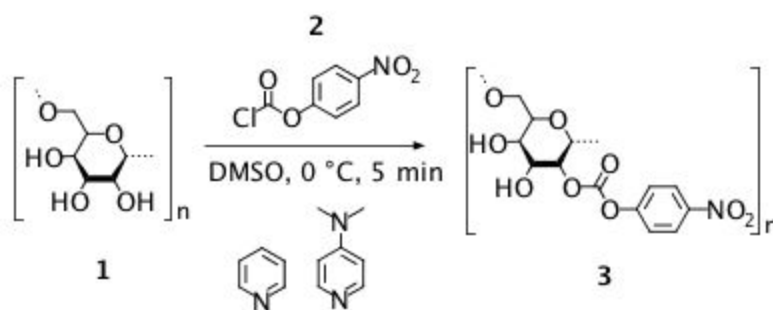
Overall 158 mg FITC- $\alpha$ -Lys-D70 **8** was synthesized from 5.2 g of D70 **1**. Total yield was 59% for a four step reaction. Two of the key intermediates **3** (2.45 g) and **5** (1.53 g) was saved for further investigation. The conducted analyses confirm presence of desired products.

### 3 Experimental

Ultrafiltration (UF) was done using a Vivaflow 200 Sartorius with a MWCO 5000 filter and water as solvent. pH measurements was done using pH/Temp meter MW120 Milwaukee. Gel Permeation Chromatography was done through Superose™ 12 matrix using a Varian ProStar Autosampler Model 400. UV/Vis absorption was done using a Hitachi U-1900 UV spectrometer. Fluorescence spectra were recorded using a Hitachi F-2700 Fluorescence spectrometer.

#### 3.1 Synthesis

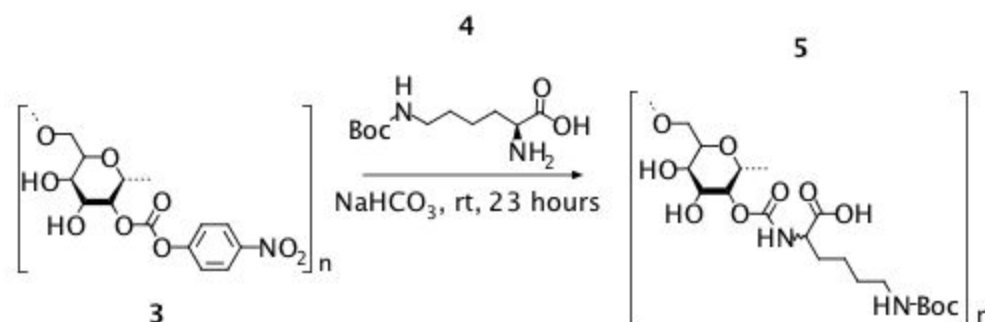
##### Step 1: $\alpha$ -[4-nitrophenyl chloroformate]-D70 **3**



D70 **1** (5.2 g,  $M_w = 70$  kDa) was added to 25 mL of DMSO in a 100 mL round-bottomed-flask under vigorous magnetic stirring. The suspension was heated in water bath (40 – 50 °C) until reaction mixture was clear and **1** was completely dissolved (15 min). 8 mL (98.9 mmol) of pyridine was added To this solution under stirring; Reaction mixture was then cooled in ice bath followed by the addition of DMAP (4-[dimethylamino]pyridine; 40 mg, 0.3 mmol) under stirring. 4-NPC **2** (4-nitrophenyl chloroformate) was added (203.6 mg, 1.0 mmol). Reaction mixture was allowed to stir for 5 min and was then put in fridge overnight. The  $\alpha$ -[4-NPC]-D70 **3** mixture (0.16 mg/mg; 32 mL) was precipitated in ethanol (95%; 800 mL) in a 3 L beaker during vigorous magnetic stirring. Stirrer was then changed to overhead stirrer and further stirred for 1 hour. The mixture was then allowed to sediment for 15 min followed by decanting of the supernatant. 100 mL of ethanol (99%) was added; mixture was then mixed with a hand-held

