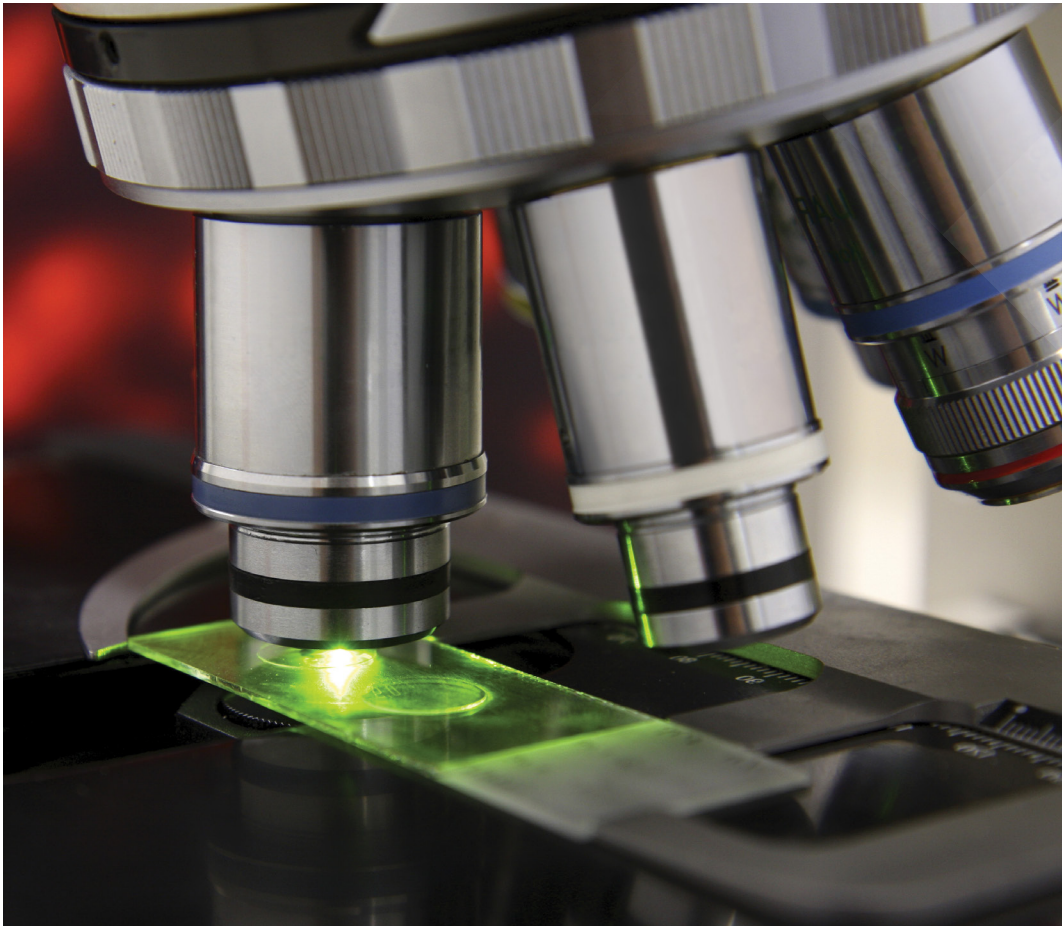
University of Otago

MEDICAL LABORATORY SCIENCE
INFORMATION BOOKLET



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The Bachelor of Medical Laboratory Science

We offer one undergraduate qualification: the Bachelor of Medical Laboratory Science (BMLSc). This course requires four years of full-time study.

Year one is the competitive Health Sciences First Year course, also taken by those wishing to enter Medicine, Dentistry, Pharmacy or Physiotherapy. It must be taken on-campus at the University of Otago in Dunedin.

Years two and three are also spent studying full-time in Dunedin. Papers are taught by the Otago School of Medical Sciences and the Dunedin School of Medicine.

Year four consists of two semesters in selected medical laboratories in New Zealand or overseas. Overseas placements are currently available in Sydney, Australia and Copenhagen, Denmark. Students gain work experience while taking part in academic courses taught by distance from Dunedin.

