Ministry of Education

Identified Competency Focus Areas and Core Courses for Ethiopian Higher Education Institutions' Exit Examination

Program: Bachelor of Science in Biotechnology

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Courses and Competencies Identified for Exit Exam 2022 (First Draft)

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1. Introduction

Biotechnology is a rapidly growing and a cross-cutting field that uses a combination of biology and technology to develop technologies and products which help to improve our health, agriculture, industry and environmental management. Biotechnology helps to design and produce new molecules, plants, animals and microorganisms with improved characteristics. It offers seemingly unlimited opportunities to combine genes from related or unrelated species to produce useful organisms with desirable properties that were not previously found in nature. To realize the full potential of this field as a frontline area of research and development with an overwhelming impact on the societal and national economic development, higher education institutions of Ethiopia are expected to produce competent professionals that can make the country beneficiary of the modern applications in the discipline. Therein, biotechnology program was launched in various public universities of Ethiopia, aiming to produce competent graduates with the appropriate knowledge, attitude and skills (KAS).

The BSc. program in Biotechnology requires four years of studies. In the program, the first year is designed for national common courses, while the rest is for major and supplementary courses. In addition to offering basic theoretical knowledge, and skills (practical and entrepreneurial), the curriculum is designed to include fundamental concepts that span across other basic life and social sciences, chemistry, physics, and mathematics. As a result, students are expected to take 53 courses with a minimum of 151 credit hours. At the post completions of the B.Sc. program, the students are envisaged to acquire a comprehensive understanding on the core concepts and applied aspects of the constantly growing niche of modern biotechnology and its allied wings. Thus, it is necessary to measure the achievement of learning objectives through exit exams. In addition, the implementation of exit examination is related to the regulation and improvement of quality in higher education

University exit exam is a standardized comprehensive curriculum-based test, which is designed to assess if students have achieved the minimum competence that was stipulated in the graduates' profile. Thus, the ministry of education (MOE) has planned to deliver exit exams for several undergraduate programs, including biotechnology. For successful implementation of the exit exam, it is necessary to identify the key graduate profiles and the core competences of the curriculum. Moreover, student attainment of learning outcomes should be also assessed through standardized exams, which is set to measure KAS of graduates. As a result, it is necessary to select core

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biotechnology courses, which are necessary to prepare in exit exam as measure of attainment of core competences of the biotechnology program.

1.1. Objectives of the Exit Examination

The Biotechnology exit exam shall have the following objectives:

- To produce skilled and competent manpower to national and international market
- Assessing students' educational achievement in major areas of Biotechnology.
- Ensuring whether the graduation profile of Biotechnology curriculum have achieved at least common standards of knowledge and practical skills
- Improving public trust and confidence in Biotechnology activities of professionals
- Facilitating the efforts of students to revise the core learning outcomes of the courses covered by the exit examination
- Ensuring all graduates from HEIs satisfy the requirements of the labor market and employability through the national wide implementation of competency-based exit exam
- Creating competitive spirit among Biotechnology departments in Ethiopia with the aim of encouraging them to give due attention to the national standards

1.2. Significance of the Document

It is important to set competency areas of the subject matter (program) in order to measure the how much graduates are acquired with skills, knowledge and attitudes. The following shows us the significance or setting competencies and identifying core courses of the program;

- To set competencies that helps to assess the basic KAS of graduating students;
- To systematically identify the core courses which will be included the exit exam

2. Expected Graduate Profiles

The graduates of Biotechnology program will be expected to:

- work at governmental, non-governmental or private institutions in agricultural, medical, industrial, environmental protection as researchers and graduate assistants, laboratory technicians, service providers, and development workers;

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- have basic understanding of technical and scientific tools of Biotechnology;
- be aware of and adopt current advances of technology in life science;
- identify problems; design and execute research projects in biotechnology and related areas;
- follow and adapt standard procedures to carry out qualitative and quantitative analysis in Biotechnology laboratories;
- assist regulatory bodies in using and managing Biotechnology products;
- apply basic biotechnological principles for innovation;
- capable of understanding current issues and debates in Biotechnology and biosafety at national and international levels;
- pursue further specialized educations in various fields of Biotechnology and related fields;
- write scientific papers in order to disseminate scientific knowledge of biotechnology;
- be entrepreneurs who will invest their knowledge in different sectors of life sciences

3. Competences and Learning Outcomes

The graduates of Biotechnology are anticipated to have a minimum competence of KAS in core Biotechnology courses.