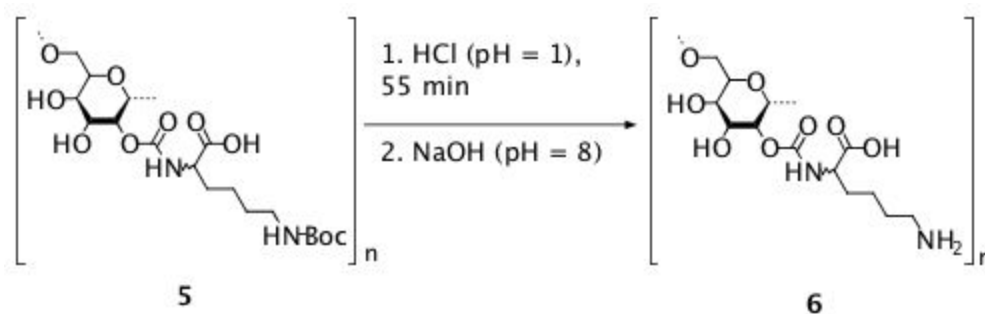
mixer to a fine powder, filtrated and let dry in oven (50 °C) overnight, yielding 4.85 g (93%) of 3. 2.45 g was saved for future investigation.

### Step 2: $\omega$ -Boc-Lysine carbamino-D70 5



1.2 g (4.9 mmol) of  $\omega$ -Boc-L-lysine 4 was added under stirring to 75 mL of NaHCO<sub>3</sub> (aq., 1 M) in a 250 mL Erlenmeyer flask, and stirring was continued until complete dissolution. 2.4 g of product 3 from step 1 was added under stirring followed by the addition of 10 mL NaHCO<sub>3</sub> (aq., 1 M). Solution was then allowed to stir in room temperature overnight. Mixture was filtered through a Schott Duran 3 filter followed by dilution with distilled water to a total volume of 120 mL. The solution was then purified using Ultra Filtrat for 2 hours. Solution was tested for free amino groups using ninhydrin (appendix 1).

### Step 3: $\alpha$ -Lys-D70 6



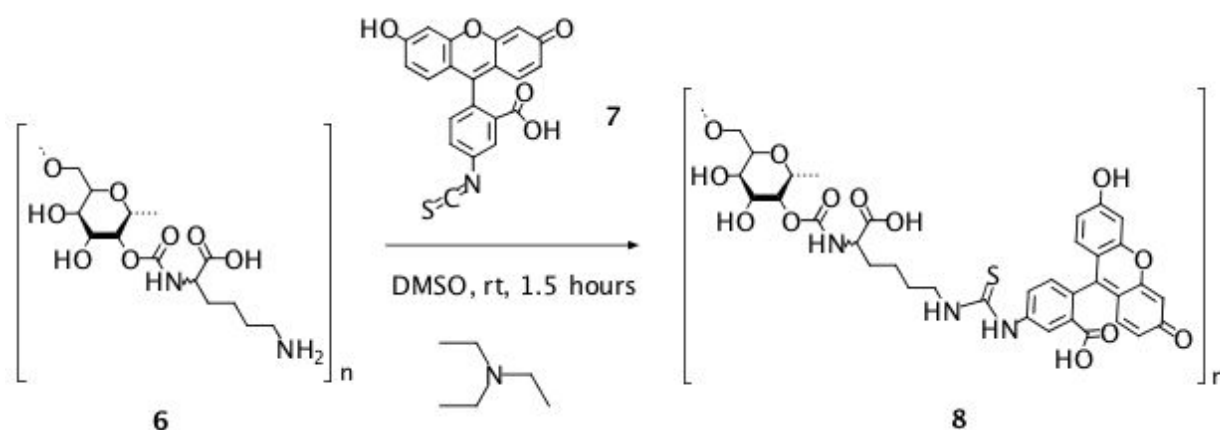
Solution from step 2 was transferred to a 150 mL beaker and pH was measured at 8.43. Approximately 8 mL of HCl (aq., 1 M) was added under magnetic stirring until pH = 1.00.

Mixture was left for 55 min then neutralized to approximately pH 8 by addition of NaOH (aq). Solution was analysed by TLC. TLC was developed by ninhydrin to detect amines (appendix 2). Solution was then evaporated down to about 8 mL total volume followed by ethanol precipitation (95%, 150 mL) under vigorous stirring in a 600 mL beaker. The precipitate was filtered off and dried overnight in vacuum at 50 °C. The yield of **6** was 2.53 g (105%) after drying. 1.53 g of **6** was saved for future investigation.