There are a variety of career opportunities for graduates. Around 70% of graduates choose to work for at least six months in diagnostic medical laboratories. This is necessary to fulfil the requirements for registration as a medical laboratory scientist. The Medical Science Council of New Zealand accredits the Otago BMLSc degree and is responsible for registration in the profession.

Medical Laboratory Science Sub-Disciplines

Medical laboratory science consists of a number of sub-disciplines (listed below). The Otago BMLSc programme covers all these sub-disciplines in years two and three of the degree. For fourth year, you will choose two sub-disciplines to study in your clinical placements in community or hospital diagnostic laboratories.

Chemical Pathology

Overview

Chemical pathology is the study of chemical and biochemical mechanisms of the body in relation to disease, mostly through the analysis of body fluids, such as blood or urine. In many diseases there are significant changes in the chemical composition of body fluids such as raised blood enzyme levels due to their release from heart muscles after a heart attack, or a raised blood sugar level in diabetes mellitus due to lack of insulin. Tests are designed to detect these changes qualitatively or quantitatively compared to results from healthy people.

Chemical pathology includes:

- General or routine chemistry – commonly ordered blood chemistries, e.g. electrolytes, blood gases, lipids, liver and kidney function tests
- Special chemistry – elaborate techniques such as electrophoresis, and manual testing methods
- Clinical endocrinology – the study of hormones, and diagnosis of endocrine disorders
- Toxicology – the study of drugs of abuse and other chemicals
- Therapeutic drug monitoring – measurement of therapeutic medications blood levels to optimize dosage
- Urinalysis – chemical analysis of urine for a wide array of diseases, along with other fluids such as CSF and effusions
- Fecal analysis – mostly for detection of gastrointestinal disorders

These tests are important in the diagnosis of health issues such as kidney failure, heart attacks, infections, infertility, diabetes and high cholesterol. Screening for genetic abnormalities and illegal drug use are also carried out in the chemical pathology laboratory.

Teaching in chemical pathology

You will begin to develop complex practical and interpretive skills required for chemical pathology. Practical skills you will learn begin with manual techniques progressing through to operation and management of highly automated testing systems. You will learn how to monitor and quality-control assays to maintain the integrity of the results produced.

Interpretation and reporting of laboratory results requires knowledge of human pathology and the effect of disease processes on the chemicals being measured. You will gain this knowledge throughout the course of the BMLSc degree. You will be taught how to integrate this knowledge with an understanding of the analytical techniques, including limitations.

Cytology

Overview

Cytology is the study of cells from the body. These cells are obtained by either spontaneous exfoliation into a body fluid or by physical exfoliation. Cells are prepared onto glass slides and stained to allow for visualisation using the light microscope. The role of the scientist is to prepare and examine these slides to detect and differentiate pre-malignant and malignant (cancer) conditions from non-malignant (non-cancer) conditions. They work with cytopathologists to provide a diagnosis.

The diagnosis of cytology samples is an important part of the clinical pathway as it provides clinicians with information to treat and manage a patients disease, or exclude the presence of a disease. Cytology is a challenging and rewarding career and offers a hands-on approach to medical testing.

Collection of samples

Specimens for cytology are generally categorised into gynaecological specimens and nongynaecological specimens. Gynaecological samples include cervical smears, which comprise the majority of the daily workload for the scientist.

Cervical cytology is part of the National Cervical Screening Programme. It involves the screening of cervical smears for the early detection of cervical cancer and its precursor lesions. Nongynaecological samples include specimens from the respiratory tract, urinary tract, body cavities and lumps from the body (sampled by fine needle aspiration). Examples include breast, lymph node and thyroid samples.

Preparation and testing of samples

There are a number of methods used in the preparation of cytology samples. Medical laboratory scientists must evaluate both the samples and accompanying clinical information, and apply the most appropriate method to provide optimal results. Adjunct testing can also be utilised, including immunocytochemistry and molecular testing.

