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Chapter 7

Job and Career Opportunities in the Pharmaceutical Sector

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Additional information is available at the end of the chapter

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Abstract

The pharmaceutical field offers a wealth of job and career opportunities for talented young graduates with a sound background in life sciences and various other academic disciplines. Because these employment options are often insufficiently known to young academics, the aim of this chapter is to give them a better idea about the many job opportunities and presents the entire drug life cycle. The first part of the chapter includes a general description of the drug life cycle and what is understood by 'the pharmaceutical sector'. The core of the chapter gives an overview of job opportunities that either are specific to the different parts of the drug life cycle or are important as support functions over the entire life cycle. It also includes a section on career perspectives and training opportunities. The last part of the chapter focuses on important employability elements, as well as some practical do's and don'ts for effective job application.

Keywords: job, career, drug discovery and development, pharmaceutical sector

1. Introduction

The field of drug discovery, development and commercialisation offers a wealth of job and career opportunities for talented young graduates with a sound background in life sciences

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or other academic disciplines and a genuine interest and motivation to start a professional career in the pharmaceutical sector.

The drug life cycle is usually subdivided into discovery research, development and commercialisation and spans the whole trajectory from idea to patients, from bench to market (withdrawal).

The professional field covers the whole pharmaceutical sector, which is not just limited to drugs or to medicines for human or animal use but also includes medical devices, diagnostics, radiopharmaceuticals, nutriceuticals and other related areas of activity. Nor is this sector limited to the (bio-)pharmaceutical industry, but it also includes health authorities, academia and research centres, clinical investigator sites, contract research organisations (CROs) and many more. The need for a highly educated workforce is clearly present in all of these areas and the pharma sector is offering opportunities for a wide spectrum of academic graduates with a Bachelor, a Master, or a PhD degree. Despite the many job opportunities in this sector, competencies of young university graduates are seldom adjusted to the specific requirements listed in the job vacancies. Moreover, they often lack an understanding of the drug development process and the various perspectives it offers for career development.

The aim of this chapter is to give academic graduates a better idea about the many job opportunities over the entire drug life cycle, offered by a wide variety of companies and organisations and for a broad spectrum of qualified professionals.

All the above will be presented in more detail in Sections 2–5 of this chapter.

After the overview of job opportunities, career perspectives and training opportunities will be discussed in Sections 6 and 7 and important employability elements in Section 8.

As this chapter is primarily targeted at young graduates, Section 9 adds some practical dos and don'ts for effective job application. The chapter ends with some concluding remarks (Section 10) and a bibliography for further reading.

2. The drug life cycle

The life cycle of a drug involves essentially three parts: drug discovery and design (research), drug development and drug commercialisation [1]. They are largely consecutive in nature, but some activities are carried out in parallel.

Drug research is primarily driven by an unmet medical need, i.e. a therapeutic area in need of a (better) drug. Drugs are either discovered in nature or in existing chemical libraries, or either (semi-)synthesised or designed *de novo* in laboratories. Drug discovery research and drug design require highly intellectual creativity, perseverance and some serendipity. As drugs interact with molecular targets of biological relevance for a disease, mostly proteins (such as receptors, enzymes, ion channels, or antigens), drug research requires intense collaboration between project team members of several scientific disciplines (such as biologists, medicinal chemists and pharmacologists). Drug discovery and design are characterised by a fairly high

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degree of freedom. It is mostly done in (big) pharmaceutical companies, academic research centres, as well as in small spin-offs and start-ups. The ultimate goal of the research project team is to deliver a (few) patented drug candidate(s), ready for development. This can take 3–5 years.

During drug development, the potential drug candidate progresses to a drug or a medicinal product which is effective and safe to be administered to humans (or animals) to prevent, diagnose, or treat a disease. It is a complex and highly regulated process, with a lot of intermediate failures, (re-)assessments and (re-)iterations along the long road. Because of these characteristics, drug development is often subdivided in non-clinical and clinical development, as well as in early and late development. In drug development for humans, clinical development includes all experiments with the drug in human subjects (healthy volunteers or patients), while non-clinical development includes all experiments with the drug in animals, *in vitro* and *in silico*. Non-clinical development consists of chemical and pharmaceutical development (of the drug product as a formulation, such as a tablet or an injectable solution), non-clinical efficacy and safety pharmacology, non-clinical toxicology and non-clinical pharmacokinetics. Non-clinical development is partly preclinical, i.e. some of it has to be performed and has to generate safe results before (a certain phase in) clinical development can start. Clinical development is classically divided into consecutive phases: phase 1 (first administration in man, single and multiple ascending dose studies, mostly in healthy volunteers), phase 2 (proof of concept that the drug has the intended effect in patients with the targeted disease, dose-finding studies), phase 3 (confirmation of efficacy and safety in clinical trials with large groups of patients), phase 4 (real-world studies when the drug is on the market, pharmacovigilance). Alternatively, clinical development is also split into an exploratory and a confirmatory phase, or a preapproval (before market authorisation) and a post-approval phase. Drug development is a highly risky and costly process; it takes easily 5–8 years and a very talented team of several disciplines (different life scientists, clinicians, engineers, regulatory affairs experts and others), all working together to make it a successful enterprise.

The final part, drug commercialisation, starts with the market authorisation (or drug approval), based on all the available data about quality, efficacy and safety on the medicine and a positive benefit-risk balance in the targeted population, allowing the drug to be marketed and to generate return on investment. But market authorisation (per country, per region like the European Union, or worldwide) is not enough to be successful on the market; there are other hurdles to be taken such as a fair price setting and drug reimbursement by social security systems (based on the added value of the drug for patients and its affordability by society), together known as market access hurdles. Once taken, the drug can be launched and marketing and sales can really start, in parallel with large-scale production and distribution. When the patent of the drug expires (generally 20 years after its application), generic and biosimilar competitors enter the market and the sales of the original drug suddenly drop (the patent cliff), but a drug with added value can still stay on the market for many more years, until it is finally withdrawn. Drug commercialisation is more a world of health economists, marketers, pharmacists, pharmaceutical physicians, sales reps, lawyers and business managers. A schematic representation of the drug life cycle is given in **Figure 1**.

