Course title: **Recent Trends in Biology Education**

Course No.: Bio. Ed. 535 (T) Nature of course: Theoretical

Level: M.Ed. in Biology Credit hours: 2

Semester: Third Teaching hours: 32

 Period per week: 2

1. **Course Description**

This course is designed to acquaint students with current trends in biology teaching and learning. The course aims to develop a professional biology teacher equipped with pedagogical knowledge, better understanding of classroom practices, and proficiency to biology teaching and learning. Furthermore, it incorporates innovative concepts and recent trends and development in biology education by blending technological skills to create learning activities.

1. **General Objectives**

The general objectives of this course are as follows:

* To provide the knowledge of developmental perspectives of biology education.
* To equip the students with the knowledge of the nature, values and scope of biology education.
* To acquaint students with the biology curriculum at school and university levels.
* To demonstrate the knowledge of biology on the basis of contemporary pedagogical concerns.
* To develop knowledge and skills of planning, designing and managing biology education classrooms and co-curricular activities.
* To review innovative approaches in biology teaching and apply them in biology teaching and learning.
* To develop skills of evaluation in the school and the university level.
* To promote an awareness of the social and technological implications of biology.
1. **Specific Objectives and Contents**

|  |  |
| --- | --- |
| **Specific Objectives** | **Contents** |
| * Comprehend the aims and objectives of school biology education.
* Elaborate the scope of biology education.
* List the importance of biology education in daily life.
* Review the development of biology education at the school and the tertiary level in Nepal, India, U.K., and U.S.A.
* Describe the changing faces of biology
* Discuss the biology education in a broader context.
* Deal with the issues of biology education.
* Explain the major paradigm shifts in biology education.
* Discuss the interdisciplinary dimensions of biology including correlation of biology with social sciences, chemistry, mathematics, and biology.
* Explain the relationship between the biology and society in-terms of environment, agriculture, and kitchen.
* Explain the importance of biology for sustainable development.
* Explore indigenous knowledge in biology in local context.
* Define and explain misconceptions.
* Give a comparative account of concepts, alternative concepts and misconceptions in biology.
* Explore the students’ misconceptions on the school, +2 and the university level in biology education.
 | **Unit I: Developmental Perspectives of**  **Biology Education (6pds.)*** 1. Aims and objectives of biology

Education* 1. Scope of biology education
	2. Importance of biology education
	3. Development of biology education in Nepal, India, U.K., and U.S.A.
	4. Changing faces of biology
	5. Biology education in a broader context
	6. Issues in biology education
	7. Paradigm and paradigm shift in biology education
	8. Interdisciplinary dimension of Biology
	9. Relation between the biology and the society (environment, agriculture and kitchen)
	10. Biology for sustainable development
	11. Indigenous knowledge in biology
	12. Concepts, alternative concept and misconceptions in biology education
 |
| * Introduce biology curriculum and its components.
* Explain innovative approaches in school biology curriculum of SAARC countries.
* Analyze critically the curriculum of secondary level and the university level biology curricula of Nepal.
* Illustrate the features of competency-based biology curriculum.
* Introduce the innovative biology education projects in-terms of their objectives, materials procedure, application and importance
* Biological Sciences Curriculum Study (BSCS).
* Nuffield O-level biology.
* Elaborate the concept of STEAM literacy.
* Discuss the needs, features and design of STEAM in the school curriculum.
 | **Unit II: Biology Education Curriculum (5pds.)*** 1. Introduction
	2. School and university level biology curricula in SAARC countries
	3. Analysis of secondary and university level biology curricula of Nepal
	4. Competency-based biology curriculum
	5. Innovative biology projects
		1. Biological Sciences Curriculum Study (BSCS)
		2. Nuffield O-level biology
	6. STEAM Literacy
		1. STEAM in school curriculum
 |
| * Design unit plan and lesson plan in the areas of biology.
* Enlist the advantages of planning in teaching biology.
* Design lesson plans in biology based on different approaches.
* Discuss the criteria for the evaluation of lesson plan.
 | **Unit III: Planning of Biology Teaching**  **(6pds.)*** 1. Unit plan and lesson plan
	2. Advantages of planning in teaching biology
	3. Approaches to design lesson plan
		1. Herbert approach,
		2. ABC approach,
		3. 7Es approach,
		4. Constructivist approach
		5. Project-based approach,
		6. Problem-solving approach
		7. Investigative approach
		8. Discovery approach
		9. Laboratory approach
	4. Criteria for the evaluation of lesson plan
 |
| * Design an instructional module of a biology lesson.
* Develop a programmed instruction in biology lesson.
* Elaborate the importance of computer-assisted instruction in biology teaching and learning.
* Discuss virtual learning environment for teaching and learning biology.
* Develop teaching materials in biology using the simulation mode.
* Apply the gaming mode in teaching biology.
* Design digital learning lessons on biology in VLEs, LMSs.
* Organize videoconferencing in learning biology.
* Advance learning experience through virtual field trip.
 | **Unit IV: Instructional Module and e-** **learning (5 pds.)*** 1. Instructional module
	2. Programmed instruction
	3. Computer Assisted Instruction (CAI)
	4. Virtual environment for teaching and learning biology
	5. Simulation in teaching biology
	6. Teaching biology in gaming mode
	7. e-learning products: VLEs, LMSs, web-based educational materials, video conferencing
	8. Virtual field trips: concept, process, and application

