QUALIFICATION SPECIFICATION SECTION A						
QUALIFICATION DEVELOPER	Botswana International University of Science and Technology					
TITLE	Bachelor of Science Honours in Chemistry (Drug Discovery and Development)			**NCQF LEVEL**	8	
FIELD	Natural, Mathematical and Life Sciences		**SUB-FIELD**	Drug Discovery and Development		
New qualification	✓	Review of existing qualification				
SUB-FRAMEWORK	General Education		TVET		Higher Education	✓
QUALIFICATION TYPE	Certificate		Diploma		Bachelor	
	Bachelor Honours	✓	Master		Doctorate/ PhD	
CREDIT VALUE					126	

1. RATIONALE AND PURPOSE OF THE QUALIFICATION

1.1. Qualification Rationale

The need for Chemists with a qualification in Drug discovery in Botswana, the region and internationally has been indicated in various reports, surveys and documents. The Botswana Human Resources Development Council (Top Occupations in high Demand as at December 2016 and 2019) lists Science and Technology Researchers as being in demand in Botswana. The chemistry profession is also described as of short supply at medium level (Department of Research, Science and Technology 2009). According to the report, chemistry professionals are required in the mining, energy, agriculture and health sectors. Physical Scientists and Physical Science Technicians are also in short supply in the education sector. Chemists are among the 42 professional categories enjoying scarce skill allowance in the civil service owing to their scarcity in Botswana. Chemists, including chemistry teachers enjoy the highest scarce skill allowance of 40% to basic salary and are categorized in the same bracket as medical doctors, dentists, engineers,

architects, quantity surveyors, pharmacists. Laboratory chemist are also categorized as a profession with acute scarcity (Tsa Badiri Consultancy 2015).

Most of researchers in Botswana hold Bachelors/Masters degrees as opposed to Doctorate degrees (DRST 2009). There is therefore need to upgrade Chemistry researchers to Honours, Masters and PhD levels. During the National Development Plan (NDP) 11 the Botswana Government will continue to grow the economy through beneficiation of minerals, various agricultural products and indigenous products/herbs. The proposed qualification will produce graduates with relevant skills to work in these sectors.

Chemistry is required to support other disciplines such as biology, engineering, pharmacy and medicine. The proposed qualification will help to diversify the economy as there is potential for growth in the pharmaceutical industry. This innovative industry will benefit from the skill set produced by the qualification in terms of drug development. Botswana has the potential to develop fine chemicals and drugs. This could replace imported fuels and other chemicals. These activities require Chemistry which a bulk of it will be covered in this course.

The high demand for chemistry graduates applies regionally and internationally. The Republic of South Africa has a high demand for Research and Development Managers, Environmental Managers, Safety, Health, Environment and Quality Practitioners, Air Pollution Analyst, Water Quality Analyst, Physical Science Teachers, Natural Science Teachers, Chemistry Technicians, Physical Science Technicians, Forensic Technicians, Food and Beverage Technicians, Manufacturing Technicians and Water Inspectors (South Africa Government Gazette 2014).

In the United states of America, the demand for Chemists and Chemical Technicians grew by 3.1% and 4.2%, respectively in 2014 (Rovner, 2014). Chemists are in demand in Australia (http://www.visabureau.com/australia/anzsco/jobs/chemist-jobs-australia.aspx). In Europe, shortages of Chemical Technicians are expected (C and E News, 93 issue 24, pp34-26, 2005). The proposed qualification is in line with vision 2036 as it will promote the following pillars (i) a knowledge-based economy - the use of science, technology and innovation to propel economies to high levels of efficiency is key to supporting socio-economic development. The drug and development is an innovating field capable contributing immensely to the GDP. (ii) promote human capital development-as the country will have developed an internationally competitive workforce that is productive and has international exposure and

(iii) Education and skills development-Botswana society will be knowledgeable with relevant quality education that is outcome based, with an emphasis on technical and vocational skills as well as academic competencies and (iv) Ecosystem functions and services-providing research for the identification and development of marketable products. It will also produce chemists (and Chemical Technicians) for the region as well as the international community.