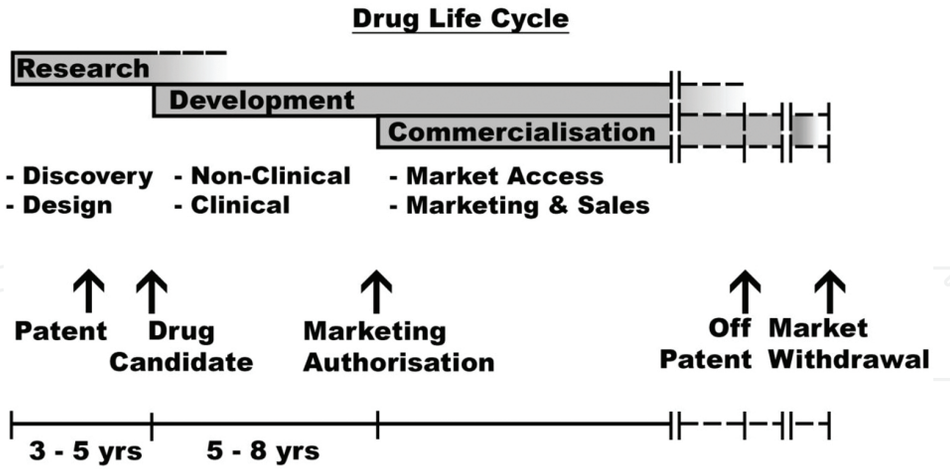


Figure 1. Schematic representation of the drug life cycle. yrs, years.

3. The pharmaceutical sector

The (bio-)pharmaceutical industry is probably the biggest employer in this sector worldwide.

It is already a world in itself, as it is an umbrella term with its main representatives being 'big pharma' companies, active throughout the whole value chain of the drug life cycle. They research, develop, manufacture and market innovative medicines, either the more classic small molecules or the more recently introduced large biopharmaceuticals such as therapeutic proteins and monoclonal antibodies (produced by living organisms or cells). Under the umbrella also operate medtech companies (e.g. medical devices, implants, biomaterials and *in vitro* diagnostics); biotech companies specialised in biopharmaceuticals, but also in advanced therapy medicinal products (ATMPs) such as gene and cell therapy, or tissue-engineered products; small- and medium-sized enterprises (SMEs) often as niche players; start- or scale-up companies more focused on drug research and early development; companies producing generics and biosimilars; organizations representing the pharmaceutical industry, such as P*h*RMA in the USA and EFPIA in Europe; and last but not least, the ever growing business of Contract Research Organizations (CROs) as full or specific service providers to this industry.

However, the pharmaceutical sector is a lot broader than the pharmaceutical industry and offers many additional jobs and career opportunities. Other important organisations, institutions, or actors in this sector are regulatory agencies, such as national or regional medicines agencies (such as the FDA in the USA and the EMA in Europe, granting drug approvals), certified bodies (the equivalent for medical devices), or patent offices; academia, research centres and spin-offs active in basic research, drug discovery and design, but also early drug development; clinical investigator sites, be it phase 1 or clinical pharmacology units (CPUs) either university- or CRO-owned, university or regional hospitals, site management organi-

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sations (SMOs), or the European Organisation for the Research and Treatment of Cancer (EORTC); patient organisations; non-profit drug research funders such as the Bill and Melinda Gates Foundation; consultants, lobbyists and law firms; venture capitalists and investment banks; entrepreneurs and self-employed persons; and many more…

Overall, the pharmaceutical sector offers a wealth of job opportunities and career perspectives for young and talented graduates of the necessary calibre and commitment.

4. Job opportunities throughout the drug life cycle

In this section, we walk through the drug life cycle and focus on job opportunities that are specific to the different parts of the cycle. Support functions that are important over the entire cycle are presented in Section 5.

4.1. Discovery research

Drug discovery research is either phenotypic-based (empirical and response-driven) or target-based (molecular and hypothesis-driven). Although the phenotypic-based approach has been very successful in the past, today's drug discovery is more target-based. The process is as follows: (1) selection and validation of a (druggable) target, mostly a protein (e.g. receptor, enzyme, ion-channel and antigen), but also carriers of genetic information (e.g. DNA/RNA and oncogenes); (2) development and validation of a proper assay, allowing to study the interaction between the target and potential drug candidates; (3) (high-throughput) screening (HTS) of potential drugs, generated through *de novo* synthesis or from existing natural or chemical libraries, in order to identify 'hits' (interactions with the target); (4) hit-to-lead finding, i.e. limited optimisation of drug candidates in order to identify a limited number of promising lead compounds; (5) lead optimisation, with the objective to improve target selectivity and specificity, as well as the pharmacodynamic, pharmacokinetic and toxicological properties of the candidate drug, in order to get it ready for development.

Drug discovery research is highly dependent on the interplay between different scientific and other disciplines. In practice, it includes intensive collaboration between mainly:

- different types of biologists, such as molecular biologists, biochemists, biotechnologists, bioinformaticians and biomedical scientists;
- different types of chemists, such as medicinal chemists, combichem specialists, computer-assisted drug designers, protein chemists and analytical chemists;
- pharmacologists, pharmacokineticists, pharmacometricians, toxicologists, biopharmacy and pharmaceutical technology experts;
- as well as representatives of other disciplines, such as (bio-)engineers, data analysts, intellectual property (IP) specialists and patent lawyers.

Drug research departments may be organised per therapeutic domain (more specialised and more compartmentalised) or rather more 'holistically' per biological platform, such as a similar target family (e.g. kinases and ion channels), or a similar biological mechanism (e.g. angiogenesis, inflammation, cell cycle control and epigenetics), or per common technological platform (e.g. 3D modelling, X-ray crystallography and NMR spectroscopy).