 |
| * Explain the basic characteristics of a good biology laboratory.
* Develop the designs of biology laboratory.
* Describe the techniques of laboratory management.
* Develop the biology laboratory skills.
* Point out the major causes of biology laboratory accidents and suggest their safety measures.
* Use the virtual biology laboratory for teaching and learning biology.
* Illustrate the importance of the mobile biology laboratory.
* Explain the construction of improvised biology laboratory materials and equipment.
 | **Unit V: Biology Laboratory (5 pds.)*** 1. Characteristics of a good biology laboratory
	2. Planning and designing of a biology laboratory
	3. Laboratory management techniques
	4. Biology laboratory skills
	5. Biology laboratory accidents and safety measures
	6. Virtual biology laboratory
	7. Biology mobile laboratory
	8. Improvisation of laboratory biology materials and equipment.
 |
| * Define evaluation.
* Explain the functions of evaluation.
* Describe summative, formative and diagnostic evaluation.
* Prepare the specification grid based on the biology courses.
* Discuss attributes of good biology test items
* Explain the general steps of test construction.
* Construct different test items in biology courses based on the revised Bloom’s taxonomy.
* Construct standardized biology test items of different levels.
* Calculate discrimination index of test items.
* Describe the criteria of item analysis and use them for standardization of test items.
* Calculate the item difficulty and discrimination index of biology test items.
* Introduce the letter grading system in Nepal.
 | **Unit VI: Evaluation (5 pds.)*** 1. Introduction
	2. Functions of evaluation
	3. Types of evaluation
	4. Specification grid
	5. Test items
	6. Attributes of good biology test items
	7. General steps of test construction
	8. Construction of test items based on the revised Bloom’s taxonomy
	9. Standardization/ analysis of test
	10. Letter grading system
 |

***Note:*** *The figures in the parenthesis indicate the appropriate teaching hours for the respective units*.

1. **Instructional Techniques**

The instructional techniques for this course are divided into two groups. First group consists of general instructional techniques applicable to most of the units. The second group consists of specific instructional techniques applicable to the particular units.

* 1. **General Instructional Techniques**
* Discussion
* Demonstration
* Presentation
* Inquiry
* Project work
* Cooperative and collaborative work
* Internet (web) surfing
* Group work

 **4.2 Specific Instructional Techniques**

|  |  |
| --- | --- |
| **Units** | **Specific Instructional Techniques** |
| **I** | Classroom presentation on biology and biology education. |
| **II** | Curriculum review, and curriculum display of SAARC countries and reflect on it with comments. |
| **III** | Workshop cum discussion |
| **IV** | Paper writing and presentation followed by discussion. |
| **V** | Presentation by studying the handouts provided by the teacher followed by teachers' suggestions on biology laboratories. Student must visit biology laboratory and observation made by observation check list.  |
| **VI**  | Presentation by studying the handouts provided by the teacher and makes the report include the suggestions.  |