1.2. Purpose of the Qualification

The purpose of this qualification is to Produce graduates with highly specialized knowledge, Skills and competences to:

- Embrace diverse perspectives to nurture innovation in search for small molecules.
- Develop and use analytical, modelling and spectroscopic techniques to solve drug and development problems such as the search for and analysis of drug like molecules
- Communicate scientific information effectively to diverse audience.
- Conduct applied research to address various health problems involving drug discovery and development facing the country and the world at large working in multidisciplinary teams.

2. ENTRY REQUIREMENTS (including access and inclusion)

1.1. Bachelor's degree, NCQF Level 7 in Chemistry (drug discovery and development) or Bachelor of Science in Chemistry with a major in Organic chemistry or cognate field.

1.2. Applicants who do not meet the above criteria but possess relevant industry experience may be considered through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) policies for access. This consideration will be done following guidelines of the ETP which are aligned with BQA/National policies.

QUALIFICATION SPECIFICATION SECTION B	
3. GRADUATE PROFILE (LEARNING OUTCOMES)	**ASSESSMENT CRITERIA**
Upon completion of this qualification candidates will be able to:	**Evidence is required that the graduate will be able to**
3.1 **Apply advanced** chemistry concepts in the discovery of drug likeness of molecules.	3.1.1 Evaluate chemistry literature to solve a problem in the drug discovery of molecules such as anticancer and antibacterial agents 3.1.2 Develop hit and lead molecules using medicinal chemistry concepts for hit identification such as virtual screening.
3.2 Develop advanced digital skills in using library search tools and chemical simulation software	3.2.1 Use the library portal to access data bases (e.g Science Direct) in search for appropriate literature data such as for antibacterial agents 3.2.2 Use chemical simulation software to draw chemical structure 3.2.3 Predict chemical and biological properties suitable for drug like molecules using simulation softwares 3.2.4 Gather and interpret data in a research project on drug design 3.2.5 Use molecular models to predict structure activity relationships studies in identifying hit and lead molecules

3.3 **Analyze highly** specialized chemistry knowledge in the characterization and biosynthesis of small molecules	3.3.1 Use spectroscopic techniques to solve the determination chemical structure problems. 3.3.2 Use analytical tools such as HPLC to purify and determine purity of synthesized small molecules 3.3.3 Verify that the structure and purity of compounds are correct 3.3.4 Use literature to evaluate the desirable features of druggable targets for anticancer and antibacterial small molecules 3.3.5 Evaluate the biosynthesis of drugs from natural sources such as anticancer agents originating from nature
3.4 **Communicate** the results of specialized academic field studies using main concepts, constructs and techniques to an audience	3.4.1 Use scientific language correctly to produce clear and coherent written laboratory reports and/or research project document 3.4.2 Use appropriate referencing conventions, avoid plagiarism and observe intellectual property laws in written reports 3.4.3 Conduct seminar presentations topics in drug discovery and development to a wider audience 3.4.4 Use non-verbal forms of representation correctly and appropriately when representing chemical structure
3.5 **Apply** advanced scientific knowledge with core ethical virtues in resolving societal issues	3.5.1 Exercise sensitivity and confidentiality when dealing with sensitive information such as clinical trial data 3.5.2 Take ethically and culturally sensitive decisions when dealing with sensitive data
3.6 **Apply highly** advanced research methods to solve problems in search for small and large molecules.	3.6.1 Select appropriate chemistry methodologies, collect accurate and relevant data, evaluate recent literature, discuss and present the results. 3.6.2 Evaluate and critique current research practices and techniques in drug development 3.6.3 Compare the theoretical predictions with published data to evaluate the significance of the results in context.