Innovative drug research organisations (pharmaceutical companies, academic centres, spin-offs, or start-ups) are looking for highly educated and talented individuals with at least a master's degree and preferably a PhD in the aforementioned disciplines. However, being an excellent scientist is not enough to be successful in this field. You also need the right creative mindset, being able to think out of the box and to work together in a multidisciplinary team on a specific project for several years.

Discovery research is the least regulated phase of the drug life cycle and confers to professionals working in this field a fairly high degree of freedom, although in the competitive world of today, research teams also have to deliver quality products, in time and within budget.

As drug R&D is costly and risky; drug candidates are patented so that they later gain market exclusivity without competition for a set period (in general, 20 years after patent filing). Therefore, drug research organisations as well as national and international patent offices also offer job opportunities for IP specialists, such as patent lawyers and patent reviewers.

4.2. Non-clinical development

Non-clinical drug development, including all experiments not involving human subjects, is an umbrella term referring to the following activities: chemical and pharmaceutical development (also known as 'chempharm' or 'chemistry, manufacturing and controls (CMC)'), experimental pharmacology (including safety pharmacology), non-clinical toxicology and non-clinical pharmacokinetics. It is essentially a lab activity, involving *in vitro* and *in silico* research as well as animal experiments. Its goal is to generate the data needed as prerequisites for the different clinical development phases (the preclinical part of non-clinical development), all the non-clinical data for the marketing authorisation application (the preapproval phase), as well as all the non-clinical data during the continued development when the drug is already on the market (the post-approval phase). Non-clinical development is much more regulated than discovery research and has to be executed within a framework of international guidelines (ICH Quality and Safety guidelines) and according to the international standards of good laboratory or good manufacturing practices (GLP and GMP).

Chemical and pharmaceutical development, including drug (product) manufacturing and drug (product) analysis, offers opportunities especially for analytical and green chemists, chemical or bio-engineers, pharmaceutical technologists and (industrial) pharmacists.

Non-clinical efficacy and safety pharmacology units are rather looking for experimental pharmacologists, biomedical, or (bio-)pharmaceutical scientists.

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Non-clinical pharmaceutical toxicology departments are essentially in need of toxicologists, veterinary surgeons and pathologists, but can also do well with interested biomedical or (bio-)pharmaceutical scientists.

Non-clinical pharmacokinetics departments are especially looking for pharmacokineticists, experts in drug metabolism and bio-analytical chemists. As model-based drug development is booming, there is also a high need for pharmacometricians, modelling and simulation experts, or more generally, biomedical or (bio-)pharmaceutical scientists with a sound background in mathematics.

For most executive functions in all the above-cited fields, having a master's degree is an absolute must and a PhD a big plus, although a lot of lab technicians are also welcome.

Non-clinical drug development specialists are also needed in (inter-)national medicines agencies as assessors of the CMC (quality) and the non-clinical (safety) parts of the common technical document (CTD), the international harmonised dossier for application of a marketing authorisation of pharmaceuticals for human and animal use.

4.3. Clinical development

Clinical drug development, defined as all studies involving human subjects, is (because of its complexity and long duration) usually subdivided into different phases. It starts classically with small-scale phase 1 studies, including the First-in-Man or First-in-Human (FiM/FiH) study, the single ascending dose (SAD) and the multiple ascending dose (MAD) studies, usually in healthy volunteers (but sometimes in patients), in order to have a first impression of the safety, pharmacokinetics and pharmacodynamics of the drug in development in humans. Then follows phase 2a, to investigate whether the drug works at all in patients according to the presumed mechanism of action (the so-called Proof-of-Concept or POC study) and to have a preliminary idea about the effective and safe dose range in tens of patients with the intended indication. Nowadays, phase 1 is often preceded by a phase 0 study with a limited number of subjects, with a single radioactive microdose of a limited number of drug candidates in order to help researchers in the selection of the best candidate for further full development. In a more recent classification, the preceding phases are together defined as 'early' or 'exploratory' clinical drug development. The corresponding 'late' or 'confirmatory' clinical development phase is then corresponding to the classic phases 2b, 3 and 4. The main objective of phase 2b is proper dose (regimen) finding in hundreds of patients with the targeted disease, whereas phase 3 clinical trials aim at confirming a positive clinical benefit/risk balance versus existing therapies in thousands of patients. If successful after this phase, a marketing authorisation application is filed, allowing the drug, if granted, to be put on the market and generate return on investment. This part of the late development phase is also called the preauthorisation or preapproval phase. Finally, in phase 4 of clinical drug development (the post-authorisation or post-approval phase), the use of the drug in everyday clinical practice is studied, its pharmacovigilance (adverse drug reactions) is (are) monitored and new developments are initiated (for new indications, new associations, or new formulations).

Clinical drug development also involves many different disciplines, each offering several job opportunities. Within clinical drug development organisations (e.g. pharmaceutical companies and CROs), they are usually grouped in the following departments: Clinical Research, Clinical Operations, Medical Review and Pharmacovigilance, Clinical Biometry and Clinical Services, although names can vary from company to company. Their role is to extensively collaborate with one another and generate all clinical data for the marketing authorisation application (preapproval phase), as well as all clinical data for continued developments in the post-approval phase.

Clinical Research is responsible for the content of the clinical development plan of the new drug. They define the strategy, do the planning, oversee the methodology and coordinate the overall (worldwide) management of all clinical trials. In the early clinical development phase, they primarily need clinical pharmacologists, clinical pharmacokineticists, clinical pharmacometricians, but also clinicians (either medical specialists or general practitioners). In the late clinical development phase, this need shifts more towards clinicians and pharmaceutical physicians, pharmaco-epidemiologists and (hospital or clinical) pharmacists.

Clinical Operations is in charge of the implementation of the clinical development plan, the local project management, as well as the monitoring and administration of all clinical trials. They typically hire international and local clinical trial managers, clinical research associates (CRAs or monitors) and clinical trial administrators (CTAs), often with just a master's degree in life sciences (e.g. biomedical or pharmaceutical scientists, research nurses, physiotherapists, or even physicians).

