Professional options for life science PhDs

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Outline

• Drug development process
• Different industries
• Different jobs in biotech and pharma industry
• Ways to enter industry
• Skills
Developing a new drug

12-15 years, 1.5 bill. EUR
Developing a new drug

12-15 years, 1.5 bill. EUR

1-2 y
- Discovery research: identification of target molecules, test development

1 y
- Lead structure identification

2-4 y
- Lead optimization

1-2 y
- Preclinical development

6-7 y
- Clinical development (3 phases)

1 y
- Approval
Medical Biotechnology

- Bioinformatics
- Data science
- Biochemistry
- Immunology
- Tissue cultures
- Gene expression
- Protein purification
- Fermentation technology
- Biomedical engineering
- Stem cells
- Neuroscience...

- Medical biotech
  - Diagnosis
  - Gene therapy
  - Implants, Artificial replacements
  - Biopharmaceuticals (drugs, hormones, antibiotics)
  - Gene profiling
  - Vaccines
  - Devices/diagnostics
Agricultural Biotechnology

Bioinformatics
Data science
Biochemistry
Plant science
Gene expression
Protein purification
Fermentation technology
Cell biology
Developmental biology
Veterinary medicine
...

Agricultural biotechnology

Plant breeding
GMO plants
Transgenic animals
Natural substances
Fertilizers
Plant protection (herbicides, fungicides,..)
Biocontrol
Industrial Biotechnology

- Detergents (bio-degradables)
- Food additives (e.g. citric acid)
- Food processing (enzymes)
- Industrial biotech
- Biofuels
- Biorefinery products
- Biomaterials

Additional topics:
- Bioinformatics
- Data science
- Biochemistry
- Enzymes
- Biopolymers
- Gene expression
- Protein purification
- Fermentation technology
- Microbiology
...
Research positions in industry – example BI

Jobs & Career Levels

Scientific Director – Group Leader

Leading: Role model in Leadership, driving research strategy

Scientific Director – External Research

Leading: Bringing external innovation into BI. Contributing to BI's reputation in the scientific community.

Senior Principal Scientist

Driving: efficiency, effectiveness and Team Science across the organization. Role modelling leadership competencies

Principal Scientist

Acting: efficiently and effectively along the principles of Team Science and leadership competencies

Associate Principal Scientist

Learning: and adapting to BI culture, leadership and processes

Prerequisite: Ph.D. + PostDoc
Research positions in industry

Research Lab Scientist Career Model

- **Distinguished Lab Scientist**
  - No time limitation
  - Project support, establishing/generation of novel methods/techniques, innovative pro-activity presentation to a greater audience etc.

- **Lab Scientist**
  - Gain competencies, learning/supervising, mentoring/teaching

- **Trainee Lab Scientist**
  - Less complex experiments, planning, implementation data analysis, documentation, communicating

Prerequisite: HTL, M.Sc./Mag. (Ph.D.)
Research position

• In the US
  – Scientist 1 position – after PhD
  – Scientist 2 position – with postdoc experience
# Research in industry vs academia

**Industry**
- Goal-driven (you influence your goals)
- Less independence, how much depends on position
- Often generalists
- Working in interdisciplinary teams is a must
- More vertical and horizontal career development options
- No need to acquire external funding, but internal, competitive funding
- Greater potential for salary development
- More indefinite contracts, but jobs can be terminated; moves between companies usual

**Academia**
- Curiosity driven, but funding agencies and publishers have preferences
- Higher degree of independence
- Often more specialized
- Working in teams advantageous
- Little horizontal career options, limited vertical career options
- Need to acquire third party funding
- Reliable, moderate potential for salary development
- Precarious working conditions at the beginning, high job security for tenured jobs
Data Science/bioinformatics

• Data science skills + understanding of biology
• Lots of data: gene expression, biomarker reliability, patient outcomes, personalized health, tying environmental data to disease patterns, or disease patterns to drug research, or drug efficacy to dietary trends
• Can be part of R&D or IT departments (function as consultants) or located within different therapeutic areas

*Personalized medicine:
“It is more important to know what type of person has a disease than to know what type of disease a person has.”

