

[National Institute for Communicable Diseases](#)

[Medical Scientist Intern Training Program – Microbiology](#)

**Introduction**

The National Institute for Communicable Diseases (NICD) provides laboratory based surveillance and diagnostic testing for diseases of public health importance to South Africa and the Southern African region. The NICD also sends outbreak response teams to sites confronted with infectious disease epidemics. The NICD houses national and regional referral laboratories. The NICD comprises ten centres, each of which focuses on different diseases, including HIV, tuberculosis, malaria, diarrhoeal diseases and meningitis. The NICD serves as an expert authority, providing advice to Department of Health and medical practitioners. The NICD is a resource to all universities and technical colleges in South Africa, with multiple training programs in place and a strong complement of university-affiliated staff. The NICD is a division within the National Health Laboratory Service (NHLS), the national laboratory diagnostic network.

The Microbiology aspect of training includes teaching and training across various centres within the NICD: Centre for Enteric Diseases (CED), Centre for Emerging and Zoonotic Diseases (CEZD), Centre for HIV and Sexually Transmitted Infections (CHIVSTI), Centre for Tuberculosis (TB) and the Centre for Respiratory Diseases and Meningitis (CRDM).

**1. Centre for HIV and Sexually Transmitted Infections (CHIVSTI)**

The Centre for HIV & Sexually Transmitted Infections (STI) is a resource of knowledge and expertise in HIV and other regionally relevant STIs to the South African Government, to SADC countries and to the African continent at large, in order to assist with the planning of policies and programs related to the control and effective management of HIV/STIs. The Centre also aims to be a place of academic excellence in terms of both research and teaching/training. The Centre has a strong track record in the research disciplines of HIV virology, HIV immunology, HIV/STI epidemiology, HIV/STI diagnostics and HIV-STI interactions, as well as in successful supervision of PhD and MSc students.

Laboratory techniques/tests offered:

- Phenotypic identification of *Neisseria gonorrhoeae* (culture, Gram stain and biochemical tests)
- *Neisseria gonorrhoeae* antimicrobial susceptibility testing (E-Test and agar dilution)
- Phenotypic identification of *Chlamydia trachomatis* (culture and confirmatory tests)
- Nugent scoring for the diagnosis of bacterial vaginosis on Gram-stained smears
- Detection of Donovan bodies in Giemsa stained smears
- Real time molecular identification of genital discharge causing pathogens: *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, *Mycoplasma genitalium* and *Trichomonas vaginalis*
- Real time molecular identification of genital ulcer causing pathogens: Herpes Simplex Virus (HSV), *Haemophilus ducreyi*, *Treponema pallidum* and *Lymphogranuloma venereum*
- Antimicrobial susceptibility testing using nucleic amplification tests
- Genotyping and sequencing of STI pathogens

- Serological assays for: *Treponema pallidum* (RPR and TPPA), HSV- 2 (ELISA), *Chlamydia* species (Microimmunofluorescence test)

Assignments/Assessments:

- Participation in all routine laboratory tests
- Participation in all quality assurance activities
- Participation in all teaching activities
- Research project(s): interns will be given small semi-independent research project(s) which would usually take 2-4 months to complete.
- Presentations: interns will be expected to attend all NICD scientific presentations (research forums) and CHIVSTI journal club meetings. Interns will be expected to participate and give presentations at these meetings.
- Meetings and report back to manager, head of department and senior medical scientist: interns will have discussion, feed-back, verbal assessment and question/answer sessions.

2. Centre for Enteric Diseases (CED)

The centre is tasked with developing strategies and providing information to combat diarrhoeal diseases in South Africa. In addition, the centre monitors trends in diarrhoeal pathogen incidence and identifies areas for the introduction of additional interventions. The bacterial division of the CED collects data on patients presenting throughout South Africa with both invasive and non-invasive disease caused by *Salmonella* species (including *Salmonella Typhi*), *Shigella* species, *Vibrio cholerae* and diarrhoeagenic *Escherichia coli*.