The *Medical Review and Pharmacovigilance* Department is populated by medical reviewers and pharmacovigilance (PV) experts, responsible for the critical review of all medical data gathered in clinical trials and especially all data on adverse events and adverse drug reactions. These aspects are best handled by (pharmaceutical) physicians (hospital or clinical) pharmacists and clinical toxicologists, with the external help of clinicians and medical specialists for specific problems.

The *Clinical Biometry* unit, in charge of clinical data management and clinical statistics, is particularly looking for clinical trial methodologists, data managers, (big) data analysts, biostatisticians and computer programmers.

And finally, the *Clinical Services* Department is responsible for the supply and logistics of all clinical study material, e.g. supply, storage and shipment of investigational drugs (including placebo and comparators) and central laboratory materials (to and fro the study centres, all over the world), or provision of standardised study equipment (e.g. a treadmill for exercise tolerance tests, including the software to run the test). They usually hire pharmaceutical or biomedical scientists for these jobs.

Clinical drug development specialists are also needed in (inter-)national medicines agencies as assessors of the clinical parts of clinical trial or investigational new drug applications (CTA in Europe, IND in USA) and Marketing Authorisation (MA, Europe) or New Drug Applications (NDA, USA).

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A particular characteristic of clinical drug development is that clinical trials are largely performed in investigational sites that do not belong to the drug development organisation itself. With the notable exception of phase 1 trials, usually performed in phase 1 units with healthy volunteers (of which some are owned by pharmaceutical companies or CROs), clinical trials recruit patients who can only be found in institutions, e.g. (university) hospitals, academic phase 1 units, or nursing homes, or else in private practices of general practitioners or medical specialists. Besides, many (academic) hospitals perform their own clinical (drug) research as investigator-initiated trials (IIT). All these investigational sites also offer a lot of job opportunities as investigator, research physician, research nurse, study coordinator and clinical research pharmacist. Some sites are grouped in site management organizations (SMO) or specific organizations such as the European Organisation for Research and Treatment of Cancer (EORTC) that coordinate clinical trials for their member sites. They too need qualified professionals.

4.4. Commercialisation

The last part of the drug life cycle and hopefully the longest for many years, is the commercialisation phase. It starts with the marketing authorisation of the new medicine and ends with its withdrawal from the market, thus also ending its life cycle (see **Figure 1**). During this phase, there is a period that an innovative drug can be on the market without competition thanks to its patent protection and additional exclusivity rights, so that the owner can maximise its return of investment (ROI). Once off-patent, sales in general suddenly drop (the patent cliff) because of the introduction of generics or biosimilars, but may find a new equilibrium for years thereafter.

Drug commercialisation activities are mostly the prerogative of pharmaceutical companies, although some can also be subcontracted to CROs. They can be found in the following departments: market access, marketing, medical affairs, production and distribution and sales.

A marketing authorisation is not sufficient to get a drug for human use on the market. You also need to negotiate a fair price with different national health authorities (price setting) and to demonstrate added value in order to gain acceptable coverage or reimbursement conditions with different national health insurance system providers. These steps are known as market access hurdles. *Market access* departments mainly group financial experts, drug pricing specialist, experts in health technology assessment (HTA), pharmaco-economists, core value dossier writers and pharmaceutical policy experts, together with marketing specialists. They generally hire professionals with specific qualifications such as Master of Finance or Economics, but also life scientists (pharmacists, physicians and biomedical scientists) often with a second degree in, for instance, health economics or pharmaceutical medicine. Similar jobs can, of course, also be found in the national institutes, agencies, or committees that have to decide on drug prices and reimbursement conditions.

Pharmaceutical marketing is responsible for promoting the sales of a (new) medicine. It supposes a good knowledge of the pharmaceutical market, general marketing principles (communicating the value of a product to customers), specific pharmaceutical marketing principles (e.g. operating in a regulated market), as well as the specificities of pharmaceutical marketing

activities (market analysis, marketing strategy and plan, marketing channels and tools) adapted to the different phases of the commercial life span of a drug (prelaunch, launch, ascending phase, maturity and end-stage phase); and all this, within the rules of local drug promotion, legislation and regulation. This is typically the work space of national or international product managers and brand or group product managers (responsible for several drugs within a given therapeutic area), either specialists with a marketing degree or life scientists with a Master in Business Administration (MBA).

Medical affairs focuses on clinical drug development in the post-approval phase and on the medical and scientific aspects of pharmaceutical marketing, such as managing medical communications and publications, key opinion leaders (KOLs) and advisory boards and medical information (answering questions from health care providers and patients). Medical affairs professionals bridge the gap between R&D and marketing and hold positions such as medical advisor, medical science liaison (MSL), medical information manager, or pharmacovigilance expert, usually filled by physicians or pharmacists, often with a postgraduate degree in pharmaceutical medicine.

Pharmaceutical sales is the ultimate activity that brings in the money to reinvest in new drug R&D. The sales teams are made up of pharmaceutical sales representatives or (medical) reps, who promote (a selection of) the drugs of a pharmaceutical company. Prescription drugs are promoted toward physicians, while non-prescription drugs (over-the-counter or OTC medication) is promoted toward pharmacists. Sales reps are usually responsible for a given franchise or therapeutic class of drugs, a given target audience (private practices or hospitals) and a given local territory. There work is supervised by regional and country sales managers. Most pharmaceutical companies have their own sales force, but additional sales reps can either be (temporarily) insourced from a CRO, or the entire sales activity for a given franchise or brand can be outsourced to a CRO. Sales departments typically hire holders of bachelors and masters in life sciences (including physiotherapists), with strong communication skills and the necessary motivation and stamina to reach sales objectives, which are trained in-house and on the job.

Finally, *pharmaceutical production* facilities make sure that the necessary volumes of medicines are manufactured in due time with high quality, from the active pharmaceutical ingredient (API) to the end product. The *distribution* department sees to it that drug orders are channelled appropriately in order to reach wholesalers, community and hospital pharmacies on a regular basis. This is typically a world of chemical engineers, industrial pharmacists and supply chain managers.