Hippocrates
Data Science/bioinformatics

- Research on new approaches to analyzing data
- Help design and possibly even build analysis tools
- Examine existing open-source algorithms and apply them in novel ways or create new algorithms
- Investigate trends in diseases and drug development (collaboration with marketing)
- Provide quantitative support for business decisions
MODERN DATA SCIENTIST

Data Scientist, the hottest job of the 21st century, requires a mixture of multidisciplinary skills ranging from an intersection of mathematics, statistics, computer science, communication and business. Finding a data scientist is hard. Finding people who understand who a data scientist is, is equally hard. So here is a little cheat sheet on who the modern data scientist really is.

MATH & STATISTICS
- Machine learning
- Statistical modeling
- Experiment design
- Bayesian inference
- Supervised learning: decision trees, random forests, logistic regression
- Unsupervised learning: clustering, dimensionality reduction
- Optimization: gradient descent and variants

PROGRAMMING & DATABASE
- Computer science fundamentals
- Scripting language e.g. Python
- Statistical computing packages, e.g., R
- Databases: SQL and NoSQL
- Relational algebra
- Parallel databases and parallel query processing
- MapReduce concepts
- Hadoop and Hive/Pig
- Custom reducers
- Experience with xaaS like AWS

DOMAIN KNOWLEDGE & SOFT SKILLS
- Passionate about the business
- Omnious about data
- Influence without authority
- Hacker mindset
- Problem solver
- Strategic, proactive, creative, innovative and collaborative

COMMUNICATION & VISUALIZATION
- Able to engage with senior management
- Storytelling skills
- Translate data-driven insights into decisions and actions
- Visual art design
- R packages like ggplot or lattice
- Knowledge of any of visualization tools e.g. Flare, D3.js, Tableau
Product Development

• Even more applied research
• Focuses on production of chemical and biological entity
  drug products are created, formulated, and manufactured
• Advance drug candidates through clinical trials to commercialization
• Scientists develop formulations and produce clinical supplies to support trials
• Scale up chemistry or bioprocessing to allow for commercial production
• Nontherapeutic products (e.g. industrial enzymes, reagents, catalysts) also require product development
Product Development

- Background in chemistry/biochemistry/biotechnology or equivalent required:
  - Process chemistry, chemical development, synthetic chemistry, analytical chemistry
  - Formulation
  - Cell culture, recombinant technology
  - Fermentation
  - Purification
  - Bioprocessing and manufacturing engineering
- Often postdoc required
Project management

- Coordinates activities of the many scientific disciplines that are frequently involved in projects
- Ensure projects are moving forward in terms of timeline, scope, budget
- Risk assessment
- No direct authority over functional team members
- This job is all about communication and interpersonal skills
- Certificates in project management are advantageous (e.g. PMI or IPMA)
- PhD mostly required for research projects
- Most project managers have previously been team members
Clinical development
Clinical development

• Typically MDs, but PhDs are hired, too
• Biological scientists tend to migrate to phase I jobs, project management, or clinical scientist positions
Regulatory affairs

• Manage regulatory approval process → center of drug development
• You learn the big picture, the minutiae, and how it all ties together
• Provide strategic advice for therapeutic and business development
• Oversee regulatory submissions process
• Primary liaison between companies and health authorities
• Required: Structured way of working, attention for detail, interested in writing, ability to keep the big picture in mind
• You will be constantly learning new technology, processes and science
• Specialized certificates and postgraduate programs available to learn regulations
• PhD not required, but not uncommon
Regulatory affairs
On the other side: European Medicines Agency

Moving from London to Amsterdam
Medical affairs

• Bridge between R&D, sales, and marketing: Brings together the product, the science of the product and the product’s impact on the marketplace
• Provide strategic advice for clinical development programs, for potential business development deals, and for sales and marketing efforts
• Phase IIIb and IV clinical trials can be part of medical affairs
• Medical support for company’s marketing efforts
• Post-drug approval efforts
• Medical background preferred, but PhD with general medical knowledge possible
Medical Science Liaisons