3.1 Competences

3.1.1 Knowledge

- Applying the principles of Biotechnology in industrial, environmental, health and agricultural sectors
- Acquiring and applying new knowledge and technologies in the bio-economy development.
- Determining the mechanisms how molecular defects cause human disease, including the mechanisms by which gene abnormalities may lead to various abnormalities in protein structure and function
- Applying biological methods used for removal of various pollutants from the environment
- Understanding the process of enzyme production and their wide application for different commercial products
- Identifying the fundamental principle and processing of food technology
- Familiarizing with current advances in the animal biotechnology (stem cells, hybridoma, IVF) and their public concerns.

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3.1.2. Skill

- Designing a system, process, procedure or program to meet desired needs of biotechnological applications in agriculture, industry, environment and health development,
- Developing and conducting appropriate experimentation, manipulating molecular activities, genetic engineering and sequencing, analyzing protein and DNA database,
- Applying the basic principle of genetic engineering to solve the problems in agricultural sector to promote crop and livestock production and productivity/ ability to solve agricultural, industrial, health, and environmental problems,
- Solving environmental problems posed by human and natural phenomena using ecofriendly biological methods to maintain the environment clean and restore the degraded lands

3.1.3. Attitude

- Comprehend the advantage and disadvantages of biotechnological products
- Perceive debating biosafety issues in biotechnology
- Reason out the main areas of public concern in biotechnology
- Appreciate the current use and potential of enzyme technology
- Develop attitude towards application of biotechnology in the areas of industry, agriculture, environment and health
- Develop positive attitude towards GMO

3.2 Learning outcomes

At the end of four-year study, the learning outcomes achieved in Biotechnology program include:

- Identifying, formulating, and solving broadly defined technical or scientific problems by applying principles and practices of biotechnology, sciences, and mathematics.
- Formulating or designing a system, process, procedure or program to meet desired needs of biotechnological applications in agriculture, industry, environment and health development.
- Developing and conducting appropriate experimentation, analyze and interpret data and use scientific judgment to draw conclusions.

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- Understanding ethical and professional responsibilities and make informed judgment, which must consider the impact of biotechnological solutions in global, economic, environmental, and societal contexts.
- Developing an entrepreneurial mindset and understand the dynamics of bioscience industry to translate scientific innovations into bio-based products, processes, services and viable business opportunities

4. Courses to Be Included in the Exam

Biotechnology represents a nexus of interdisciplinary realms. The students shall trace their journey from the basics of enzymology, techniques in molecular biology, molecular biology and genetics towards understanding the current endeavors to unmask the intricate networks of the molecular building blocks of life and engineer biomolecules and nucleic acid through courses on omics science, bioinformatics, genetic engineering and others. Likewise, course-content on the basics and advanced developments in the realms of microbial, plant and animal biotechnology would be complementing the various topics of tissue culture, molecular markers, industrial biotechnology, food biotechnology, enzyme technology as well as environmental biotechnology. In a similar vein, courses like diagnostic technology, immune-technology and medical biotechnology would open the portal towards the various advancements in the domain of health biotechnology. Besides being cognizant about the fields of aquatic biotechnology, forensic biotechnology as well as fungal biotechnology, the students would learn the various issues of intellectual property rights and biosafety. Overall, many of these courses are included in harmonized BSC curriculum delivered in several higher institutions as well as in Addis Abba science and technology curriculum designed for accreditations. Hence, 15 courses for exit exam preparation are uniquely selected from basic biotechnology areas as well as from major application areas of the discipline for measuring the competences the graduate nationally and internationally.