5. Job opportunities in support and management functions

Within drug development organisations (e.g. mostly pharmaceutical companies, CROs or specialised start-ups and more rarely academic research centres or spin-offs), all the disciplines described above have to work together with the additional help of data managers, data analysts, (bio-)statisticians, quality management experts, specialists in regulatory sciences/

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affairs, report writers and planning specialists. The coordination and oversight are kept by project team leaders (who prepare the documents needed for decision-making), while go/no go-decisions are taken by (a team of) senior managers.

These activities in the pharma sector are not only important in a specific part of the drug life cycle, but cover the entire business and value chain. They too offer many job opportunities.

5.1. Regulatory sciences/affairs

As the pharmaceutical sector is highly regulated, the regulatory affairs department makes sure that their pharmaceutical organisation or company complies with all (inter-)national legislations, regulations and guidelines pertaining to their business (worldwide). They are at the forefront in the negotiations with medicines agencies when asking them for scientific advice, or when discussing with them about the marketing authorisation of a new drug, or when arguing about changes to the Summary of Product Characteristics of a drug (SmPC in Europe, labelling in USA). They also see to it that all regulatory documents, such as clinical trial applications, marketing authorisation applications and variations, as well as drug safety reports are prepared, assembled and send to the appropriate health authorities in due time. Regulatory affairs professionals may be responsible for a country or a geographical region (e.g. Europe, USA, or Asia), or they may be specialised in preapproval or post-approval affairs. Most of them are pharmacists or occasionally other life scientists, often with a post-graduate in regulatory sciences or pharmaceutical medicine.

5.2. Quality management

The quality of all the activities at all the steps and levels throughout the drug life cycle is assured by a quality management system (QMS) that typically consists of a set of rules and regulations (good practices or GxP), translated into standard operational procedures (SOP), the proper application of which is regularly monitored by quality control during operations (by self-control and monitoring) and occasionally checked by audits (by internal or external auditors) and inspections (by regulatory authorities).

Quality management professionals oversee that all operational departments comply with the recommended best practices, e.g. good laboratory practices (GLP), good clinical practices (GCP), good manufacturing practices (GMP), good pharmacovigilance practices (GVP), good distribution practices (GDP). Typical quality assurance (QA) activities include SOP writing, training of operational staff and investigator teams in quality management and performing audits from which lessons can be learned for further improvement of activities or processes.

QA professionals are usually life scientists, often with a postgraduate degree in quality management and with previous experience in an operational function in the pharmaceutical sector. Inspectors from health authorities are usually pharmacists.

5.3. Scientific/medical writing

All the activities throughout the drug life cycle generate a lot of study reports, publications, regulatory documents and applications to be written in several languages. Most pharma

companies have a scientific and/or medical writing department responsible for that. These departments are populated by life scientists and translators with excellent writing and communication skills. Some of these professionals are self-employed and work as external service providers on a freelance basis.

5.4. Training and development (personal, professional)

Most pharmaceutical companies have their proper training department or corporate training academy, but there is also a plethora of training opportunities offered by specialised service providers (either in-house or external). Their objective is to provide the induction training to newcomers (including company-specific strategic thinking and knowledge transfer), as well as continuous training and development for all (individuals and teams). Training activities are offered to all operational disciplines throughout the drug life cycle, e.g. to researchers, clinical research associates, project and product managers and sales reps. These learning activities are not only meant to optimise their technical knowledge, but also target as much at the development of their core workplace skills. Trainers come in all shapes and sizes, have different backgrounds and qualifications, should have some expertise in the field to be taught, but most of all should have excellent communication and teaching abilities and should love to work with people. The rest can be learned on the job by training the trainer.

5.5. Management

The success of any business depends heavily on the effectiveness of its managers. This is equally true in the complex pharmaceutical sector, where many aspects of management come into play, such as strategic management (e.g. innovation, portfolio or risk management and go/no go decision-making) as well as operational management (e.g. project management, clinical, or sales operations). Therefore, there is a high need for visionary leaders and talented managers in this sector. Some people have inborn leadership and management talents, but others grow in it during their career development. Senior and corporate managers in the pharmaceutical business have different backgrounds and qualifications, from life scientists to economists and lawyers, often with a Master in Business Administration (MBA).

6. Career perspectives

At entry, young professionals are often employed as a junior or an assistant, preceding their functional job title (e.g. Junior or Assistant Project Manager). After a year or two, these prefixes can be dropped and after an additional number of years of experience in the same job the prefix can change to Senior (e.g. Senior Project Manager).

Initial on-the-job training and work experience can be gained during traineeships, internships, job or work shadowing, secondments and temp jobs (all paid or not).

In the (bio-)pharmaceutical industry, many young academics start their career as an employee of a CRO, which then outsources them for a certain period (6 months or a year) to a pharma-

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ceutical company for a specific job. After a couple of such secondments in different companies, these young professionals get a better idea of what they really want and what is offered out there for their future career development.

After an initial work experience of a varying number of years, young professionals usually start thinking of their career development in the pharmaceutical sector. An important element to consider is whether you want to stay an expert in your field or become a manager or a leader, as they require different skills, training and work experience.

Career moves can be of several types:

- You can move along the path of the drug life cycle, e.g. you can start in Clinical Operations (as Project Manager) and move to Regulatory Affairs (as Country or Regional Manager) or Marketing (as Product Manager). Moving backwards from marketing to R&D is much harder though.
- You can move lateral (e.g. switch in the same position from one country to another) or move up (e.g. become a Project Team Manager or Group Product Manager).
- You can start an international career, working in several countries worldwide and then return to the company headquarters for a senior management job.
- You can switch from one company to another within the pharmaceutical industry, or you can switch from a CRO to a pharma company, or you can switch back to academia, or start a career in a governmental agency.

With every career move, you confront new challenges and over the years you get more responsibility, eventually as senior manager. The ultimate move may be that you become Chief Executive Officer (CEO), the 'big boss' of a company.