• Not allowed to promote or sell drugs
• Field application scientists
• Inform physicians of relevant new data
• Provide expertise about products and diseases
• Inform customers about latest clinical findings
• Answer questions, interact with industry experts, and find potential investigators for Phase II and IV trials
• Are permitted to discuss the latest clinical, safety, and other “off-label” information (not yet approved by EMA/FDA)
Medical Science Liaisons

MSL Activities

98%
KOL relationship management

97%
Delivering scientific presentations

97%
Attending medical conferences

92%
Educating KOLs and other Healthcare professionals

82%
Support advisory boards

76%
Identifying and Training speakers
Drug safety/ pharmacovigilance

- Monitoring of adverse side effects after product launch
- Review of case reports, maintenance of database
- Clinical experience and pharmacological knowledge are needed
- Highly formalized processes, great attention to details required for patient safety
- Often as move within company

“Drug safety is like detective work – you gather the clues and put together a complete story.”
PHARMACOVIGILANCE SERVICES that ensure safety and expedite approvals.
Medical Writing

• Summarize information from various sources to compile registration dossiers used in clinical brochures, expert reports, NDAs, and INDs.
• Follow regulatory guidelines
• Important to present data that support key conclusions
• Excellent career opportunity for scientists
• Much time is spent in interacting with content experts and team members
• Many different types of medical writers
Medical Writing
Quality

- Detail-oriented, interested in developing procedures and more efficient processes (GLP, GMP, GCP)
- Translate protocols developed in discovery research into SOPs (standard operating procedures)
- Guarantees that company is conforming to agreements made with the regulatory authorities
- Quality control for chemistry, microbiology, cell biology labs, animal groups
- Quality provides a good balance of administrative and laboratory work
- PhD not required, but advanced degree advantageous; PhD in technical fields are common at supervisory level; transition easier if you first work in discovery or preclinical research
Sales

- All about interacting with people
- For those who enjoy explaining scientific details
- Focus on working with physicians, hospitals and other health care professionals
- Entrepreneurial attitude required
- You operate independently, are individually accountable for your success, financial reward for results
- Excellent foundation for many other careers, particularly in marketing and business development
- Lucrative career option
- Pressure to reach quarterly quota
- Classical entry to industry
Marketing

• Data driven, understanding of business mind-set required
• Science to and psychology behind “positioning” products
• Develop strategies, responsibility for revenues → excellent prep for executive career path
• Analyzing market potential, competitive environment, customers’ and stakeholders’ needs
• Creating and executing marketing and promotional strategy including forecasts and budgets
• Organizing sales
  – Sales rep often an entry level function
Business Development

- Corporate development and strategy
- Competitive intelligence
- Portfolio management
- Technology scouting
- Analytics/financial analysis, understanding markets
- Assess value of patents, consideration of risk (e.g. legal)
- Negotiating deals
- Investor relations
- Networking
Patent Attorney

- Science degree + special legal training (3-4 years)
  - European and national trainings
- Need to understand the science to manage IP
- Drafting and filing patent applications
- Prosecuting patent applications through to grant, defending patents, opposing third party patents
- Good advocacy skills are key, good language skills needed
- Being able to give clear advice that is relevant to clients’ commercial goals
- Time management: You can’t miss deadlines!
Contract Research Organizations (CROs)

- Provide support to the pharmaceutical, biotechnology, and medical device industries via outsourced research services on a contract basis
- Biopharmaceutical development, biologic assay development, commercialization, preclinical research, clinical research, clinical trials management, or pharmacovigilance
- Tend to pay less than biopharma companies, but provide more training for entry-level hires
- More likely to provide broader exposure to the entire drug development process
### Contract Research Organizations (CROs)