GPC: Mn = 53 411 Da; Mw = 74 000 Da; PD = 1.3855

TLC: Rf = 0.0

#### Step 4: FITC- $\alpha$ -Lys-D70 **8**



1.0 g of **6** was dissolved in 7 mL of DMSO under stirring. 0.2 mL triethylamine was added and reaction mixture was put in water bath at 60 °C and stirred for 15 min, then cooled down to room temperature. 26.4 mg of fluorescein isothiocyanate **7** was added under stirring and left for 1.5 hours. After the addition of 1.5 mL of water, the solution was precipitated into 75 mL of ethanol (96%) and stirred for 15 min. The precipitate was filtered off and dried overnight in vacuum at 50 °C. Crude yield of FITC- $\alpha$ -Lys-D70 **8** was 764.3 mg (76%). 200 mg **8** was separated on Sephadex G25 column with distilled water as eluent. The pure fractions of **8** were then poured into a 100 mL round-bottomed-flask and rotary-evaporated. 180 mg of **8** was left. 92  $\mu$ L was taken for analysis using GPC and a fluorescence spectrometer, and DS consequently calculated.

The rest was dissolved in 1 mL of distilled water and product was precipitated in 30 mL of EtOH (99%). Supernatant was decanted and product was centrifuged and dried overnight in vacuum at 50 °C. Purified yield of **8** was 158 mg (79%)

**GPC:**  $M_n = 49\,580$  Da;  $M_w = 71\,979$  Da; PD = 1.4518

**UV:**  $\lambda_{\text{abs, max}} = 493$  nm; Abs = 0.111

**Fluorescence:**  $\lambda_{\text{emission, max}} = 519$  nm; DS = 0.0012

## 4 Discussion

Total yield was approximately 59%, which is probably an overestimation since loss of drying was not accounted for. This means, there probably was some water trapped with the product, which can also explain the yield for **6** (105%). Neither of the calculated yields are absolutely certain because of this.

The main concern for this synthesis would be the rather low DS at 0.0012 (which is minimum acceptable according to company standards). This concern is due to the fact that fluorescent signal intensity is of key value to potential customers. Since the intensity of the fluorescent signal in vivo is positively related to DS, a higher DS should be aimed for in subsequent development. In regard to possible racemization, this is deemed to not have an effect on the intended use of the end product, but is something to have in mind for further development. The final stereochemistry is not confirmed in this work.

The presence of free (FITC)<sub>2</sub>-Lysine (appendix 8.3) in final product **8** tells us that there was probably not a detectable amount of free lysine in crude product **6** that FITC **7** reacted with. Since  $\omega$ -boc-lysine **4** is supposed to react to 4-NPC-D70 **3** on 4-NPC **2** activated sites, the activation in step 1 is key. It is possible that a longer reaction time in step 1 could increase the final DS. For this experiment the reaction mixture in step 1 was stirred for 5 min and then put in fridge overnight. An alteration would be to let it stir on cooling overnight. Further, the unknown

species detected in ninhydrin-developed TLC for **6** (appendix 8.2, Figure 8) tells us that some unknown reaction took place. A plausible reaction is the hydrolysis of the carbamate linker. To deal with this, a shorter reaction time in step 3 can be applied (e.g. from 55 min to 30 min). Also a less stable protecting group for L-lysine can be used so that the deprotection takes place under milder conditions to countermeasure the risk of carbamate hydrolysis.

## 5 Conclusion

This four step synthesis resulted in 158 mg (yield  $\approx$  59%) of FITC- $\alpha$ -Lys-D70 **8** with a degree of substitution at 0.12%. The low degree of substitution might be due to a low initial degree of substitution in step 1. Next experiment should involve an extension of step 1 reaction time. Further, a less stable protecting group for L-lysine should be used because carbamate linker can be hydrolyzed at pH = 1 to release of some free L-lysine.

## 6 Acknowledgement

I would like to thank my supervisor Alexander Paptchikhine for his helpful guidance on this project.

## 7 References

1. Nance, D.M. and Burns, *J. Brain Res. Bull.* (1990) **25** (1), 139
2. Turvey, M.R. and Thorn, P. *Pflugers Arch. - Eur. J. Physiol.* (2004) **448** (5), 552
3. Norrman, B. *Acta Chem. Scand.* (1968) **22**, 1381
4. Haines, A.H. *Advan. Carbohydr. Chem. Biochem.* (1976) **33**, 59
5. Molecular probes, ch.14 p. 582, <http://www.mobitec.de/probes/docs/sections/1405.pdf> [accessed 2017-04-12]
6. De Belder, A.N. *Amersham Biosciences Dextran Handbook.* (2003).