Cervical cytology has advanced over the last 15 years and many laboratories are using liquid- based cytology and automated screening platforms for cervical screening. This automation provides location-guided screening, assisting the scientist to identify areas of the slides that could potentially harbour abnormal cells. These areas are then evaluated by the scientist using the light microscope. Other advances include automated preparation and staining machines. Despite these advances, cytology still requires a large degree of manual benchwork, particularly microscopy.

Teaching in cytology

In addition to learning about the different diseases in which cytopathology plays an important role, you will learn how to process and stain samples to differentiate between normal and abnormal cells.

Haematology

Overview

Haematology is a core discipline in pathology, and is represented in practically all pathology departments. The discipline consists of three main areas: blood counts, blood morphology and haemostasis. Each of these areas employs a range of different skills and techniques, which are taught in the Bachelor of Medical Laboratory Science programme.

Blood counts

In blood counts, the numbers and physical characteristics of blood cells are measured and logged by automated analysers using combinations of electrical detection and flow cytometry. But even though laboratories are becoming increasingly automated, automation is only as good as the skill of the operator allows.

Haematology is no exception and the knowledge you gain will help you to be confident that you are releasing reliable results. It's important that you know the manual techniques underpinning the automation, so you will also learn these as part of the course.

Blood morphology

Variation in blood count results provides important diagnostic information, and a percentage of samples are forwarded for further investigation in blood morphology – especially when significant abnormalities are suspected and need to be confirmed. Here, thin smears of blood are stained, and the blood cells are manually examined under the light microscope.

Haemostasis

Haemostasis is concerned with the functioning and control mechanisms of blood coagulation. This includes areas as diverse as the monitoring of patients' therapies, to detection of dangerous conditions such as coagulopathies and clotting tendencies. Plasma proteins and platelets function together in a highly complex and dynamic system, making this a challenging and fascinating area in which to work.

Teaching in haematology

You will learn both the theory and practice of haematology, with an emphasis on the principles underlying diagnostic techniques. The basic foundation of knowledge you will gain will enable you to distinguish between normal and abnormal test results. The teaching you receive is just the foundation for competency in blood morphology: continuous learning and review are a feature of this area, making it constantly challenging and interesting.

Histology

Overview

Histology involves the microscopic study of tissues. It incorporates both the technical procedures used to prepare tissue, so that it is suitable for observation on a microscope, and the actual process of observing the tissue under magnification.

Histology is used in diagnostic and research settings for the study of human or animal tissue samples, including autopsy and forensic specimens, to gain a better understanding of biological processes. It is one of the least automated disciplines and is challenging from both an academic and practical perspective.

Diagnostic techniques

Fixation, processing and sectioning are the first three steps towards getting a diagnosis.

Fixation: Fixation of tissue is required to preserve the tissue in as lifelike a manner as possible. All aspects of fixation are covered including what type of fixative is needed for different types of tissue, or freezing of tissue when chemical fixation is not suitable or for specimens requiring an urgent diagnosis.

Processing: Processing involves taking tissue from a fixed state to a point where it is of sectioning consistency usually by impregnation with wax or resin. Finally the tissue is sectioned on a microtome to produce very thin sections, which are mounted on a microscope slide.

Staining: Staining is one of the most critical aspects in the diagnosis of tissue sections and in our course we cover dye staining, histochemical staining, enzymatic staining and immunohistochemistry (antibody/antigen reactions) which are all designed to differentiate specific elements within the tissue.

Molecular techniques: With the advent of molecular biology techniques, histology scientists also carry out molecular techniques such as in-situ hybridisation, to identify specific proteins, hormone receptors, viruses and enzymes in tissues, which enhance both the diagnosis and the treatment of the patient.

Teaching in histology

You will learn to fix, cut and stain your own tissue sections as well as exploring the diseases in which histology is an important part of patient diagnosis, such as cancer, infection and autoimmune disorders.

Immunology

Overview

Immunology is fast becoming an important discipline in medical laboratory science. The diagnostic immunology laboratory provides information about patient status through the testing of clinical samples, particularly blood and serum. Diseases that can be detected using immunological techniques include allergies, immune deficiency, autoimmune diseases and a range of infectious diseases.

Instead of isolating and identifying microbial pathogens (which takes place in the microbiology laboratory), infection is inferred by the presence of antibodies in the patient's serum or changes in prevalence of different white blood cell types.

