

<b>QUALIFICATION SPECIFICATION</b>						<b>SECTION A</b>
<b>QUALIFICATION DEVELOPER</b>		Botswana International University of Science and Technology				
<b>TITLE</b>		Bachelor of Science in Chemistry (Drug Discovery and Development)		<b>NCQF LEVEL</b>	7	
<b>FIELD</b>	Natural, Mathematical and Life Sciences		<b>SUB-FIELD</b>	Drug Discovery and Development		
New qualification		✓		Review of existing qualification		
<b>SUB-FRAMEWORK</b>		General Education		TVET		Higher Education ✓
<b>QUALIFICATION TYPE</b>		Certificate		Diploma		Bachelor ✓
		Bachelor Honours		Master		Doctorate/ PhD
<b>CREDIT VALUE</b>					522	
<b>1. RATIONALE AND PURPOSE OF THE QUALIFICATION</b>						
<p><b>Qualification Rationale:</b></p> <p>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</p>						

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.

#### Purpose of the Qualification

The purpose of this qualification is to produce graduates who can apply specialized knowledge, skills and competences to:

- Develop medicinal product solutions for complex and unpredictable problems.
- Carry out searches in databases to retrieve information relevant to the development of a new drug.
- Apply communication skill to effectively communicate scientific information to a wider audience.
- Apply specialized skills to the synthesis and analysis of small molecules.
- Manage drugs laboratories and infrastructure with adherence to applicable standards.

## **2. ENTRY REQUIREMENTS (including access and inclusion)**

- 2.1. Certificate IV, NCQF Level 4 (BGCSE or equivalent)
- 2.2. Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) will be applied.

<b>QUALIFICATION SPECIFICATION</b>	
<b>SECTION B</b>	
<b>3. GRADUATE PROFILE (EXIT LEARNING OUTCOMES)</b>	<b>ASSESSMENT CRITERIA</b>
3.3 Apply specialized knowledge of chemistry concepts in the design and discovery of small molecules.	3.1.1 Evaluate chemistry literature to design small molecules such as anticancer and antibacterial agents 3.1.2 Develop hit and lead molecules using medicinal chemistry concepts such as virtual screening.
3.2 Use library search tools and chemical simulation software	3.2.2 Use data bases (e.g Science Direct) to search for appropriate literature data such as for antibacterial agents 3.2.3 Use chemical simulation software to draw chemical structure 3.2.4 Predict chemical and biological properties suitable for drug like molecules using simulation softwares 3.2.5 Gather and interpret data related to small molecule design and discovery 3.2.6 Use molecular models to predict structure activity relationships studies in identifying hit and lead molecules
3.3 Use the evidence based comparative chemistry approach to explain chemical synthesis and analysis in the synthesis of hit and lead small molecules	3.3.1 Develop ideas to resolve the drug properties of molecules such as Lipinski rules. 3.3.2 Apply specialized knowledge to develop sustainable environment friendly green initiatives in the chemical synthesis 3.3.3 Analyze small molecules from natural sources such as anticancer agents originating from nature
3.4 Analyze specialized chemistry knowledge in the characterization of small molecules, large molecules and drug targets	3.4.1 Apply spectroscopic techniques to solve the determination of chemical structure. 3.4.2 Use proper tools to verify that the chemical structure and purity of compounds are correct

	<p>3.4.3 Use analytical tools such as HPLC to purify and determine purity of synthesized small molecules</p> <p>3.4.4 Use literature to evaluate the desirable features of druggable targets for anticancer and antibacterial small molecules</p>
<p>3.5 Communicate the drug discovery projects results using main concepts, constructs and techniques to an audience</p>	<p>3.5.1 Use scientific language correctly to produce clear and coherent project reports</p> <p>3.5.2 Adhere to standard practices in the discovery of small molecules and observe intellectual property laws</p> <p>3.5.3 Conduct seminar presentations in drug discovery and development to a wider audience</p> <p>3.5.4 Attend and contribute to internal and external project meetings</p>
<p>3.6 Employ specialized problem-solving skills in qualitative and quantitative methods for drug discovery and development</p>	<p>3.6.1 Analyze abstract drug synthesis such as in anticancer small molecule synthesis.</p> <p>3.6.2 Analyse qualitative and quantitative scientific data to make informed decision during drug discovery</p> <p>3.6.3 Integrate the data analysis results from biochemistry, bioinformatics and chemical synthesis in the delivery of drug discovery projects.</p>
<p>3.7 Work effectively as a team member in specialized drug discovery projects or teams.</p>	<p>3.7.1 Contribution meaningfully to team work projects</p> <p>3.7.2 Apply organizational skills in managing team work</p> <p>3.7.3 Complete the deliverables/milestones within deadlines</p>
<p>3.8 Apply advanced scientific knowledge with core ethical virtues in resolving societal issues</p>	<p>3.8.1 Exercise sensitivity and confidentiality when dealing with sensitive information such as clinical trial data during all drug development stages</p> <p>3.8.2 Make ethically and culturally sensitive decisions when dealing with sensitive data during drug discovery project implementations</p> <p>3.8.3 Apply for appropriate research permits</p>

<p>3.9 Apply appropriate research methods to solve problems in search for targeted small molecules and druggable targets.</p>	<p>3.9.1 Evaluate and critique current research practices and techniques in drug development to identify gaps</p> <p>3.9.2 Compare the theoretical predictions with published data to evaluate the significance of the project results.</p> <p>3.9.3 Explain the implications of the research project findings on the drug discovery problem under consideration.</p> <p>3.9.4 Analyze and draw conclusions on the results of a drug discovery project such as anticancer small molecules</p> <p>3.9.5 Propose recommendations related to the drug discovery project deliverables</p>
<p>3.10 Apply specialized research skills and competence in a drug design, discovery and development projects</p>	<p>3.10.1 Evaluate literature review on a selected project when writing a project report.</p> <p>3.10.2 Apply appropriate research methodology to produce meaningful results in a drug discovery and development project</p> <p>3.10.3 Conduct appropriate chemical synthesis methods to create and/or refine target small molecules</p> <p>3.10.4 Analyze collected research data using appropriate statistical methods such as SPSS.</p> <p>3.10.5 Discuss and present results in the form of a written report and oral presentation to clients and stakeholders</p>