Laboratory techniques/tests offered:

- *Salmonella* species: identification, serotyping and antimicrobial susceptibility testing
- *Shigella* species: identification, serotyping and antimicrobial susceptibility testing
- *V. cholerae* (O1 and non-O1): identification, serotyping and antimicrobial susceptibility testing
- Diarrhoeagenic *E. coli*: identification (via conventional PCR to detect for virulence genes), serotyping and antimicrobial susceptibility testing
- *Campylobacter* species: real-time PCR detection and identification
- *V. cholerae* and cholera toxin: real-time PCR detection and identification
- *Salmonella* species and *Salmonella Typhi*: real-time PCR detection and identification
- Genotyping: pulsed-field gel electrophoresis (PFGE) analysis of enteric pathogens
- Genotyping: multiple-locus variable-number tandem-repeats analysis (MLVA) of enteric pathogens
- Genotyping: multi-locus sequence typing (MLST) of enteric pathogens
- DNA sequencing

Assignments/Assessments:

- Participation in all routine laboratory tests
- Participation in all quality assurance activities
- Participation in all teaching activities

- Research project(s): interns will be given small semi-independent research project(s) which would usually take 2-4 months to complete. Research projects should culminate in a short report (1-2 page summary) or preparation of a manuscript for publication in a peer-reviewed journal
- Presentations: interns will be expected to attend all NICD scientific presentations (research forums) and CED journal club meetings. Interns will be expected to participate and give presentations at these meetings.
- Meetings and report back to managers: interns will have weekly meetings with their principle trainer to have discussion, feedback, verbal assessment and question/answer sessions. In addition, interns will have a formal meeting every 6-8 weeks with their principle trainer and head of department to discuss progress of their training and report on results for their research projects.

### **3. Centre for Respiratory Diseases and Meningitis (CRDM)**

The Centre for Respiratory Diseases and Meningitis (CRDM) is a resource of surveillance, diagnostics, expertise and research in the field of communicable respiratory diseases and meningitis for South Africa and the African continent. The centre generates data and provides expertise related to respiratory diseases and meningitis of public health importance to the South African National Department of Health, health care providers, regional and international collaborators, to assist with the planning of public health policies and programs and response to respiratory disease and meningitis outbreaks. The CRDM is also a source of capacity building and formal training within South Africa and the African region.

#### Microbiology laboratory techniques/tests offered:

- Phenotypic (culture, Gram stain, biochemical tests, serotyping/grouping) identification and characterisation of *Neisseria meningitidis*, *Haemophilus influenzae* and *Streptococcus pneumoniae*
- Antimicrobial susceptibility testing (disc diffusion, E-Test, broth dilution)
- Molecular (real-time PCR) identification and serotyping/grouping of *Neisseria meningitidis*, *Haemophilus influenzae* and *Streptococcus pneumoniae*
- Real-time PCR identification of atypical pneumonia-causing pathogens – *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Legionella* spp., *Bordetella pertussis*
- Molecular strain characterisation using multilocus sequence typing (MLST) and whole genome sequencing

#### Assignments/Assessments:

- Phenotypic – interns will be given ‘spots’ i.e. agar plates with bacterial cultures and will have to identify and characterise independently
- Molecular/genotypic – this is ongoing as interns will be included in the staff rotation so will perform the tests routinely throughout the duration of the internship (all results will be authorised by senior staff). Interns will raise non-conformances as appropriate/necessary
- Tutorials – interns will attend a series of departmental tutorials where they will be actively participate on a Q&A basis or be given tasks associated with the particular topic
- Mini-project – interns will carry out a research project

- Interns will actively participate in the weekly journal club (including presenting), bi-monthly research forum, academic days etc. Where possible and depending on the timing, opportunities for local conference attendance will be provided (e.g. FIDSSA) and interns will be encouraged to submit an abstract.