1. **Evaluation**
	1. **Evaluation (Internal Assessment and External Assessment)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nature of course** | **Internal Assessment** | **Semester Examination** | **Total Marks** |
| Theory | 25 Marks | 40 Marks | 65 Marks |

***Note****: Students must pass separately in internal assessment and semester examination.*

* + 1. **Internal Evaluation 25 Marks**

Internal evaluation will be conducted by the course teacher based on following

activities:

|  |  |  |
| --- | --- | --- |
| 1. | Attendance and participation in learning activities | 5 Marks |
| 2. | First assignment (written assignment) | 5 Marks |
| 3. | Second assignment (report writing and presentation) | 5 Marks |
| 4. | Third assignment/ Term exam | 10 Marks |
|  | Total | 25 Marks |

**Note:** *First assignment/assessment might be book review /article review, quiz, home assignment etc. according to nature of course. Second assignment/assessment might be project work, case study, seminar, survey/field study and individual/group report writing, term paper based on secondary data or review of literature and documents etc. and third assignment will be term exam.*

**5.1.2. External Evaluation (Final Examination) 40 Marks**

Examination Division, office of the Dean, Faculty of Education will conduct final examination at the end of semester. The marks distribution will be

|  |  |
| --- | --- |
| 1. Objective questions (Multiple Choice Questions 10 x 1mark)
 | 10 Marks |
| 1. Subjective short questions (6 questions with 2 ‘OR ‘questions x 5 marks)
 |  30 Marks |
|  Total | 40 Marks |

1. **Recommended Books and References**

Agarwal, P. K. (2018). Retrieval practice & Bloom’s taxonomy: Do students need fact

knowledge before higher order learning? *Journal of Educational Psychology*.

**(For Unit-VI)**

Ahmad, S. (2007). *Teacher’s hand Book of Science*, New Delhi: Anmol Publication Pvt. Ltd.

 **(For All Units)**

Amos, S. &. Boohan, R. (2002). *Aspects of teaching secondary science: Perspective on practice.* New York & London: Routledge Taylor and Francis Group. **(For Unit I)**

Banks, F., & Barlex, D. (2014). Teaching STEM in the secondary school: Helping teachers meet the challenge. New York. Routledge. **(For Unit II)**

Bhatnagar A. B. & Bhatnagar S. S. (2004). *Teaching of Science*, Meerut: Surya Publication.

**(For All Units)**

Bork, D. (2019). A Framework for Teaching Conceptual Modeling and Metamodeling Based

on Bloom’s Revised Taxonomy of Educational Objectives. **(For Unit -VI)**

Chambers, D. (1993). Toward a competency-based curriculum. *Journal of Dental Education, 57*, 790-790. **(For Unit - II)**

CLEAPSE. (2009). *Designing and Planning Laboratories.* Brunel Science Park: CLEAPSE (Consortium of Local Education Authorities for the Provision of Science Equipment).

**(For Unit - V)**

Davar, M. (2012). *Teaching of Science.* New Delhi: PHI Learning Private Limited.

**(For Unit- I, III, IV, & V)**

Diberardinis, L. J., Baum, J. S., First, M. W., Gatwood, G. T., & Seth, A. K. (2013). *Guidelines forlLaboratory design: Health, safety, and environmental considerations (4th ed.)* New York: Wiley Publications. **(For Unit - V)**

Gil-Perez, D., & Carrascosa, J. (1990). What to Do About Science “Misconceptions”. *Science Education 74(5)*, 531-540. **(For Unit - I)**

Gupta, V. (2005). *Teaching and learning of science and technology.* New Delhi: Vikas Publishing House. **(For Unit-IV)**

Guskey, T. (2011). Five obstacles to grading reform. *Educational Leadership, 69(3)*, 16.