Diagnostic techniques

Techniques that are used in the diagnostic immunology laboratory range from fairly simple procedures, with the use of antibodies coupled to fluorescent dyes or enzymes, through to more sophisticated techniques such as flow cytometry, where lasers are fired at individual cells (e.g. white blood cells) labelled with fluorescent dyes in order to characterise the population. This technique can be used to monitor the success of treatment in patients suffering from HIV infection.

Many immunology laboratories are also able to quantify viral load in clinical samples using quantitative polymerase chain reaction. This is particularly useful for assessing patients infected with hepatitis viruses. In the diagnostic immunology laboratory, quality control and interpretation of results are essential functions and many techniques are now automated.

Teaching in immunology

The teaching you receive initially in the medical laboratory science course will provide you with a basic understanding of the function of the innate and adaptive immune systems and some of the problems that can arise. Later in the course you will receive further teaching in autoimmunity, allergy, immune deficiency and other diseases affecting the immune system.

You will be taught basic immunology laboratory techniques that will provide the background required to enter the hospital diagnostic immunology laboratory in the fourth year of the course.

Microbiology

Overview

Microbiology is an essential discipline in Medical Laboratory Science. The diagnostic microbiology laboratory is responsible for detecting and identifying disease-causing microbes in clinical samples and, where appropriate, testing for susceptibility of the microbes to antimicrobial agents. Clinical samples commonly examined in the microbiology laboratory include urine, stool, sputum, skin,cerebrospinal fluid and blood.

The diagnostic microbiology laboratory enables clinicians to make accurate diagnoses and provide the correct treatment for patients, thus saving lives.

Diagnostic techniques

Initially, clinical samples may be viewed under a microscope, following Gram or other staining methods, to gain an indication of the types of human cells present (e.g. red and white blood cells) as well as other structures such as fungal elements. Traditional culture methods, in which the microbes are isolated in pure culture, and DNA-based methods, such as the polymerase chain reaction, are the mainstay of diagnostic techniques.

In health, humans are colonised by a large number of different species of bacteria and yeasts, and considerable skill is required in deciding which microbes are causing infection and which are normally present. Susceptibility testing is routinely performed on infecting bacteria following culture of the organism from a clinical sample. This is achieved by measuring the activity of the antibiotic against the bacteria. Recent advances in medical microbiology include the use of automated and semi-automated systems.

Hard to grow bacteria and viruses are often detected using nucleic acid-based tests, such as PCR, which amplifies a segment of a gene unique to the species.

Teaching in microbiology

The teaching you will receive in the medical laboratory science course will provide the background you need to enter the hospital diagnostic laboratory. You will be equipped with knowledge of both disease-causing microorganisms and those present in health. You will be taught the basic techniques required for safe handling of microbes.

You will have the opportunity to culture and identify microbes using a variety of traditional and modern techniques, and you will learn how to carry out tests for antimicrobial susceptibility.

Molecular Diagnostic Pathology

Overview

The field of molecular diagnostics has grown rapidly over the last twenty years and will continue to do so for the foreseeable future. The basic techniques used in molecular diagnostics are now being introduced into most of the other medical laboratory science disciplines; hence most of the methods learned in this course will also be invaluable in other laboratory settings.

Molecular diagnostic tests are important in the diagnosis of gastrointestinal infections and respiratory infections such as SARS (Severe Acute Respiratory Syndrome) caused by the epidemic Coronavirus COVID-19. Molecular tests are helpful in the diagnosis and treatment of non-infectious diseases such as cancer and congenital abnormalities.

Applications of diagnostic molecular pathology

These techniques and the theoretical knowledge are also extremely portable and have much wider application than just a medical laboratory.

Your practical know-how could also see you working in a university or industrial research laboratory, a government agency or in the private sector.

Teaching in molecular diagnostic pathology

As this is still a young discipline it remains relatively "hands-on". You will learn the theory behind the methodologies used in diagnostic molecular pathology, while also being provided with in-depth practical experience in these techniques.

