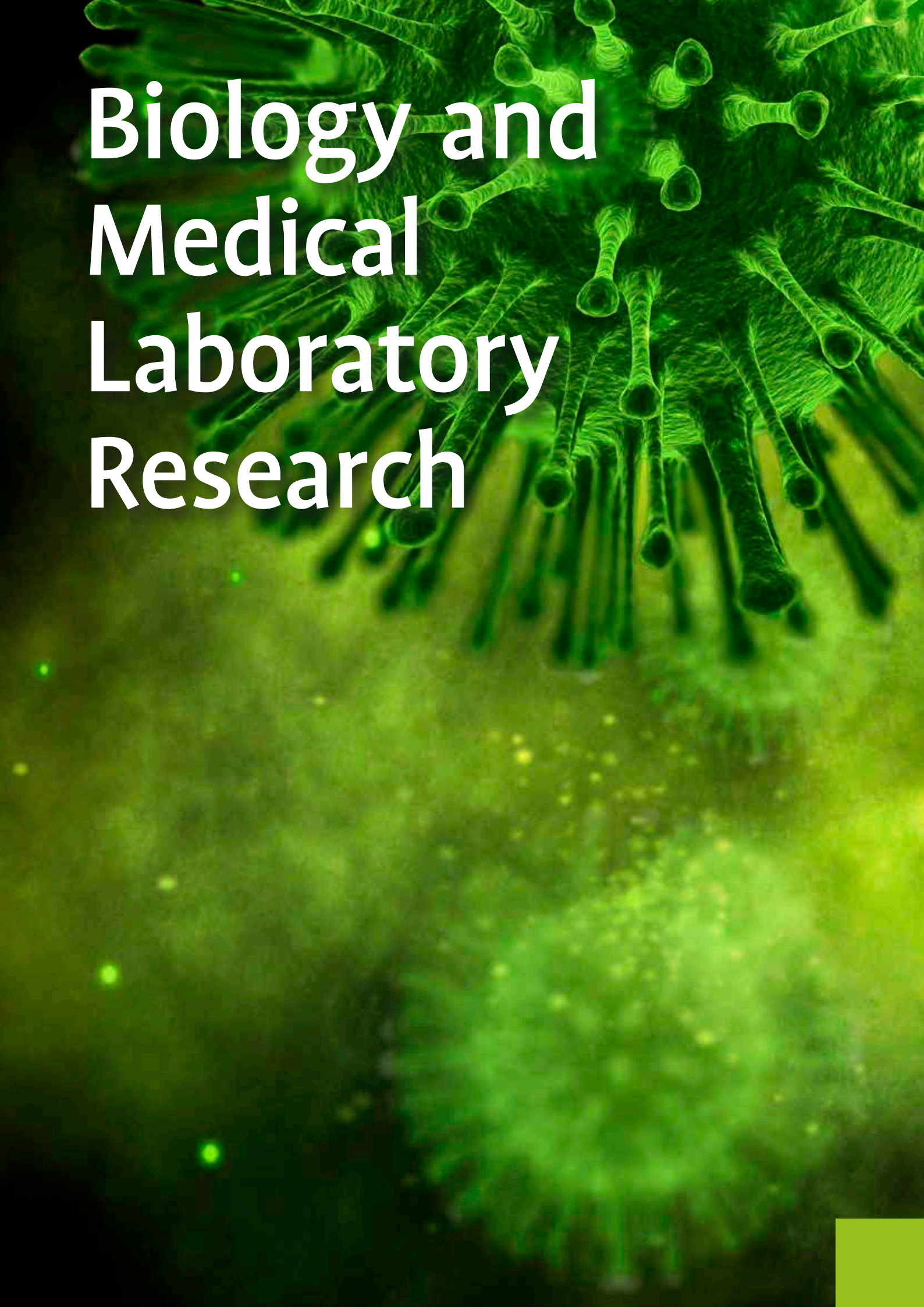
Biology and Medical Laboratory Research



BIOLOGY AND MEDICAL LABORATORY RESEARCH is a programme that trains students to work as research staff in a laboratory. The key element is biology as referred to by the term Life Sciences, a wide-ranging course in molecular biology focusing on research into bacteria, plants, animals and humans.