	3.6.4 Explain the implications of the research project findings on the problem under consideration. 3.6.5 Analyze and draw conclusions on the results of an experiment 3.6.6 Propose recommendations related to the research problem
3.7 **Apply highly** specialized research knowledge, skills and competence in a practical research project aligned to Drug Design and Development	3.7.1 Select a Drug discovery and development project and use relevant research methodology to produce meaningful results. 3.7.2 Plan and conduct scientific experiments in the lab to create and refine target molecules 3.7.3 Evaluate literature review on a selected research topic when writing a research report. 3.7.4 Analyze collected research data using appropriate statistical methods such as SPSS. 3.7.5 Discuss and present results in the form of a written report and oral presentation.

3. QUALIFICATION STRUCTURE

SECTION C

FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	**Title**	**Level**	**Credits**
CORE COMPONENT			
	Advanced Research Project	8	30
	Advanced Organic Chemistry	8	36

Subjects / Units / Modules /Courses	Green Chemistry	8	12
	Advanced Physical Chemistry	8	24
	Sensor and diagnostics	8	12
	Drug synthesis and purification	8	12
ELECTIVE COMPONENT Subjects / Units / Modules /Courses			

4.1. Rules of Combinations, Credit distribution (where applicable)

Table 1. Credit Distribution

NCQF Level	Credit Contribution
Level 8	126
Total Credits	126

Table 2. Credit Contribution for Fundamental and Core modules

Component	Credit Contribution
Core modules	126
Total Credits	126

All core modules are compulsory

4. ASSESSMENT AND MODERATION ARRANGEMENTS

4.1. **Formative Assessment**

Formative assessment will contribute 50% to the final grade.

4.2. **Summative Assessment**

Summative assessment will contribute 50% to the final grade.

Assessors must be BQA registered and accredited

Moderation arrangements

Moderators must be BQA registered and accredited. Internal and external moderation will be done in line with both institutional and national policies.

5. RECOGNITION OF PRIOR LEARNING (if applicable)

Candidates may submit evidence of prior learning and current competence and/or undergo appropriate forms of RPL assessment for the award of credits towards the qualification in accordance with applicable RPL policies and relevant national-level policy and legislative framework

6. PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

This qualification is designed to facilitate vertical and horizontal progression both locally and internationally.

6.1. Horizontal Progression

Graduates may progress horizontally to the following programmes:

- Bachelor of Science (Honours) Chemistry (Forensic Sciences)
- Bachelor of Science (Honours) Organic Chemistry
- Bachelor of Science (Honours) Medicinal Chemistry
- Bachelor of Science (Honours) Chemistry (Environmental and Analytical Chemistry)

6.2. Vertical Progression

Graduates may progress vertically to level 9 qualifications:

- Master of Science in Organic Chemistry
- Master of Science in Medicinal Chemistry
- Master of Science in Pharmaceutical Science

6.3. Employment pathways

Graduates of the qualification may find employment in a range of public and private organisations. Typical roles include:

- Quality control

- Site Chemist
- Medicinal Chemist
- Research and development Chemist
- Development Chemist
- Synthetic Organic Chemistry

7. QUALIFICATION AWARD AND CERTIFICATION

A candidate will be awarded a qualification in Bachelor of Science (Honours) in Chemistry (Drug Discovery and Development) upon meeting the minimum of 126 credits as prescribed in the rules of combination.

Certificate and transcript will be issued to graduates upon successful completion of BSc (Honours) Chemistry (Drug Discovery and Development).

8. REGIONAL AND INTERNATIONAL COMPARABILITY

University of North West, South Africa, BSc with Biochemistry and Chemistry and University of Johannesburg, BSc Hons in Biochemistry

The admission are level 7 and stated that a minimum of 65% in biochemistry is required. The honors qualification demands a high level of theoretical engagement and intellectual independence. It has four theory modules and a research module and a formative assessment inclusive of practical work experiments. It utilizes chemistry analytical tools in the research project. The proposed qualification develops skills in the field of drug discovery and development through the application of chemistry analytical tools with research project as a one semester module (25 % or 30 credits).