<b>4 QUALIFICATION STRUCTURE</b>				
			<b>SECTION C</b>	
<b>FUNDAMENTAL COMPONENT</b>	<b>Title</b>	<b>Level</b>	<b>Credits</b>	
Subjects / Units / Modules /Courses	General Chemistry level 1	5	12	
	Pre-Calculus	5	24	
	General Physics	5	24	
	General Biology level 1	5	12	
	Introduction to computing	5	12	
	Academic Literacy Skills	5	12	
	General Biology level 2	6	12	
	General Chemistry level 2	6	12	
	Introduction to Calculus	6	12	
<b>CORE COMPONENT</b>	Organic Chemistry	6	12	
	Analytical Chemistry	6	12	
	Inorganic Chemistry	6	12	
	Physical Chemistry	6	12	
	Calculus	6	24	
	Statistics	6	12	
	Cell Biology	6	12	
	Biochemistry	6	12	
	Technical Report Writing	6	12	
	Approaches to drug development	7	12	
	Inorganic chemistry in drug development	7	24	
	Organic Spectroscopy	7	12	
	Physical and Chemical Equilibria	7	12	
	Toxicology, and biosensors	7	12	
	Instrumental Analysis	7	24	
Chemistry of biomolecules	7	12		

	Molecular Modelling and Drug design	7	12
	Quality Assurance	7	12
	Heterocyclic chemistry	7	12
	Organic Synthesis	7	36
	Research Methods	7	6
	Polymer chemistry and applications	7	12
	Principles of drug degradation and stability	7	12
	Research Project	7	12
	Entrepreneurship	7	24
	Work based learning, Winter semester	7	24
ELECTIVE COMPONENT Subjects / Units / Modules /Courses			

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

Table 1. Level Credit Contribution for Fundamental and Core modules

Component	Credit Contribution
Fundamental level 5	96
Fundamental level 6	36
Core level 6	120
Core level 7	270
Total Credits	522

## **5. ASSESSMENT AND MODERATION ARRANGEMENTS**

### Assessment arrangements

#### 5.1. Formative Assessment

Formative assessment will contribute 50% to the final grade.

#### 5.2. Summative Assessment

Summative assessment will contribute 50% to the final grade.

### Moderation arrangements

Internal and external moderation will be done in line with both institutional and national policies for quality assurance purposes.

Assessors and Moderators must be suitably qualified and preferably must be BQA registered and accredited

## **6. 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

## **7. PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)**

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

### **Horizontal Progression (NCQF Level 7)**

- Bachelor of Science in Pharmaceutical Science
- Bachelor of Science in Medicinal Chemistry
- Bachelor of Science in Chemistry (Materials and Nano Chemistry)
- Bachelor of Science in Chemistry (Environmental and Analytical Chemistry)
- Bachelor of Science in Chemistry (Forensic Sciences)

### **Vertical Progression (NCQF Level 8)**

- Bachelor of Science (Hons) in Pharmaceutical Science
- Bachelor of Science (Hons) in Medicinal Chemistry
- Bachelor of Science (Hons) in Chemistry (Materials and Nano Chemistry)

- Bachelor of Science (Hons) in Chemistry (Environmental and Analytical Chemistry)
- Bachelor of Science (Hons) in Chemistry (Forensic Sciences)
- Master of Science in Chemistry

### **Employment pathways**

Graduates of the qualification may find employment in a range of public and private organisations.

Typical roles include:

- Site Chemist
- Medicinal Chemist
- Research and development Chemist
- Development Chemist

### **8. QUALIFICATION AWARD AND CERTIFICATION**

A candidate must earn a minimum of 522 credits and satisfy the stipulated rules of combination to be awarded the Bachelor of Science in Chemistry (Drug Discovery and Development) and a certificate bearing the same.

Certificate and transcript will be issued to graduates upon successful completion of Bachelor of Science in Chemistry (Drug Discovery and Development).

### **9. REGIONAL AND INTERNATIONAL COMPARABILITY**

University of Northwest, South Africa, Level 7

This regional qualification is a 3-year double major of Biochemistry and Chemistry allows exit a level 7 or continuation to level 8. Regionally there is no directly equivalent qualification as the proposed qualification.

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

This United Kingdom qualification is a 3 year, 180 ECTS credits, at QAA/EHEA level 6.

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

This is a QAA level 6, 3-year qualification with 300 credits. The qualification has specialist modules and project on final year.

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

This Irish NQF level 8, 240 ECTS credits has a 4-year duration inclusive of level 5 in contrast to the University of Bath qualification.

The main similarities are that the qualifications utilizes both the knowledge based and performance based assessment strategies as outlined in the outcome based education. A research project at the final level of study is a common denominator. These shows the requirement for both “Knowledge” and “Skill” outcomes at BSc study level. In terms of domains, Organic chemistry, Analytical chemistry, Physics and Biochemistry are common features. The difference are at mainly in structure, the entry level (A-Level, level 5) for international qualifications which affects duration. The proposed qualification conclusively takes from the compared qualification to develop the necessary skills in the field of drug design, discovery and development.

#### 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 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 at Level 7 with 360 credits and level 7 at 120 credits.

#### **10. REVIEW PERIOD**

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