## 8 Appendix

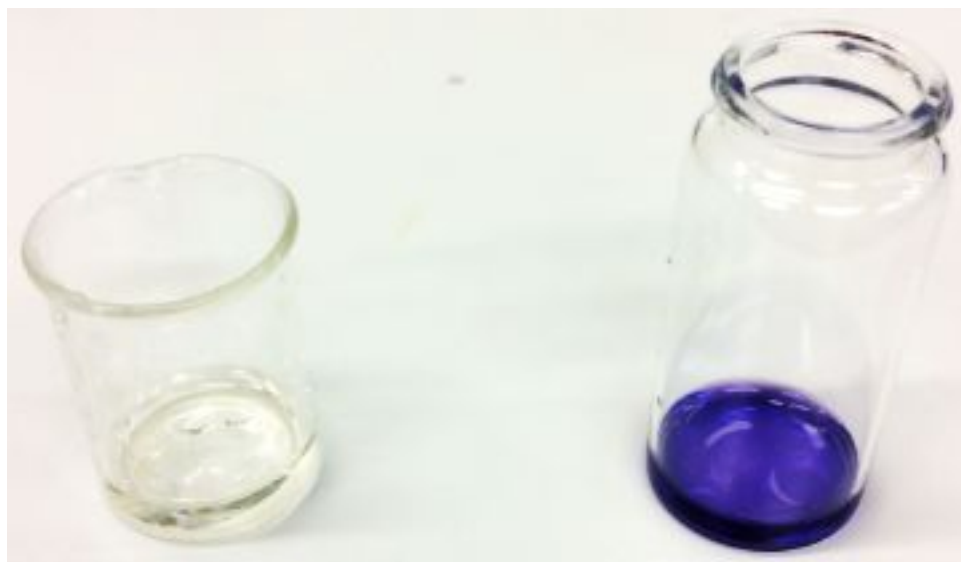
### 8.1 Analytical Results for Boc-Lys-D70 5

#### *Ninhydrin*

$\omega$ -Boc-Lys-D70 **5** tested for free amino groups using ninhydrin, and using free  $\omega$ -Boc-L-lysine **4** as a reference. Results are presented in Table 1 and Figure 6 below.

**Table 1.** Results from free amino-group test using Ninhydrin. A purple color indicates presence of free amino groups.

Analyte	Result after ninhydrin addition
Solution ( $\omega$ -Boc-Lys-D70)	Clear and colorless
$\omega$ -Boc-L-lysine	Clear and purple



**Figure 6.** Picture showing the  $\omega$ -Boc-Lys-D70 on the left and free  $\omega$ -Boc-L-Lysine on the right, both with added Ninhydrin.

## 8.2 Analytical Results for $\alpha$ -Lys-D70 6

### GPC

Gel permeation chromatography on  $\alpha$ -lys-D70 **6** revealed the parameters presented in Table 2 below.

**Table 2.** GPC results for  $\alpha$ -Lys-D70.

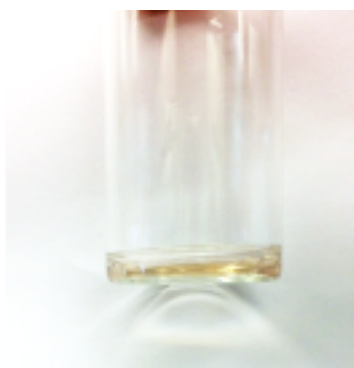
Mn	Mw	PD
53411	74000	1.3855

### Ninhydrin

$\alpha$ -Lys-D70 **5** tested for free amino groups using Ninhydrin, results presented in Table 3 and Figure 7 below.

**Table 3.** Results from free amino-group test using ninhydrin. A purple color indicates presence of free amino groups.

Analyte	Result after ninhydrin addition
Solution ( $\alpha$ -L-Lys-D70)	Clear & slight brown color.

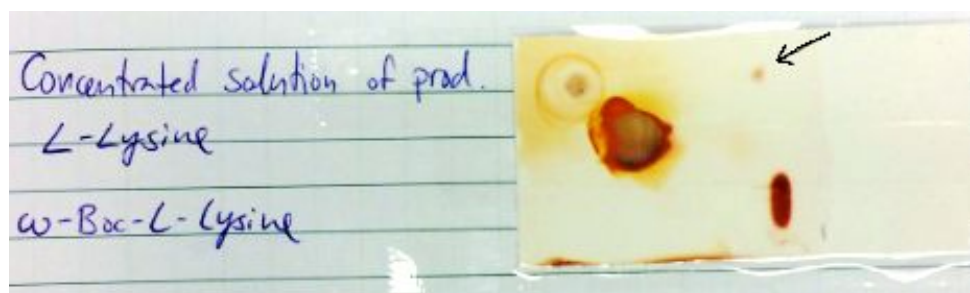


**Figure 7.** Solution of  $\alpha$ -Lys-D70 with added ninhydrin, slight brown color.

### *TLC (developed with ninhydrin)*

Eluent: BuOH:EtOAc:water:AcOH; 1:1:1:1. Ninhydrin development.