University of Bath, BSc Chemistry for drug discovery-QAA/EHEA (level 6)

The UK admission requires an A-level Chemistry plus other science and Maths. Thus, A-level will be equivalent to year 1/level 5 of the proposed qualification. It is noticeable that Maths, Statistic and other sciences are not listed as covered domains. The Learning outcomes develops an in-depth knowledge and skills in the design, synthesis of drugs as seen from the listed domains.

Canterbury Christ Church University, BSc Chemistry for drug discovery-QAA (Level 6)

This is another similar qualification which assert that their learners would gain theoretical scientific knowledge base to active research areas that address contemporary challenges and will develop practical skills by undertaking a significant amount of laboratory work. This program takes a practical, project based approach to teaching and learning based on the CDIO (Conceive, Design, Implement and Operate) engineering education approach. These are attributes that are found on the proposed program. The domains at level 100 and 200 for the Proposed qualification. University of Bath and Canterbury Christ Church University, BSc Chemistry for drug discovery have higher degree of similarity, in that they build the Chemistry knowledge by exposing learners to general chemistry and then introduces the four branches of chemistry (Organic, Physical, Analytical and Inorganic chemistry) at level 200. The specialization is introduced alongside advanced chemistries at level 300. Level 400 offers modules biased towards a specialty area and special topics on drug Discovery and discovery. Generally the qualifications are biased towards Organic Chemistry as shown by the pursuing of modules such as topics in organic chemistry, synthesis, catalysis and spectroscopy aligned study modules. A research project at the final level of study is a common denominator.

Dublin City University's BSc in Chemical and Pharmaceutical-Irish NQF (level 8)

Inspection of the Dublin City University's BSc in Chemical and Pharmaceutical (240 ECTS credits) shows learner knowledge growth starting from general chemistry, biology and physics modules, into level 200 organic chemistry and physical chemistry modules. While, specialist modules are introduced at level 300.

The exit learning outcomes of this international qualification reflect that students should demonstrate understanding of the field knowledge, apply the knowledge on practical settings, interpret and synthesize knowledge, carry out research projects, interpret and communicate the research results. These shows requirement for both "Knowledge" and "Skill" outcomes at BSc and BSc (Hon.) study level. The above qualifications utilizes both the knowledge based and performance based assessment strategies as outlined in the outcome based education.

BSc (Hon.) in Chemistry (Drug Discovery and development)

The BSc (Hon.) in Chemistry (Drug Discovery and development) compatibility with qualification descriptors has been demonstrated in terms of the comparisons of the learning outcomes and domains. The award NCQF level 8 differs from the level 6 for Frameworks for Higher Education Qualifications and Credit (FHEQ) and Qualification framework of the European Higher Education Area (Qf-EHEA) with comparable descriptor and gives access to Master's Degree qualification. The NCQF level 8 exit outcomes aligns with the

important Dublin descriptor for ordinary and Honours BSc degrees, which are used by EU countries in the Bologna process to align their frameworks.

The proposed qualification generally compares well with the three qualifications studied in terms of content scope and learning outcomes and hours to be achieved before assessment. The assessment assess the ability to analyze concepts, synthesize whole ideas and concepts, and to evaluate the value of concepts, prepare and communicate a research report.

NQF comparability notes

In terms of NQF levels, the United kingdom quality assurance agency (QAA) using Frameworks for Higher Education Qualifications and Credit (FHEQ) denotes a BSc with honours at level 6 with 360 credits and BSc with 300 credits. But, the Qf-EHEA (Qualification framework of the European Higher Education Area) awards 180-240 ECTS credits. Quality and Qualifications Ireland places BSc at level 7 and BSc with honours at level 8 with 180-240 ECTS credits. Higher Education Qualification Sub Framework (HEQSF) places BSc honors at Level 8 with 120 credits.

9. REVIEW PERIOD

Review period is 5 Years and as an when the need arises.