**(For Unit - VI)**

Hofstein, A., & Lunetta, V. (1982). The role of the laboratory in science teaching: Neglected aspects of research. *Review of educational research, 52(2)*, 201-217. **(For Unit - V)**

Howarth, S. & Scott, L. (2014). Success with STEM: Ideas for the classroom, STEM clubs and beyond. Oxon: Routledge. **(For Unit II)**

Karpudewan, M., Md.Zain, A. N., & Chandrasegaran, A. (2017). Overcoming students' misconceptions in Science. Singapore: Springer Singapore. **(For Unit - I)**

Lau, D. (2001). Analyzing the curriculum development process: Three models. *Pedagogy, culture and society, 9(1)*, 29-44. **(For Unit - II)**

Levine, M., Serio, N., Radaram, B., Chaudhuri, S., & Talbert, W. (2015). Addressing the STEM gender gap by designing and implementing an educational outreach chemistry camp for middle school girls. *Journal of Chemical Education*, *92*(10), 1639-1644. **(For Unit II)**

Lubiano, M. L. D., & Magpantay, M. S. (2021). Enhanced 7E Instructional Model towards

Enriching Science Inquiry Skills. *International Journal of Research in Education and*

*Science*, *7*(3), 630-658. **(For Unit - III)**

Mammi, H. K., & Ithnin, N. (2012). Competency based education (CBE) for IT security: towards bridging the gap. *INTERNATIONAL JOURNAL OF ENGINEERING PEDAGOGY (IJEP)*, 24-26. **(For Unit- II)**

Mohan, R. (2007). *Innovative science teaching.* New Delhi: Prentice-Hall of India Pvt. Ltd. (**For all Units)**

Pinner, R. (2014). What Is The Difference between an LMS and a VLE? *Learning Management Systems*. **(For Unit - IV)**

Ronen, I. (2017). *Misconceptions in science education, (1st ed.).* UK: Cambridge Scholars Publishing. **(For Unit - I)**

Sood, J. (2009). *Teaching of science.* New Delhi: Prentice Hall of India.

 **(For Unit -I, II, III & V)**

Wei, B., & Ou, Y. (2018). A Comparative Analysis of Junior High School Science

Curriculum Standards in Mainland China, Taiwan, Hong Kong, and Macao: Based on

Revised Bloom’s Taxonomy. *International Journal of Science and Mathematics*

*Education*, 1-16. **(For Unit - VI)**

Yakman, G. (2008). STEAM education: An overview of creating a model of integrative

education. **(For Unit - I)**

Zhao, X., Wang, J., Wang, M., Li, X., Gao, X., & Huang, C. (2020). A new model for assessing the impact of environmental psychology, e-learning, learning style and school design on the behavior of elementary students. *Kybernetes*. **(For Unit -IV)**

|  |  |
| --- | --- |
| Course Title**: Recent Trends in Biology Education** |  |

 Course No.: Bio. Ed. 535 (P) Nature of course: Practical

 Level: M.Ed. in Biology Credit Hours: 1

 Semester: Third Teaching hours: 48\*

Periods per week: 3 pds/day/week/gr (P)\*\*

1. **Course Description**

This practical course acquaints students to impart the knowledge and skills they need to instruct practical classes in biology education. It boosts the ability for producing reports, presentations, and seminar papers in addition to the capacity for leading workshops, utilizing cutting-edge lesson planning strategies, e-learning, and improvised materials, designing biology labs, and assessing biology education at various levels.

1. **General Objectives**

The objectives of this course are to enable students to

* Analyze the issues of the different aspects of the biology curriculum;
* Prepare research articles based on the recent pedagogical approaches in biology education;
* Examine the existing secondary school biology practices;
* Prepare and present seminar papers by conducting seminars on the issues of biology education;
* Develop the skills in PowerPoint presentations and skills of engaged and lived presentations;
1. **Contents**