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4.1 List of Thematized Areas in the Program

1. **Industrial and Microbial Biotechnology**
   - Microbial Biotechnology
   - Food Biotechnology

- Industrial Biotechnology
- Enzyme Technology

2. **Agricultural Biotechnology**

- Plant Biotechnology
- Animal Biotechnology
- Plant Cell and Tissue Culture

3. **Basic Biotechnology**

- Molecular Biology
- Techniques in Molecular biology
- Biochemistry

4. **Health Biotechnology**

- Medical Biotechnology
- Immunology and Immune-technology

5. **Environmental biotechnology**

- Environmental Biotechnology
- Biosafety and Intellectual Property Right in Biotechnology

6. **Genomics and Bioinformatics**

- Genetic Engineering
- Bioinformatics

5. Categorizing Courses In To Sub-Themes

Table 1 shows coursers selected for exit exam preparation along with their categories. The numbers of course selected from each category is based on the coverage of each stream/area in curriculum and also expected graduate profile.

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Table 1. Selected course distributions in them areas

S. N	Areas/Streams	Selected Courses	Cr. Hrs.
1	Microbial and industrial Biotechnology	Microbial Biotechnology	(2+1)
		Food Biotechnology	(2+0)
		Industrial Biotechnology	(2+1)
		Enzyme Technology	(2+1)
		Total	**27**
2	Agricultural Biotechnology	Plant Biotechnology	(2+0)
		Animal Biotechnology	(2+1)
		Plant Cell and Tissue Culture	(1+1 /0+2)*
		Total	**21**
3	Basic Biotechnology	Molecular biology	(2+0/3+0)*
		Techniques in Molecular biology	(0+1/0+2)*
		Total	18
4	Medical Biotechnology	Medical Biotechnology	(2+1 /3+0)*
		Immunology and Immune-technology	(2+1)
		Total	**16**
5	Environmental Biotechnology	Environmental Biotechnology	(2+1/ 3+0)*
		Biosafety and Intellectual Property Right in Biotechnology	(2+0)
		Total	**14**
6	Genomics and Bioinformatics and Bioinformatics	Genetic Engineering	(2+1)
		Bioinformatics	(2+1)
		Total	**13**

*= Credit hour difference in the harmonized and Addis Ababa Science and Technology University

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6. Conclusion

Providing quality education is a major goal of higher education's institution. To achieve this, it is necessary to track and evaluate student knowledge, attitude and skill through exit exam by focusing on core competency and graduate profiles. Though 53 courses are delivered in Biotechnology BSc curriculum, MOE recommended 10-15 courses to be selected for exit exam preparation. As a result, 15 courses are selected from major Biotechnology courses. In the preparation of exams,

- It should be prepared in manner to measure the attainment of program learning outcomes by specially focusing on core competency of each subject
- Since many of the selected courses include practical sessions, exam should address the skills obtained
- Timing of exam should be properly planned to avoid burden of completion of second semester courses of graduates.

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7. Appendix

List of all courses in thematized areas

1. **Industrial and Microbial Biotechnology**

- Microbial Biotechnology
- Fungal Biotechnology
- Industrial Biotechnology
- Enzyme Technology
- Food Biotechnology
- Fundamentals of Biochemical Engineering
- Fuel Biotechnology

2. **Agricultural Biotechnology**

- Plant Biotechnology
- Animal Biotechnology
- Plant Cell and Tissue Culture
- Plant Anatomy and Physiology
- Animal Anatomy and Physiology
- Principles of Plant Breeding
- Animal Breeding

3. **Basic Biotechnology**

- Molecular Biology
- Techniques in Molecular biology
- Biochemistry
- Principles of Genetics
- Cytogenetic

4. **Health Biotechnology**

- Medical Biotechnology
- Immunology and Immune-technology
- Pharmaceutical Biotechnology
- Diagnostic technology

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5. Environmental Biotechnology

- Environmental Biotechnology
- Aquatic Biotechnology
- Biosafety and Intellectual Property Right in Biotechnology
- Biodiversity and Conservation of Genetic Resources

6. Genomics and bioinformatics

- Genetic Engineering
- Bioinformatics
- Introduction to Omics Science

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Ministry of Education

Higher Education Development sub-sector

Competency and Core Course Identification Validation Workshop for national Exit Examination

Participants' List

Nehassie 03-04/2014 E.C (August 8/2022 G.C)

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Program: Biotechnology_____

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