#### 4. Centre for Tuberculosis (CTB)

- Sputa or other extra-pulmonary samples, culture isolates (liquid & solid media) – sample registration, preparation and processing.
- Microscopy and staining techniques for Auramine and Ziehl Nielsen (ZN) Stain – smear preparation, staining and microscopic examination of sputa and culture isolates (morphology)
- TB Culture MGIT 960 – decontamination and processing. MGIT 960 operation and result interpretation.
- MGIT MTB complex identification – perform and interpret rapid chromatographic immunoassay for qualitative detection of MTB complex antigen.
- MGIT 960 Drug Susceptibility Testing (DST) – preparation of dilutions for MTB isolates, inoculation of drugs (1<sup>st</sup>, 2<sup>nd</sup> and special drugs) and MTB isolates, Epicenter and MGIT 960 result interpretation.
- Perform LPA PCR HAIN MTBDRplus/CM/SLT assays and interpret results
- Performing GeneXpert MTB/Rif assay and interpreting results

#### Assignments/Assessments:

Assessment will be performed according to rules and regulations stipulated by the HPCSA. Ongoing assessment will consist of an evaluation report of the intern scientist by their direct supervisor. The report will be based on the interim portfolio being collated by the intern (see below) as well as an evaluation of his/her general laboratory demeanour including:

- Attention to good laboratory practice
- Participation in academic activities
- Laboratory expertise acquired
- Personal interaction with other staff members
- Research work
- Presentation skills

The evaluation report will be discussed in full with the scientist during an interview and relevant feedback given. Opportunities for improvement will be discussed and noted.

#### 5. Centre for Opportunistic, Hospital and Tropical Infections (COHTI)

The Centre for Opportunistic, Tropical and Hospital Infections aims to prevent and control opportunistic, tropical and hospital infections in South Africa by providing:

- Strategic information obtained through surveillance and research to the Department of Health and other major stakeholders
- Technical support for public health programmes such as the malaria control programme and the cryptococcal screening programme
- Reference laboratory services in the fields of parasitology, mycology, entomology and bacteriology
- Laboratory support for outbreak response

- Training for clinical, laboratory and public health personnel to ensure optimal diagnosis and control of diseases

The Centre focuses its efforts on opportunistic infections, particularly those that are HIV-related; tropical infections, especially malaria and its vectors; and nosocomial infections, concentrating on antimicrobial resistance in the hospital setting.

Microbiology laboratory techniques/tests offered:

- Routine diagnostic methods [staining, culturing, basic biochemical tests, antimicrobial susceptibility testing (automated MIC methods and disk susceptibility)etc.] for the identification of the medically important parasites, fungi and nosocomial-related bacteria.
- Automated identification and characterisation of organisms
- Molecular methods for diagnosis, surveillance and research on the parasites, vectors, bacteria and fungi relevant to the Centre's functions which may include:
  - DNA extraction (manual and automated)
  - Conventional and real-time PCR
  - RFLP, DNA sequencing, phylogenetic analysis, genotyping

Assignments/Assessments:

- Routine microbiological testing (including molecular) – this will be ongoing as interns will be included in the staff rotation so will perform the tests routinely throughout the duration of the internship. They will perform tests under supervision until competent and all results will be authorised by senior staff.
- Interns will be introduced to the laboratory quality assurance system and will be expected to maintain the systems in place including equipment maintenance, document control, training and competency, CAPA etc.
- Mini-project – interns will carry out a research project
- Interns will actively participate in the weekly journal club (including presenting), bi-monthly research forum, academic days etc.
- Interns will meet with their principle trainer on a regular basis to discuss progress.

**6. Centre for Emerging and Zoonotic Diseases (CEZD)**

The Centre for Emerging and Zoonotic Diseases (CEZD) renders diagnostic expertise and investigatory capacity on highly dangerous bacterial and viral pathogens associated with zoonotic disease in South Africa and on the African continent. The CEZD aims to function as a resource for knowledge and expertise to the South African government, the SADC countries and the African continent, in order to assist in the planning of relevant policies and programs and to harness innovation in science and technology to support surveillance, detection and outbreak response systems. In observing this goal, the CEZD supports South Africa's commitment to the International Health Regulations.