The course started out as two programmes and this division is still apparent in the main professional domains, with biological research and development on the one hand and medical laboratory diagnostics on the other.

As a researcher, the graduate is involved in developing new products, materials, methods and processes or improving existing ones, particularly in the pharmaceutical and food industries, academic research groups, research institutes and crop breeding and protection. Graduates participate unsupervised in research teams. They develop and build an experimental test setup, conduct and interpret experiments, draw conclusions and make recommendations. In smaller organisations, the approach is often more hands-on, with the graduate also being responsible for organising, coordinating and directing the work.

Diagnostics laboratories in the health sector conduct research into material of human (or sometimes animal) origin. These are usually laboratories working in the fields of clinical chemistry, medical microbiology, cytohistopathology, haematology, immunology, endocrinology or clinical genetic research. Working as researchers, graduates help to find answers to clinical questions by applying scientific methods of analysis in the diagnosis, treatment and prevention of disease. They work throughout the sampling process and it is therefore important for those occupying this post to accumulate the knowledge and understanding required to include clinical data in the performance and interpretation of the research and to make connections between medical issues and (provisional) research results. The great diversity of analyses, ranging from manual to fully automated and robotised analyses, requires versatility and the effective deployment of technologies, equipment, IT and quality assurance. In a laboratory setting, graduates can progress to specialist and/or management roles.

Institutions that offer the programme

- Avans University of Applied Sciences, Breda
- HAN University of Applied Sciences, Nijmegen
- Hanze University of Applied Sciences, Groningen
- HU University of Applied Sciences, Utrecht
- Inholland University of Applied Sciences, Amsterdam
- NHL Stenden University of Applied Sciences, Emmen
- NHL Stenden University of Applied Sciences | VHL University of Applied Sciences, Leeuwarden
- Rotterdam University of Applied Sciences
- Saxion University of Applied Sciences, Deventer
- Saxion University of Applied Sciences, Enschede
- University of Applied Sciences Leiden

National programme profile

	Competence							
	Research	Experimentation	Development	Management	Advice	Instruction	Leadership	Self-management
Minimum national attainment target adopted for the programme	**II***	**III**	**_****	**I***	**I***	**I***	**I***	**II**

* At least one of these competences must be raised by one level.
** Students can choose to raise the level of these competences by making certain choices in their range of subjects, internship and graduation project during the last two years of their course.

ILLUSTRATION OF PROFESSIONAL FIELD

Occupations, jobs and roles for graduates are mostly to be found in the following professional domains (for a full description of the professional domains, see Section 2). A few examples are given for each domain.

Research and development
- Laboratory researcher
- Animal testing worker
- Vaccine development

Medical laboratory diagnostics
- Analyst in hospital or diagnostic centre
- Introducing new diagnostic tests
- Developing test methods

Application and production
- Quality assurance in food industry
- Small-scale production of drugs

Biology and Medical Laboratory Research

KNOWLEDGE

- **Cell biology:** structure and function of eukaryotic and prokaryotic cells, metabolism, transport
- **Chemistry:** basic chemistry (atomic structure, reactions in water, kinetics), analytical chemistry (spectroscopy, chromatography), organic chemistry (functional groups)
- **Biochemistry:** biomolecules, protein and enzyme chemistry
- **Molecular biology:** DNA, heredity, molecular genetics, recombinant DNA, simple bio-informatics
- **Anatomy/physiology/pathology:** structure and function of organ systems, blood, endocrine system etc., for research and diagnostics (clinical chemistry, haematology)
- **Immunology:** innate and acquired immunity, molecular mechanisms, practical applications
- **Microbiology:** growth and classification of micro-organisms, pathogenetic mechanisms, infectious diseases, resistance
- **Mathematics:** chemical calculations, functions (differentiating, integrating)
- **Statistics:** data processing, normal distribution, confidence intervals, testing