|  |  |
| --- | --- |
| **Students Activities/Contents** | **Total hours (48)** |
| **Unit I: Developmental Perspectives of Biology Education** * Prepare a discussion paper on the application of Biology for daily life.
* Prepare report on school and the university-based issues of Biology teaching and learning.
* Critically review the assigned research papers.
* Prepare the manuscript for journal articles within the areas of this unit.
* Carry out a mini research study on indigenous knowledge in biology.
* Make a report on paradigm shifts in biology from the different perspectives.
 | 9 |
| **Unit II: Biology Study Curriculum** * Report on the issues of different aspects of curriculum (e.g., curriculum development process, aspects of curriculum) and organize discussion session.
* Analyze the secondary level Biology curriculum based on the structure, scope, objectives, organization, strategies and evaluation and then prepare a report on it.
* Prepare a sample curriculum based on the related biology topics.
 | 6 |
| **Unit III: Planning of Biology Teaching** * Prepare a unit plan for a topic of your choice in biology and present it to the class.
* Prepare a lesson plan for teaching in biology based on the ABC approach, 7E approach, project-based approach and problem-solving approach.
 | 6 |
| **Unit IV: Instructional Module and e-learning** * Design an instructional module on topics related to Biology lessons.
* Design LMSs for teaching and learning Biology.
* Search web-based materials for teaching and learning Biology.
* Review research articles related to simulation in teaching biology.
* Review research articles related to the effectiveness of gaming mode teaching strategy in the secondary level school biology.
* Apply videoconferencing to learning biology.
 | 12 |
| **Unit V: Biology Laboratory** * Design various models of biology laboratory.
* Conduct different biology related-related activities using the virtual laboratory.
* Conduct a survey on students' awareness of laboratory-based activities, lab safety, accidents, and first aid treatment.
* Design improvised materials of various kinds using locally available materials.
 | 9 |
| **Unit VI: Unit VI: Evaluation** * Develop a model specification chart for testing Biology
* Design biology courses test item of different levels of cognitive domain and then administer and calculate the item difficulty and discrimination index.
* Construct a set of test items of biology courses based on the revised Bloom’s taxonomy.
 | 6 |

1. **Specific Instructional Techniques**
* Internet surfing
* Develop manuscript by collaboration and discussion
* Workshops: Presentation, participatory activities
* Books and article review
* Field visit
* Preparation of charts, models, presentations slides, and reports.
1. **Evaluation 35 Marks**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nature of course** | **Internal Evaluation** | **External Evaluation** | **Total Marks** |
| Practical | 15 Marks | 20 Marks | 35 Marks |

**5.1 Internal Evaluation 15 Marks**

Marks distribution for practical internal evaluation will be as following.

|  |  |  |
| --- | --- | --- |
| 1. | Attendance  | 5Marks |
| 2. | Students’ portfolios (Record book and Books and article review etc.) | 5Marks |
| 3. | Participation, collaborative work and construction of teaching learning resources and planning for teaching learning \*\*\* | 5Marks |
|  | Total | 15Marks |

**5.2 External Evaluation 20 Marks**

Marks distribution for practical external evaluation will be as following.

|  |  |  |
| --- | --- | --- |
| 1. | Experiment/project work report and presentation / study reports  | 15Marks |
| 2. | Viva-voce | 5 Marks |
|  | Total | 20Marks |

 **Note:**

*Students must pass both in internal as well as external assessments of practical examination*

*\* Practical teaching hours is 3 times more than teaching hours of theory (3x 16 = 48 hours)*

*\*\*A group consists of 15 students and one teacher will be assigned for a group.*

*\*\*\*Construction of models, charts, teaching aids, develop concept map etc. Also, the collection of materials / designing biology lab, preparation of lesson plan, unit plan, annual plan, preparation of rubrics, developing test items of various levels etc. for teaching learning.*

**Recommended Books and References**

Ahmad. J., (2011). *Teaching of Biological Science (2nd edition).* New Delhi: PHI

Learning Private Limited.

Agarwal, P. K. (2018). Retrieval practice & Bloom’s taxonomy: Do students need fact

knowledge before higher-order learning? *Journal of Educational Psychology*.

Course Title : **Basic Biotechnology**

Course No. : Bio. Ed. 536 (T) Nature of course: Theoretical

Level : M. Ed. in Biology Credit hours: 2

Semester : Third Teaching hours: 32

 Period per week: 2

1. **Course Description**

This course aims to provide knowledge on recent advances on biotechnology and its applications in various fields. Specially it deals with the present status of biotechnological works in cell and tissue culture with reference to Nepal and also provides the students with knowledge of biotechnological techniques.