Microbiology laboratory techniques/tests offered:

- Phenotypic identification (culture, Gram stain, biochemical tests, specialized assays) and characterisation of *Bacillus anthracis*, *Clostridium botulinum*, *Yersinia pestis*, *Bartonella spp.* and other zoonotic bacterial pathogens.
- Molecular identification and characterization of *Bacillus anthracis*, *Clostridium botulinum*, *Yersinia pestis*, *Bartonella spp.* and other zoonotic bacterial pathogens.
- Molecular strain characterisation using multiple-locus variable number tandem repeat analysis (MLVA).

Assignments/Assessments:

- Phenotypic – this is ongoing as interns will be included in the staff rotation so will perform the tests routinely throughout the duration of the internship (all results will be authorised by senior staff). Interns will also participate in processing of samples for proficiency testing schemes.
- Molecular/genotypic – this is ongoing as interns will be included in the staff rotation so will perform the tests routinely throughout the duration of the internship (all results will be authorised by senior staff). Interns will raise non-conformances as appropriate/necessary
- Tutorials – interns will attend a series of departmental tutorials where they will be actively participate on a Q&A basis or be given tasks associated with the particular topic
- Mini-project – interns will carry out a research project
- Interns will actively participate in the monthly journal club (including presenting), bi-monthly research forum, academic days etc.

Intern Training Program

Description of training program

Each intern medical scientist will complete a 2-year training program, unless special circumstances lead to the HPCSA accepting a shorter training period (such as the candidate already having completed a masters or doctoral degree – see special case below). The training program will comprise 18 months in the host centre and a 6-month rotation through the other centres at the NICD (listed in the table below).

We have capacity to train two to three interns per centre.

Summary of training program

18 months	Host centre at NICD	Centre for Opportunistic, Hospital and Tropical Infections Centre for Emerging and Zoonotic Diseases Centre for Respiratory Diseases and Meningitis Centre for Enteric Diseases Centre for HIV and STI's Centre for Tuberculosis
6 months	Rotation (2-3 weeks per other centres)	Centre for Opportunistic, Hospital and Tropical Infections Centre for Emerging and Zoonotic Diseases Centre for Respiratory Diseases and Meningitis Centre for Enteric Diseases

		Centre for HIV and STI's Centre for Tuberculosis Electron Microscopy NHLS routine microbiology (e.g. CH Bara, Helen Joseph, Charlotte Maxeke) – 1-2 weeks by prior arrangement with laboratory manager/pathologist-in-charge and dependent on laboratory capacity to assist with training
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**Outline of training programme during eighteen month program**

The following general principles will be covered in the 18 month rotation:

- **Good Laboratory Practice:** Regular training is conducted for all staff. Laboratory divisions conducting patient testing have SANAS accreditation for ISO 15189. This will include exposure to: laboratory management, quality assurance activities of the department, role of standard operating procedures and adherence to these, documentation such as quality manual, safety manual etc. This will involve an orientation program and ongoing bench exposure.
- **Safety Training** – regular training provided for all staff. The safety representative in the laboratory will be responsible for the training.
- **General Laboratory techniques:** centrifugation, pipetting, sample preparation, chain of custody, laboratory information system, sample storage.

The 18-month rotation will ensure that the intern emerges with expert knowledge in a particular field, able to troubleshoot as well as use initiative to instigate new work in a particular area. During this time, they will be expected to spend at least 50% of their time on routine work done by the laboratory. Research projects they are doing, including the possibility of a Masters project, should fit within the remaining 50% of time.