In Figure 8 below, a contaminant in the crude product can be seen, indicated by the arrow. The contaminant does not seem to be free  $\omega$ -Boc-L-Lysine or L-Lysine.



**Figure 8.** TLC-analysis of  $\alpha$ -L-Lys-D70 **6**, showing the concentrated solution of product on top, followed by L-Lysine second and  $\omega$ -Boc-L-Lysine third from the top.

## **8.3 Analytical Results for FITC- $\alpha$ -Lys-D70 8**

### *GPC*

Gel permeation chromatography on FITC- $\alpha$ -Lys-D70 **6** revealed the parameters presented in Table 4 below.

**Table 4.** Showing GPC results for FITC- $\alpha$ -Lys-D70.

<b>Mn</b>	<b>Mw</b>	<b>PD</b>
49580	71979	1.4518

### *TLC*

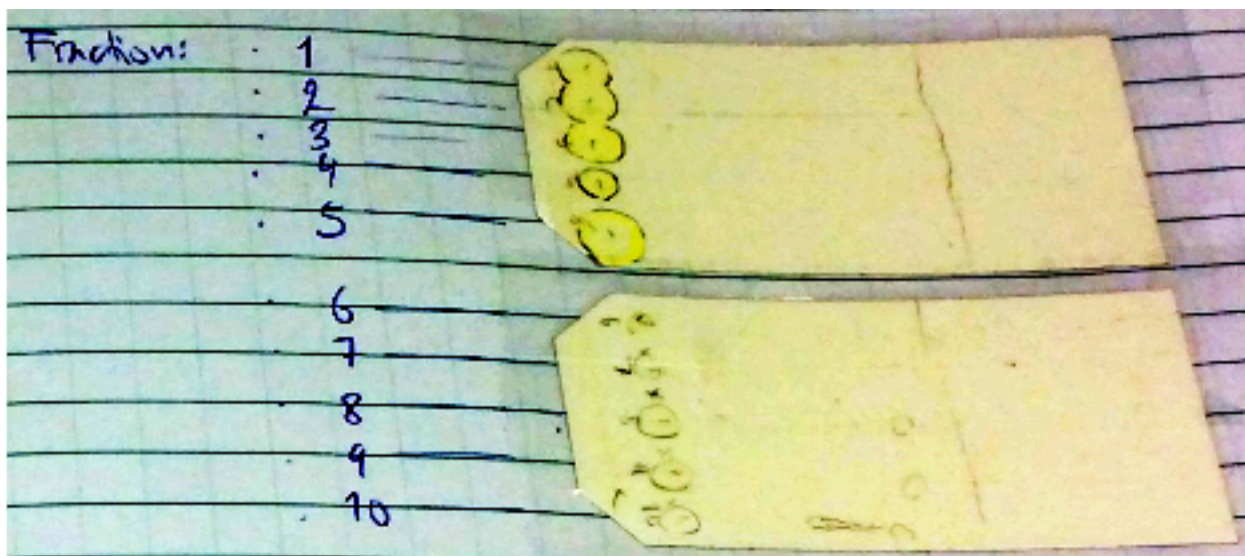
Eluent used was CHCl<sub>3</sub>:MeOH; 3:1. Result presented in Figure 9 below.



**Figure 9.** TLC analysis of FITC- $\alpha$ -Lys-D70 ( $R_f = 0$ ), showing presence of free (FITC) $_2$ -Lysine ( $R_f = 1$ ).

### **Column**

Stationary phase: G25 Sephadex, moving phase: laboratory water (distilled). TLC on fractions 1 through 10 is presented in Figure 10 below.



**Figure 10.** Contaminants can be seen for fraction 8, 9 and 10 with  $R_f > 0$ , products are seen with  $R_f = 0$ . TLC-eluent:  $\text{CHCl}_3$ :MeOH; 3:1.

## 8.4 Calculations

$Yield_n$  is calculated as  $m_{product, n} / m_{reactant, n}$ , where  $n = step\ number$ . The mass of the added substituents are assumed to be much less than the dextran backbone and were thus set to 0.

$$Yield_1 \cdot Yield_2 \cdot Yield_3 \cdot Yield_4 = Yield_{total}$$

$$0.93 \cdot 1.05 \cdot 0.76 \cdot 0.79 \approx 59\%$$