1. **General Objectives**

General objectives of this course are as follows:

* To acquaint students with the knowledge of present status and scope of biotechnology.
* To provide knowledge on tissue culture methods.
* To familiarize with the recent advances in biotechnology and its applications in various fields with particular reference to Nepal.
1. **Specific Objectives and Contents**

|  |  |
| --- | --- |
| **Specific Objectives** | **Contents** |
| * Explain the scope and importance of biotechnology.
* Summarize the present status of biotechnology in Nepal.
* Explain briefly about biotechnological applications in plant and agriculture, food and industries, medicine and pharmaceuticals and environment and conservation
* Discuss the risks and hazards of biotechnology.
 | **Unit I. Biotechnology (6 pds)*** 1. Introduction
	2. Scope and importance of biotechnology
	3. Present status of biotechnology in Nepal
	4. Biotechnological Applications
		1. Plant and Agriculture (Plant tissue culture, Biofertilizer -Rhizobia, blue green algae, Frankia and Mycorrhiza, Biopesticides)
		2. Food and Industries (vitamins and enzymes; biogas, alcohol, organic acid, and amino acid), Biotechnology in diary industry
		3. Medicine and Pharmaceuticals (antibody production, production of human and animal vaccines, diagnosis of infectious disease, hormones, enzymes, pharmacogenomics),
		4. Environment and Conservation (Bioremediation, Bioplastics, waste treatment)
	5. Risks and hazards of biotechnology
 |
| * Give the concept of Genetic Engineering and its applications in the field of medicine, human health, agriculture and environment.
* Explain some important drawbacks of genetic engineering.
 | **Unit II. Genetic Engineering (4 pds)*** 1. Genetic engineering or recombinant DNA technology.
		1. Concept of genetic engineering
		2. Application of Genetic Engineering in the field of medicine and human health (recombinant vaccine, Human Growth hormone, Insulin, Interferons).
		3. Application of Genetic Engineering in the field of Agriculture and Environment (production of resistant varieties of crops, bio-fertilization, increase the protein content)
		4. Possible drawbacks of Genetic Engineering
 |
| * Elaborate the concept of different types of tissue culture.
* Describe the requirements for tissue culture (Different culture media and their composition, and sterilization techniques).
* Explain micro-propagation techniques and their applications.
* Describe important applications of tissue culture in micropropagation, protoplast fusion, somatic hybridization, disease free plants
* Explain the present status of tissue culture laboratories in Nepal.
 | **Unit III. Plant Tissue Culture (12 pds)*** 1. Introduction
	2. Types of tissue culture
		1. Seed culture
		2. Embryo culture
		3. Anther culture
		4. Organ culture
		5. Suspension culture
		6. Single cell culture
		7. Meristem culture
		8. Protoplast culture
	3. Requirements for Plant Tissue Culture
		1. Different media and their composition used in plant tissue culture
		2. Media preparation
		3. Inorganic nutrients
		4. Organic nutrients
		5. Growth hormones
		6. Agar
		7. PH
		8. Sterilization Techniques
	4. Applications of Plant Tissue Culture
		1. Micropropagation
		2. Protoplast fusion
		3. Somatic hybridization
		4. Disease free plants
	5. Status of tissue culture laboratories in Nepal
 |
| * Give brief introduction to environmental biotechnology.
* Describe the role of biotechnology in preservation of the environment with respect to waste treatment.
* Elaborate the application of biotechnology for biodegradation and bioremediation.
 | **Unit IV.** **Environmental Biotechnology (2pds)*** 1. Introduction
	2. Waste Treatment
		1. Aerobic Waste treatment
		2. Anaerobic Waste treatment
	3. Biodegradation and Bioremediation
 |
| * Give the concept, importance and drawbacks of genetically modified crops (GM crops).
 | **Unit V. Genetically Modified (GM) Crops**  **(2pds)**5.1. Introduction 5.2. Importance of GM crops. 5.3. Drawbacks of GM crops. |
| * Give the concept of In-vitro fertilization in animals.
* Describe different methods of In-vitro fertilization in animals for artificial insemination, embryo transfer technology.
* Illustrate transgenic animals and give importance of transgenic animals.
* Elaborate the concept of test tube baby.
 | **Unit VI.** **Manipulation of Reproduction in**  **Animals (4pds)**6.1. Introduction6.2. Methods of Manipulation In-vitro fertilization in animals6.2.1. Artificial insemination6.2.2. Embryo transfer technology 6.3. Transgenic animals and their importance6.4. Test Tube baby |
| * Give introduction to cryopreservation.
* Explain the methods and uses of cryopreservation
 | **Unit VII. Cryopreservation (2pds)*** 1. Introduction
	2. Methods of Cryopreservation
	3. Uses and importance of Cryopreservation
 |