SKILLS

- **General laboratory skills based on GLP rules:** weighing, pipetting, making solutions (buffers, culture media) and preparations, colourings, microscopy, lab journal, chemical calculations
- **Safe working in the laboratory, working in accordance with GMT rules (good microbiological techniques):** working in aseptic conditions, culturing micro-organisms and eukaryotic cells, working with special media, biological materials (tissues, cells, etc.) and biomolecules (proteins and/or antibodies, DNA)
- **Using standard laboratory equipment:** pH meter, spectrophotometer, centrifuge, power sources, electrophoretic equipment, fume cupboard, safety cabinet, microscope
- **Molecular-biology techniques:** DNA/RNA-isolation, digestion, ligation, transformation, PCR, gel electrophoresis
- **Chemical analysis methods:** spectrometry, chromatography, enzyme analysis, bonding analysis
- **(Bio)chemical procedures:** fractionation methods, SDS-PAGE, blotting, preparative chromatography
- **Computer skills:** spreadsheets, slide presentations, bio-informatics tools, simple imaging
- **Social and communication skills:** collaborating, meetings, reporting (lab journal, research report), presentation, project-based work, ethics
- **Research skills:** problem analysis, research questions, desk research, research planning and implementation

The Body of Knowledge and Skills is a summary of graduates' basic knowledge and basic skills which has been prepared by the HBO-programmes in consultation with the professional field. These are obtained during the first two years of education.

TYPICAL TEXTBOOKS

- *Campbell Biology,* L.A. Urry, M.L. Cain e.a.
- *Medical Microbiology,* P.R. Murray, K.S. Rosenthal e.a.
- *Biochemistry,* J.M. Berg, J.L. Tymoczko e.a.
- *Chemistry,* J.E. McMurry. R.C. Fay e.a.
- *Molecular Cell Biology,* H. Lodish, A. Berk
- *Immunology,* D. Male, S. Peebles e.a.
- *Brock Biology of Microorganisms,* M.T. Madigan, K.S. Bender e.a.
- *Bacteriologie voor laboratorium en kliniek,* N.M. Knecht, J. Doornbos
- *iGenetics,* P.J. Russel
- *Toegepaste Wiskunde voor het hoger onderwijs,* J.H. Blankespoor

The list of typical textbooks serves as an illustration to give an impression of the level at which the subject is taught in the study programme.

Junior scientist Romy Waber:

‘You acquire real expert knowledge while you work’

Name: Romy Waber
Age: 22
Course of study: Biology and Medical Laboratory Research
Place of employment: PathoFinder BV, Maastricht
Job: Junior scientist

‘I was interested in biology from an early age and found DNA in particular extremely interesting. At the end of my senior secondary education, my subject cluster project was: CSI, what’s true and what’s not? At the time, we had the opportunity to do the practical work at Zuyd University of Applied Sciences, where I encountered pipettes, test tubes and of course DNA technologies for the first time. I thought this was so interesting and enjoyable that I decided to delve more deeply into biochemistry.

The programme met my expectations, although I thought the first year in my department was somewhat wide-ranging. I knew for sure that I wanted to go further in biochemistry and therefore found subjects like chemical engineering and process technology less interesting, although I did of course understand that a wide-ranging course can be very useful. I wanted to know more about DNA, RNA, PCR and real-time PCR but we only got the basics at university. I therefore went in search of an internship which offered a lot in terms of DNA and RNA technologies and ended up at PathoFinder: a young company which does a lot of research into the development of new molecular diagnostics. It’s not only conventional methods that are used, new technologies are also designed and tested there.

As a junior scientist at PathoFinder, I am jointly responsible for developing a point-of-care instrument for diagnosing highly contagious respiratory pathogens, resistance patterns and biomarkers. We are also developing a new generation of molecular diagnostics focusing on the rapid detection and identification of human pathogens caused by an infection. PathoFinder uses multiparameter analysis technologies which are designed to perform analyses of highly complicated samples quickly and easily. As far as I am concerned, education and work fitted seamlessly together, especially as I had completed an internship at the company. You mostly learn general theory during the programme but I think you acquire real specialist knowledge while you work.