#### TOP 10 CROs 2018

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Revenues, 2017 (USD billions)</th>
<th>Income Ratio, 2017</th>
<th>Expense Ratio, 2017</th>
<th>Service portfolio (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Laboratory Corporation of America Holdings (Covance)</td>
<td>10.441</td>
<td>12.14%</td>
<td>87.86%</td>
<td>31</td>
</tr>
<tr>
<td>02</td>
<td>IQVIA</td>
<td>9,739</td>
<td>13.44%</td>
<td>86.56%</td>
<td>92</td>
</tr>
<tr>
<td>03</td>
<td>Syneos Health</td>
<td>2,672</td>
<td>8.90%</td>
<td>91.10%</td>
<td>42</td>
</tr>
<tr>
<td>04</td>
<td>Paraxel International Corporation</td>
<td>2,441</td>
<td>4.40%</td>
<td>95.60%</td>
<td>79</td>
</tr>
<tr>
<td>05</td>
<td>PRA Health Sciences</td>
<td>2,259</td>
<td>9.69%</td>
<td>90.31%</td>
<td>27</td>
</tr>
<tr>
<td>06</td>
<td>Pharmaceutical Product Development (PPD)</td>
<td>1,900</td>
<td>5.00%</td>
<td>95.00%</td>
<td>44</td>
</tr>
<tr>
<td>07</td>
<td>Charles River Laboratories International Inc. (CRL)</td>
<td>1,857</td>
<td>6.65%</td>
<td>93.34%</td>
<td>4</td>
</tr>
<tr>
<td>08</td>
<td>ICON Public Limited Corporation</td>
<td>1,758</td>
<td>16.84%</td>
<td>83.16%</td>
<td>15</td>
</tr>
<tr>
<td>09</td>
<td>Wuxi AppTec</td>
<td>1,011</td>
<td>12.00%</td>
<td>88.00%</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Medpace Holdings, Inc</td>
<td>0,436</td>
<td>8.96%</td>
<td>91.03%</td>
<td>2</td>
</tr>
</tbody>
</table>

Lots of less known companies – worthwhile exploring
Remarks on transition

- Postdoc experience often required, usually not an obstacle, but not always needed
- Consider doing a postdoc in industry
- Focus on research topics that are relevant for industry, e.g. disease related research
- Consider CROs, in particular for entry-level positions
- Show interest in biotech and pharma industry by completing certificates and/or postgraduate programs on industry relevant content such as GLPs, regulatory affairs, etc.
- For data science: Take IST classes of the data science track, look into programs like Insight Data Science or learn skills online
- Show interest in commercialization, participate in Entrepreneur Lab, go to Science-Industry-Day, etc.
What else can you do?

You need to develop a *feeling* for careers that sound interesting! Emotions are an integral part of decision making.

- Do research on jobs that sound interesting to you
- Do an internship at companies
- Use ERASMUS+ for job shadowing
- Talk to people who work in industry
- Get in touch with alumni who work in industry
- Go to career events in Vienna (e.g. by YLSA)

Developing a feeling for careers takes time – it is a process!
Programs/certificates

- Entrepreneur Lab
- Course at U Vienna (usually in spring semester): Processes and methods in the Life Science Industry
- Project management certificates
- MSc programs in Pharmaceutical Medicine/biotech industry
- On-course (http://www.emtrain.eu/index.php/on-course)
Large biotech investments happening in Vienna

**Boehringer Ingelheim investiert 700 Millionen Euro in Wien**

En is die bisher größte Einzelinvestition des deutschen Pharmakonzerns Boehringer Ingelheim: In Wien wird bis 2021 eine neue Zellkultur-Produktionsanlage errichtet.

Boehringer Ingelheim investiert groß in Wien – FOLITIN Jindrich / MB
A final word on transitioning

- Not excited about industry? Try to figure out where this is coming from
  - Do your values not concur with industry’s?
  - Is it because you have no experience with industry? It’s hard to be excited about something you don’t know!
- Surveys show great job satisfaction of PhDs outside of academia
- We all have our stereotypes about industry (and science): Try to deconstruct the stereotypes!
  - What is based on facts
  - What is based on vague perceptions
  - Talk to many people, not just one
  - Stereotypes give orientation:
    - If you give up stereotypes, what can help you to position yourself?
Want to learn more?