As an alternative career option, you can also start your own company, either as a young entrepreneur or as a senior consultant. Both these options require a solid business plan and an entrepreneurial mindset.

7. Training opportunities

Given the high number of job and career opportunities described above, the main challenge for young students and graduates is to understand which are their preferred jobs and how to get them.

A useful approach is to attend all possible orientation events such as career days, organised nowadays by most universities in which it is possible to listen to experts coming from different companies.

Some of the biggest pharmaceutical companies, including Abbott[1], AbbVie[2], Amgen[3], AstraZeneca[4], Baxter[5], Bayer[6], Biogen[7], Boehringer-Ingelheim[8], Bristol-Myers Squibb[9], Eli Lilly & Co[10], Gilead[11], GlaxoSmithKline[12], Johnson & Johnson[13], Merck & Co[14], Merck KGaA[15], Novartis[16], Novo

Nordisk [17], Roche[18], Sanofi[19], Teva[20] have excellent traineeship programmes for young students and graduates.

Useful websites to find excellent scientific positions in public or private institutions are https://www.sciencemag.org/careers, http://www.nature.com/naturejobs/science/, http://jobs.newscientist.com/, etc.

Another valuable strategy is to apply for a traineeship in a company in another European country participating in the Erasmus+ programme.[21] The programme offers the possibility of spending periods of at least two months in non-academic institutions including pharmaceutical companies and research centres.[22] Most universities are active in this programme and students can easily obtain detailed information from their international offices.

Some European Institutions such as the European Medicines Agency (EMA),[23] the European Centre for Disease Prevention and Control (ECDC),[24] and the European Patent Office (EPO)[25] offer very interesting traineeships.

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[1] http://www.abbott.com/careers/students/development-programs.html

[2] http://www.abbvie.com/careers/student-opportunities/development-programs.html

[3] http://careers.amgen.com/university-relations/internships-co-ops/

[4] http://www.astrazenecacareers.com/students/programmes/

[5] http://www.baxter.com/careers/programs/healthcare-internships-co-ops.page

[6] https://career.bayer.com/en/career/working-at-bayer/students/

[7] https://www.biogen-international.com/en/careers1/pharmd-fellowships.html

[8] http://careers.boehringer-ingelheim.com/students

[9] http://www.bms.com/careers/university_recruitment/internships_co-ops/pages/graduates_undergraduates.aspx

[10] https://careers.lilly.com/campus

[11] http://www.gilead.com/careers/careers/current-opportunities

[12] http://futureleaders.gsk.com/en-gb/our-programmes/

[13] http://www.careers.jnj.com/explore-careers-student

[14] http://www.merck.com/careers/life-at-merck/students-and-graduates.html

[15] http://www.merckgroup.com/en/careers/graduates_and_students/faq/faq.html

[16] https://www.novartis.com/careers

[17] http://www.novonordisk.com/careers/graduates-students-and-trainees/graduates/graduate-programmes-overview-uk.html

[18] http://www.roche.com/careers/switzerland/ch_your_job/students_and_graduates/trainee_programs.htm

[19] http://en.sanofi.com/careers/join_sanofi/graduates_interns/graduates_interns.aspx

[20] http://www.tevapharm.com/teva_careers/european_leadership_programme/

[21] https://ec.europa.eu/programmes/erasmus-plus/node_en

[22] https://ec.europa.eu/programmes/erasmus-plus/individuals_en#tab-1-4

[23] http://www.ema.europa.eu/ema/index.jsp?curl=pages/about_us/general/general_content_000321.jsp

[24] http://ecdc.europa.eu/en/aboutus/jobs/Pages/Traineeships.aspx

[25] http://www.epo.org/about-us/jobs/vacancies/internships.html

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The Innovative Medicine Initiative (IMI),[26] Europe's largest public-private initiative aiming to speed up the development of better and safer medicines for patients, has several interesting projects in the field of education and training:

- European Medicines Research Training Network[27] (EMTRAIN), a platform for education and training covering the whole life cycle of medicines research, from basic science through clinical development to pharmacovigilance.
- European programme in Pharmacovigilance and Pharmacoepidemiology[28] (Eu2P) which developed numerous courses covering various aspects of medicines' research and development, including pharmacovigilance.
- Pharmaceutical Medicine Training Programme[29] (Pharmatrain), which established standards for high-quality postgraduate education and training in Medicines Development.
- European Modular Education and Training Programme in Safety Sciences for Medicines[30] (SafeSciMET) which established a new and unique pan-European education and training network, providing master's level courses in safety sciences for medicines.

Another important question often asked by students and graduates is related to the necessary level of education required for the different positions in the pharmaceutical sector. The answer to it is not always easy because despite the harmonization of the architecture of the European higher education obtained through the Bologna process since 1999[31] (1st cycle or bachelor's degree, 2nd cycle or master's degree, 3rd cycle or PhD or Doctorate), there are still significant differences in the pharmaceutical field. In most European countries, while chemistry, biology and biotechnology are usually studied in two subsequent cycles (bachelor + master), pharmacy and industrial pharmacy are usually 5 or 6 years integrated master's degree programmes. In addition, in some countries, such as Italy and France for example, it is very common to attend a 'professional master' after the master's degree to obtain the necessary knowledge and skills to be hired by pharma companies for positions in clinical monitoring, pharmacovigilance, or regulatory affairs. Finally, concerning the third cycle, despite the existence of many different research and professional PhDs, it should be mentioned that in most countries, the title of PhD is really necessary for careers in research, but not for most of the other positions described in this chapter.