I do of course need the competences of **research** and **experimentation** a lot because I am employed in the Research and Development department. **Development** is another important competence. PathoFinder is an ISO 13485 certified company and **management | coordination** is therefore also a frequently used competence.

Further study

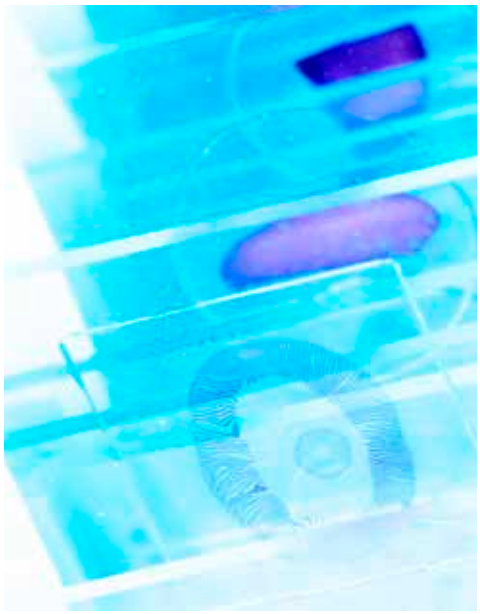
Over the next few years, I intend to study the various technologies in depth to give me a greater feel for the subject. I would also like to continue participating in international projects so that I can acquire knowledge of other companies and get to know more people in the world of molecular diagnostics. I would like to continue working at PathoFinder or its sister company PathoNostics so that my colleagues and I can put even better and even more products on the market.’ ■

General analyst Joyce Scheerman:

‘Theory provides a solid foundation’

‘Chemistry and biology were my favourite subjects at secondary school. The school counsellor advised me to do a laboratory course. After attending an open day, that seemed to be a good idea. Fortunately, biology and medical laboratory research did indeed turn out to be a very enjoyable and interesting course. I decided to specialise in cyto-histopathology because I used to get good marks for that subject and the specialisation has a lot to do with the human body, which is what attracted me.

My current job involves processing tissues sent in by the hospital and external parties (general practitioners and clinics) so that the pathologists can examine them under the microscope. This means that the samples are assessed macroscopically in the cutting room to ascertain which areas are relevant for making a diagnosis. These areas are excised and processed in a machine to become a paraffin block. Very thin slices are cut from these blocks containing tissue and pasted on to a glass slide. The tissue is coloured (HE). It can then be examined by a pathologist. Further (additional) research can also be carried out on the paraffin block.



The theory part of my programme provided a solid foundation for the work I do now. On the other hand, the practical lessons were minimal in terms of histology and were actually somewhat outdated. During my internships I only used histology techniques for research purposes. Compared with a senior secondary vocational student, higher professional students know little about the practical side of diagnostics. When I came to work in the pathology department at VUmc, I had no idea of what went on in the cutting room.

Various competences

We follow Standard Operating Procedures (SOP) in our work. If we want to change procedures or if, for example, new colourings or pieces of equipment are being used, the competence of **experimentation** is of major importance. Coincidentally, the **development** competence is playing an important role at the moment. This is because we have been involved with **lean management** in the department for a little while. We also use this competence when new equipment is introduced. It is always validated in accordance with a protocol and if necessary a new protocol is written or existing protocols are amended.

We use a number of management systems (chemicals management, quality management, incidents), so I also need the competence of **management**. **Instruction** is also involved in terms of familiarising new staff and supervising interns. The competence of **self-management** also comes into play, as we all work independently and in a group.

In future, I hope to be able to work in a different unit (e.g. molecular biology) within the pathology department and combine this with histology. Maybe I will be able to follow an internal study programme. There are plenty of opportunities!’ ■

Name: Joyce Scheerman
Age: 24
Course of study: Biology and Medical Laboratory Research
Place of employment: VUmc, pathology department, histology unit
Job: Histology general analyst

Lean management is a series of methods and techniques for reducing throughput times of processes and cutting costs without compromising on quality.