You will enhance and expand your knowledge in areas such as polymerase chain reaction and DNA extraction to include restriction enzyme digestion, Sanger and high through-put sequencing, cell culture, real-time PCR, FISH and karyotyping.

You will learn the concepts and principles of this subdiscipline in year two. In years three and four of the BMLSc, you will be taught about the applications of molecular diagnostics as they apply to the different sub-disciplines.

Patience, the ability to listen and also question are very useful skills for this subject, along with a steady hand!

Transfusion Science

Overview

Haematology and transfusion science are closely-related career fields in pathology. Both are focused broadly on teamwork in the health care sphere, and on science and data management, and involve continuing change as new tools and methods are introduced. Haematology scientists work with the cells of the blood and assessment of bleeding and clotting.

Transfusion science has developed from being a part of haematology into a major specialty on its own that is closely linked to both health care and the medicines manufacturing industry.

It deals with collection, testing, production and supply of the unique range of biological medicines made from blood and used in clinical transfusion.

Transfusion science in New Zealand

Transfusion science in New Zealand operates primarily through the New Zealand Blood Service (NZBS) and partly through pathology laboratories that operate blood banks in secondary hospital centres. Blood bank staff throughout New Zealand are a large group of medical laboratory scientists who are responsible for blood grouping and antibody screening and specialised tests to identify antibodies so that safe, compatible transfusions can be provided.

Specialised testing for blood groups and antibodies is also carried out by pathology laboratories throughout New Zealand for pregnant women and occasionally other specialised tests.

The medical laboratory scientists of NZBS have a wide range of roles. In blood banks and donation testing laboratories the work is focused on blood grouping and antibody detection so that compatible blood transfusions can be provided.

Other laboratories are involved in processing blood and specialised plasma donations to manufacture the large range of blood components and products needed throughout New Zealand.

Senior scientists play an important role in supervision of this work, quality monitoring, specialised testing and developmental work.

Teaching in transfusion science

In addition to learning the theory of transfusion science, you will have the opportunity to perform tests carried out in hospital laboratories in order to identify whether donated blood is compatible with a patient's own blood. You will become familiar with the procedures for processing donated blood to provide a range of transfusion products and accrediting donated blood to ensure it is safe for transfusion.

Virology

Overview

Virology is a specialist discipline in medical laboratory science. Diagnostic virology laboratories are responsible for the detection and identification of viruses in clinical samples. As well as assisting clinicians to make correct diagnoses, the virology laboratory gathers information that can be used for infectious disease surveillance purposes.

Many different viruses can infect humans; some important ones are influenza virus, human immunodeficiency virus, norovirus and rotavirus.

The distinction between bacterial and viral infections is an important one, because the antimicrobial treatments are different, so the diagnostic virology laboratory fulfils an important role in guiding clinicians to the correct type of treatment.

Methods of isolating viruses

Traditional methods of isolating viruses from clinical samples through the use of human and animal tissue culture cell lines are gradually giving way to modern nucleic acid techniques, so that the polymerase chain reaction is now important in viral diagnostics.

Other methods that are used include antigen detection tests, where components of a virus are detected in a clinical sample.

Enzyme immunoassays (EIA) are important because these have the ability to detect viral components as well as viral antibody, which is formed in the blood in response to a viral infection.

Immunofluorescence involves the use of specific antibody bound to fluorescent dyes for the identification of viruses.

New viruses are still being discovered and electron microscopy (EM) is a basic technique for visualising and describing new viruses. However, the high cost prohibits the routine use of EM in the diagnostic virology laboratory.

Teaching in virology

In year two of the medical laboratory science course you will learn about the structure and classification of viruses, their replication cycles and methods of control, such as vaccination.

In year three, you will receive basic training in virology techniques including PCR, EIA, tissue culture, and preparation of samples for electron microscopy.

These techniques – along with lectures on specific viral pathogens – will provide the background you need to enter the hospital diagnostic virology laboratory in the fourth year of the course.

Admission to BMLSc

Entry to the medical laboratory science programme is most commonly gained by first enrolling in the competitive **Health Sciences First Year** programme (HSFY). This will be your first year of university study. There are other ways to gain admission; for example, you can apply as a graduate or after two or more years of university study.