[26] http://www.imi.europa.eu/

[27] http://www.emtrain.eu/

[28] https://www.eu2p.org/

[29] http://www.pharmatrain.eu/

[30] http://www.safescimet.eu/

[31] http://ec.europa.eu/education/policy/higher-education/bologna-process_en.htm

8. Important employability elements

8.1. Wanted qualifications

Apart from technical qualifications, it is important to develop managerial leadership competences. So how do we know what leadership competences are important to career success? The Association to Advance Collegiate Schools of Business (AACSB) [2], which gives accreditation to business schools, developed a list of "General Skills Areas" that students are expected to develop:

- Written and oral communication: able to communicate effectively orally and in writing.
- Ethical understanding and reasoning: able to identify ethical issues and address the issues in a socially responsible manner.
- Analytical thinking: able to analyse and frame problems.
- Information technology: able to use current technologies in business and management contexts.
- Interpersonal relations and teamwork: able to work effectively with others and in a team environment.
- Diverse and multicultural work environments: able to work effectively in diverse environments.
- Reflective thinking: able to understand oneself in the context of society.
- Application of knowledge: able to translate knowledge into practice.

8.2. Vitae employability lens

Vitae is a non-profit organisation based in Cambridge, UK, with almost 50 years of experience in enhancing the skills and careers of researchers. As a spin-off of these activities, Vitae has developed an Employability Lens that could serve as a researcher development framework for careers outside academia. This tool gives an overview of the key knowledge, behaviours and attributes that are typically important for graduates from academia and as such often appreciated by employers, see link to the pdf below:

https://www.vitae.ac.uk/vitae-publications/rdf-related/employability-lens-vitae-researcher-development-framework-rdf-may-2012.pdf

The Vitae Employability Lens is particularly useful in identifying additional skills on top of the specific key knowledge of academics seeking employment outside academia, for example, in the drug development field. To achieve this, it especially focuses on behaviours and attitudes, rather than on the knowledge base that has been the original aim of studies and training during academic studies. In doing so, the lens can serve as an 'eye opener' especially for PhD holders that primarily expected to valorise their theoretical knowledge and their technical experience. Thanks to this employability lens, a range of transferable skills has been

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identified that has proved to be added value in almost any workplace, thereby significantly lowering the threshold for academic graduates to make the step towards industry. In addition, these transferable skills can be trained and many Doctoral Schools provide focused short training programs as a way to effectively support the career perspectives of PhD researchers after obtaining their degree.

Apart from this focus on transferable skills, it can be expected that many academically trained researchers will wonder in what part of the drug life cycle their specific knowledge base could still provide an added value. This would enable them to valorise their specific knowledge and experience and thus provide a basis for a career after making the step from academia towards the pharmaceutical sector. An overview of specific knowledge needed in the Drug Life Cycle is given below in **Table 1**.

Academic knowledge base for employment		**Drug life cycle expressed in five stages:**				
Academic fields by discipline	**Academic degree**	**Research discovery & design**	**Non-clinical development**	**Early clinical development**	**Late clinical development**	**Commercialisation**
Pharmaceutical sciences	MA		×		×	×
Pharmaceutical sciences	PhD	××	××	×		
Medical sciences	MD			×	×	×
Medical sciences	MD-PhD	××	×	××	×	
Biomedical sciences	MA				×	×
Biomedical sciences	PhD	××	××			
Veterinary sciences	MA	×	×			
Veterinary sciences	PhD	××	××			
Pharmacy	MA		×	×	×	
Pharmacy	PhD	××	××			
Industrial pharmacy	MA		×	×	×	×
Industrial pharmacy	PhD	××	××			

Academic knowledge base for employment		**Drug life cycle expressed in five stages:**				
Academic fields by discipline	**Academic degree**	**Research discovery & design**	**Non-clinical development**	**Early clinical development**	**Late clinical development**	**Commercialisation**
Biotechnologies	MA	×	×		×	×
Biotechnologies	PhD	××	××			
Chemistry	MA		×			
Chemistry	PhD	××	××			
Biology	MA					
Biology	PhD	××	××			
Biochemistry	MA					
Biochemistry	PhD	×	××			
Physics	MA					
Physics	PhD	×	×			
(Bio)informatics	MA	×	×			
(Bio)informatics	PhD	××	×			
Engineering	MA		×			×
Engineering	PhD	×	×	×	×	
Mathematics and data analysis	MA/PhD	×	×	×	×	
Law and legal studies	MA	×	×	×	×	××
Economy and finance	MA					×
Business administration	MA (MBA)					×
Communication studies	MA/PhD				×	×
Languages	MA				×	×

Table 1. Overview of specific knowledge needed in the drug life cycle.

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In **Table 1**, the academic knowledge base for employment has been linked to the various stages of the drug life cycle, as introduced in the beginning of this chapter. The clinical development stage has just been divided into two phases (early and late), followed by the commercialisation stage after marketing authorisation. The aim of **Table 1** is to document that disciplinary knowledge is also very important in the drug development process and that different disciplines contribute to different stages of the drug life cycle. Combined studies are not indicated in **Table 1**, but can be quite valuable, for example, a primary degree in Pharmaceutical Sciences and a second degree in Patent Law.

As can be seen in **Table 1**, the most important academic knowledge base is contributed by PhD holders in the various molecular, biotech and life sciences during stages 1 and 2, which are focused on drug discovery and non-clinical development. Academics with a background in the pharmaceutical and medical sciences can typically use their knowledge base during the whole drug life cycle. For the more advanced stages in the life cycle, a PhD could still be an advantage, but the valorisation of academic knowledge developed during the PhD studies will likely become less important, while the transferable skills and behaviours of PhD holders will start to predominate. This also implies that a vast range of academics listed in **Table 1**, can professionally contribute to any of the stages of the drug life cycle. The fact that crosses are lacking in certain positions merely indicates that in those positions the original academic knowledge base is unlikely to be the main contributor to the activities in that stage. Thus, a biologist that is employed as a Clinical Research Associate (CRA) and active in the later stage of clinical development will not have a cross in this part of **Table 1** (because there is no dominance of biological key knowledge in that stage), but he/she can still build out a very interesting career. **Table 1** is not based on quantitative data but rather reflects the authors' views on where specific academic disciplinary knowledge is expected to be most valuable in the drug life cycle.