Each centre will offer at least two modules to the intern scientist during the 18 month period. Intern scientists will be expected during this time to become proficient in running the routine assays carried out by their unit. They will become expert in the clinical indications for the assays, other testing available for related conditions, requirements and pitfalls of the assays, instrument maintenance and troubleshooting. They will be expected to attend the academic teaching available in the unit e.g.

- Bi-monthly NICD research forum (interns should be given an opportunity to present at least once during their internship)
- Weekly/monthly journal club in host centre
- *Ad hoc* /special lectures (invited speakers)
- University research days – interns are encouraged to present at least once
- National conference attendance/presentation – interns are encouraged to attend and present data at one national conference (if funding is available)

There are also a selection of optional courses from which to choose including

- All CEU courses offered by NHLS (booklet available)
- Research-related courses offered by collaborating universities

### Outline of training included in the rotation period

The intern will be exposed to the theory and techniques spanning the tests offered by the laboratory. The aim is to give an overview of tests available, equipment and expertise available, an introduction to the pathology tested in the various units, and to stimulate the interest of the intern. The intern will be expected to understand the principles involved in the techniques. They will NOT however be expected to have performed all the techniques mentioned, nor to be able to run all of the tests without supervision. Rather the aim is to learn which tests are available and for which patients they would be applicable.

### Assessment

Assessment will be performed according to rules and regulations stipulated by the HPCSA i.e. submission of a portfolio of evidence. Details for the portfolio are outlined in the national curriculum guidelines.

Requirements for internal assessment of the candidate will be the following:

### Ongoing assessment

Ongoing assessment will consist of an evaluation report of the intern scientist by the supervisor or unit/section head at the end of each rotation completed (i.e. at the end of each rotation, and during the 18-month host stay). The report will be based on the interim portfolio being collated by the intern (see below) as well as an evaluation of his/her general laboratory demeanour including:

- Laboratory expertise acquired
- Attention to good laboratory practice
- Participation in academic activities

The evaluation report will be discussed in full with the scientist during an interview and relevant feedback given. Opportunities for improvement will be discussed and noted. A hard copy of the report will be placed in the intern's portfolio.

### Final Portfolio

For registration in the discipline of **Microbiology**, the portfolio should comprise:

1. Logbook of tests performed
2. Logbook of tests witnessed but not performed
3. List of presentations (departmental/conference/research day/ Journal Club etc.) with title, date and forum presented – this must be signed off by supervisor or senior staff to ensure proof that this activity was undertaken
4. Minimum of one project demonstrating capability in the scientific method and computer literacy. This should have the form of a research paper i.e. including introduction, methods, results, discussion, conclusion and references, or an instrument/test validation report (including background, intra-run precision, inter-run precision, accuracy and references)
5. Evaluation reports from head of relevant units at the end of each block, summarising training in their respective departments
6. Log of any complaints received or corrective actions undertaken with regards to errors in specimen processing or communication
7. Additional training e.g. workshops/presentations/lectures/tutorials attended
8. Assessments (oral/written/ongoing)

### Concurrent registration in Microbiology and Molecular Biology

In the case of an intern wanting to register in two categories, it will be expected that they meet the assessment criteria for both disciplines. This involves submitting a final portfolio that meets the criteria for a Microbiology portfolio as well as a Molecular Biology portfolio. The research project(s) should be applicable to both disciplines.

### Competencies

The following are the generic competencies expected from all intern medical scientists on completion of internship:

#### Technical Competencies

1. Understanding of the principles associated with a range of techniques employed in the various microbiology specialities
2. Knowledge of the standards of practice expected from these techniques used
3. Experience of performing techniques in diagnosis/surveillance by understanding and following of SOPs
4. The ability to solve problems that might arise during the routine application of techniques (troubleshooting)
5. Understanding of the principles of quality control and quality assurance
6. Experience of the use of quality control and quality assurance techniques including restorative action when performance deteriorates
7. A critical ability to review the results and determine the significance of quality control and assessment information for relevant analytical procedures
8. An understanding of the hazards (environmental, biological, chemical, radioisotopic) associated with the practice of microbiology and the appropriate controlling legislation and procedures of risk assessment.