Admission to year two classes in medical laboratory science is determined by the admissions committees. An application for admission to the second year of the BMLSc degree must be submitted in the year preceding that to which admission is sought (usually by mid-September). You will be informed of the dates when the admissions portal will be open by the admissions office.

In order to be admitted to the year two of the degree, it is expected you will have achieved HSFY with an overall average B- grade (65%).

The Division of Health Sciences website (otago.ac.nz/healthsciences) has further information on Health Sciences First Year and admission to the Bachelor of Medical Laboratory Science Programme. Admissions regulations are also set out in the University Calendar.

BMLSc programme

Year	Papers	Points
Year 1	Health Sciences First Year	126
	Note: I. Students enrolled in Health Sciences First Year will be required to achieve a satisfactory mark in a standard diagnostic English test or another approved measure of achievement. II. No student will be permitted to take an examination in a subject of the first year course in which a pass has already be gained.	
Year 2	MELS 208 Introduction to Diagnostic Pathology	45
	MELS 223 Infection and Immunity (for BMLSc)	18
	MELS 230 Biochemistry (for BMLSc)	18
	MELS 241 Human Biology: Cells to Systems (for BMLSc)	18
	MELS 251 Physiology (for BMLSc)	21
Year 3	MELS 301 Diagnostic Chemical Pathology	30
	MELS 302 Haematology and Transfusion Science	30
	MELS 304 Principles of Pathology	15
	MELS 305 Elements of Histotechnology	15
	MELS 306 Medical Microbiology	30
Year 4	*Two of:*	60
	MELS 401 Advanced Diagnostic Chemical Pathology	
	MELS 402 Clinical Microbiology	
	MELS 403 Clinical Virology	
	MELS 404 Diagnostic Molecular Pathology	
	MELS 405 Cytopathology	
	MELS 406 Haematology	
	MELS 407 Histopathology	
	MELS 408 Transfusion Science	
	MELS 409 Clinical Immunology	
	MELS 410 Medical Laboratory Science for Rural Health	

Careers in Medical Laboratory Science

There are a number of career opportunities open to BMLSc graduates.

As a medical laboratory scientist you may be based in a hospital laboratory providing urgent and routine laboratory results to A&E, intensive care, surgery, clinics and ward staff. Medical laboratory scientists can also be found in community laboratories, where they enable general practitioners to make correct diagnoses through providing accurate test results.

From medical or industrial research laboratories to forensic and pharmaceutical laboratories, University of Otago medical laboratory science graduates' analytical, scientific and practical skills are a valuable asset. Your theoretical knowledge of human disease and diagnostic testing may set you on a route to a career outside the laboratory also.

If you are considering applying as a graduate for entry into medicine, the BMLSc is an ideal first degree to take. With its focus on pathology and diagnostics, it provides both a foundation for the medical degree and advanced knowledge in the area of laboratory diagnostic testing.

These are examples of career choices made by some of our former graduates:

- Medical laboratory scientist in a hospital or community based laboratory
- Medical laboratory scientist responsible for point-of-care diagnostic testing and validation
- Veterinary pathology laboratory scientist
- Forensic biologist
- Information technologist – development of diagnostic health information systems
- Public health and infection control researcher
- Medical research scientist
- Research scientist for pharmaceutical company
- Sales and marketing representative for scientific supply company
- Research scientist – product development for scientific supply company
- Technical support staff for scientific supply company
- Scientist based in a biotechnology company
- Mortuary assistant – assisting at post-mortem examinations
- Clinician – following successful graduate entry and completion of degree in medicine

Postgraduate Study

www.otago.ac.nz/courses/qualifications/pgdipmlsc
www.otago.ac.nz/courses/qualifications/mmlsc

Postgraduate degrees available in Medical Laboratory Science are:

- *Postgraduate Diploma in Medical Laboratory Science (PGDipMLSc)* – 1 year full-time
- *Master of Medical Laboratory Science (MMLSc)* – 1 year full-time
- *Doctor of Philosophy (PhD)* – 3 years full-time

You can study part-time for these postgraduate degrees.

Notes

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