9. Effective job application

9.1. Introduction

Successful job application requires three things: (1) having a good motivation, (2) having the required technical skill set and (3) being able to illustrate your interpersonal skills.

Having a good motivation concerns three levels, motivation for the content of the job (*what do you think this job entails on a daily basis*?), motivation for the organisation (*why do you want to work for us*?) and being able to express your own professional goals (*where do you want to be in 3 years*?). These three should line up. Desirably one's own professional goals are in line with the mission of the organisation.

Having the required technical skill set. Technical skills involve the ability to use methods and techniques to perform a task. Employers are looking for a candidate with a specific specialisation or specific degree or a previous work experience in a specific field of activity (R&D, marketing, sales, etc.) and sector. They want to be convinced that new employees will be able to do the job content wise.

For example QA professionals are usually life scientists, often with a postgraduate degree in quality management and with previous experience in an operational function in the pharmaceutical sector.

Being able to illustrate your interpersonal skills. Interpersonal skills involve to the ability to understand, communicate and work well with individuals and groups through developing effective relationships. Employers often refer to this as having the 'right attitude'. They want to learn about the candidates' positive and negative sides and how they cope with difficult situations at work, for example, *how do you solve problems or deal with conflicts*? Employers want to avoid hiring staff that are not a good match with the team. Employers will verify this by asking questions with regard to soft skills (*what is your role in a team, tell us a bit more about your communication skills, we are looking for somebody with proven leadership skills, etc*.).

9.2. Tips and tricks for a cover letter

The cover letter functions to express motivation and qualifications for the job.

- It is important to be concise and not too long (not more than one A4-page).
- Make an overview of the required hard and soft skills of the job advertisement.
- As a recent graduate you may not have all the required skills. You can still apply when covering 70–80% of all skills required.
- Make sure that the cover letter mentions all the hard and soft skills that you have.
- Use as much as possible the labels that are used in the job advertisement.
- With regard to the soft skills: describe a few activities in your current work or projects that illustrate your roles and results.
- Make clear what is important to you in your work (your professional goals) and how this links to the job content and the goals of the organization.
- Highlight those qualifications that make you an outstanding candidate.
- Use strong wording (not I think or I believe) and don't make interpretations for the jury.

9.3. Tips and tricks for a curriculum vitae (CV) or resume

- Again employers look for motivation and skills, make sure that you illustrate both in your CV.
- The work experience section is most important, describe all your roles and quantify the results. Also include relevant extracurricular activities and internships.
- You may include your motivation by adding a short elevator pitch (*summary/professional goals*) in your personal data section at the beginning of your CV. By doing so, employers know what you are heading for.
- Your CV should be in line with your LinkedIn profile and other open sources available on the Internet with regard to your profile (Twitter, Facebook, Research gate, etc.).

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- Be short and concise (max. two A4-pages).

9.4. Tips and tricks for a job interview

- The purpose of a job interview is to sell yourself and receive a job offer.
- A job interview starts with introducing yourself: prepare an elevator pitch.
- With regard to motivation: formulate what you can add to the organisation, not what is in it for yourself.
- Your body language is very important. Talk slowly, look into the eyes of all the jury members, give a firm handshake and have a confident look.
- Stay cool during a job interview; do not get irritated, even if the jury asks you confronting questions.
- Prepare three examples of your biggest achievements in your work, studies, or extracurricular activities that you can use to illustrate your skills. Describe the context, your role, the activities that you initiated and the results.
- Make sure that you can reflect on your results. Employers love employees who are open for criticism and want to improve continuously.
- Prepare three positive sides and three negative sides. Explain how you cope with your downsides.
- Many tricky questions are another way of checking again on your motivation and qualifications for the job. Just repeat what you have been saying in a nice way.
- Never discuss money or benefits before you are offered a job.

10. Conclusion

Our writing of this chapter is based on the notion that a successful launch of a career in the pharmaceutical sector depends on an overall knowledge of this sector and on a smart strategy for job application. Besides these two key elements, many companies recruit via their traineeship programs as discussed in Section 7. One should realise that also in this sector, the vast majority of jobs are never advertised. For this reason, training and networking is indeed a far more effective job-seeking strategy than screening magazines and websites for advertisements. This partly hidden job market also implies that the first step from academia to the pharmaceutical sector is often experienced as the hardest and most important one; it will determine your direction and your differentiation as an employee. At the same time, you will access a new network of professionals with its own word-of-mouth that can become vital for your next career moves.

Besides all the aspects already treated in this chapter, there are only a few closing remarks left, worth to take into account. Jobs in the pharmaceutical sector often come in location-related

clusters in Europe. These so-called research parks are often located near international research-oriented universities, where graduates are directly available for recruitment purposes. When new centres are opened, often several jobs are available, even if you can only apply for one at the time. One should realise that these new centres could only become successful when the vacancies are rapidly filled and the industrial annual targets are reached in that specific location. If vacancies stay open too long, the company will most likely move to another location. This implies that research and development hot spots in, for example, Europe can compete with each other through the speed they reach in filling their vacancies and grow more successful as a site. For this reason, it is very important for academic graduates with the right qualifications to be willing to move to a new national or international location, to fill that vacancy that perfectly matches their particular hard and soft skills and become employed in a larger R&D hotspot that might also offer perspectives for additional career moves in the future. It requires some additional study and networking to become aware of the upcoming hotspots relevant for your particular area of interest.

A last reflection is about the important work versus private life balance. If you talk to successful people in the pharmaceutical sector, you will often quickly discover that they really love their job and that, as a consequence, they work a lot. This does not mean that they have squeezed their family life to a minimum, but there are positions in this sector that simply demand more than just the regular office hours. Companies may differ in their philosophies about the work-life and gender balance and it can be an advantage to know their general view about this.

Further improvement of human health largely depends on the development of new methods in prevention, early diagnosis and treatment of disease. An input of new knowledge from young employees with fresh inspiration and energy to achieve this goal is vital for the pharmaceutical sector. With this chapter, we hope to have opened the door and lowered the threshold to enter an exciting world of opportunities.

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