#### Scientific Competencies

1. Understanding the science of microbiology in the context of medicine and clinical practice
2. Experience in searching for knowledge, critical appraisal of information and integration into the knowledge base of microbiology
3. Ability to apply knowledge to problems associated with the routine provision and development of the service
4. Ability to identify the clinical decision which the test/intervention will inform
5. Ability to make judgements on the effectiveness of procedures performed
6. Understand the principles of the techniques and methods employed in microbiology
7. Able to advise on appropriate choice of investigation and sample preparation
8. Must be familiar with information on technical developments and emerging technologies in microbiology
9. An understanding of sensitivity, specificity, positive and negative predictive values of an assay and how these are influenced by prevalence of a disease

### **Research and Development Competencies**

1. Ability to read and critically appraise the literature
2. Ability to develop the aims and objectives associated with a project
3. Ability to develop an experimental protocol and to meet the aims and objectives in a way that provides reliable and robust data
4. Ability to perform the required experimental work ability to produce and present the results (including statistical analysis)
5. Ability to critically appraise results in the light of existing knowledge and the hypothesis developed and to formulate further research questions
6. Ability to present data and provide a critical appraisal to an audience of peers – both spoken and written
7. Develop research skills and expertise sufficient to support supervised and collaborative research
8. An awareness of the current extent of knowledge in microbiology and an ability to employ appropriate information tools to search for, consolidate and critically examine information
9. Participation in local research meetings and supervised and collaborative research initiatives, leading to in-house reports (e.g. validation reports), publications or a postgraduate degree
10. Self-endeavour (e.g. literature awareness) under the tutelage of an appropriate specialist

### **Communication Competencies**

1. Ability to assess a situation and act accordingly when representing the specialty
2. Ability to respond to enquiries regarding the service provided when dealing with clinical colleagues
3. Ability to communicate with patients, carers and relatives, the public and other healthcare professionals as appropriate
4. Ability to communicate the outcome of problem solving and research and development activities
5. Evidence of presentation of scientific material at meetings and in the literature
6. Must be able to use modern communication devices
7. Must understand basic management techniques and be aware of topical management issues

### **Problem Solving Competencies**

1. Ability to assess a situation which may pose a problem
2. Ability to determine the nature and severity of the problem
3. Ability call upon the required knowledge and experience to deal with the problem
4. Initiate resolution of the problem
5. Demonstrate personal initiative
6. Must be able to interpret internal quality control and external quality assurance data
7. Must be able to recognise when a test or procedure is not within adequate performance limits
8. Must be able to recognise the consequences of inadequate performance of individual tests or procedures
9. Must be able to identify and appropriate solution to the problem and propose an effective and timely solution, including any requirement for clinical follow-up

**Management Competencies**

1. Understanding of the legal and ethical boundaries of scientific research
2. Ability to recognise the limits of personal practice and when to seek advice
3. Ability to manage personal workload and prioritize tasks appropriately
4. Understanding the principles of clinical governance including importance of confidentiality, informed consent and data security
5. The ability to contribute effectively to work undertaken as part of a multi-disciplinary team
6. Understanding of the need for career-long, self-directed learning and the importance of continuing professional development
7. Understanding of the need for, and ability to establish and maintain a safe practice environment
8. Understanding of the structure and organization of the department

**Ethics and Values Competencies**

1. Apply and maintain appropriate professional ethics, values attitudes and behaviour.
2. Use science and technology effectively and critically, showing responsibility towards the environment and health of others
3. Understand and apply ethics in both human and animal research
4. Understand and comply with the laws of copyright protection, confidentiality and ownership of intellectual property
5. Take responsibility within own limits of competence and recognise the need for lifelong learning with an awareness of personal and knowledge limitations
6. Demonstrate an ability to work as a team and to show respect for colleagues and other health care professionals and the ability to foster a positive collaborative relationship with others