***Note:*** *The figures within parenthesis indicate the appropriate teaching hours allocated to respective units*

1. **Instructional Techniques**

The instructional techniques are divided into two groups. The first group consists of general instructional techniques applicable to most of the units. The second group consists of specific instructional techniques/activities applicable to the specific units.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.N.** | **Units** | **Title**  | **General Instructional Techniques** | **Specific Instructional Techniques** |
| 1. | I | Biotechnology | Lecture and discussion methods; power-point presentation | internet search, Group activities; Inquiry |
| 2. | II | Genetic Engineering | Lecture and discussion methods; Power-point presentationInquiry | Internet surfing, Project work; Group work; Field Trip |
| 3. | III |  Plant Tissue Culture | Lecture and discussion methods; Power-point presentation | Collaborative method, Brain Storming; Seminar method; Internet search; Field Trip; Problem solving and reports |
| 4. | IV | Environmental Biotechnology | Lecture and discussion methods, Book review | Demonstration method; Project work; Field Trip; Case studies; and reports  |
| 5. | V | Genetically Modified (GM) Crops | Lecture and discussion methods; power-point presentation Internet search; | Collaborative method; Reading and Critical analysis of research article; Group work; Case studies; Problem solving and reports  |
| 6 | VI | Manipulation of Reproduction in Animals | Lecture and discussion methods; Inquiry method; power-point presentation, Book review, Inquiry Internet search,  | Collaborative work, Field Trip, problem solving and reports,  |
| 7 | VII | Cryopreservation | Lecture and discussion methods; power-point presentation, internet search, Book review Inquiry | Case studies; Field Trip |

*Note: Each student must come up with a project work individually or in group but with clear role and responsibility. The teacher and students may decide the project work from the list above or alternative related to the course work.*

1. **Evaluation**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nature of course** | **Internal Assessment** | **Semester Examination** | **Total Marks** |
| Theory | 25 Marks | 40 Marks | 65 Marks |

 ***Note:*** *Students must pass separately in internal assessment and semester examination.*

* 1. **Internal Evaluation 25 Marks**

Internal evaluation will be conducted by course teacher based on following activities:

|  |  |  |
| --- | --- | --- |
| 1. | Attendance and participation in learning activities | 5 marks |
| 2. | First assignment (written assignment) | 5 marks |
| 3. | Second assignment (report writing and presentation) | 5 marks |
| 4. | Third assignment/ Exam | 10 marks |
|  | Total | 25 Marks |

**Note:** *First assignment/assessment might be book review /article review, quiz, home assignment etc. according to nature of course. Second assignment/assessment might be project work, case study, seminar, survey/field study and individual/group report writing, term paper based on secondary data or review of literature and documents etc. and third assignment will be term exam.*

* 1. **External Evaluation (Final Examination) 40 Marks**

Examination Division, office of the Dean, Faculty of Education will conduct final examination at the end of semester. The marks distribution will be

|  |  |  |
| --- | --- | --- |
| 1. | Objective questions (Multiple Choice Questions 10 x 1mark) | 10 Marks |
| 2. | Subjective questions (6 questions with 2 ‘OR ‘questions x 5 marks) | 30 Marks |
|  | Total | 1. arks
 |

1. **Recommended Books and References**

**Recommended Books**

Dubey, R. C. (2013). *A Text Book of Biotechnology*. New Delhi: S. Chand & Company

Ltd. **(For Unit I, II, V & VI)**

Ignacimuth, S. J. (2007). *Basic Biotechnology*. New Delhi: Tata Mc. Graw Hill Pub.

Company Ltd. **(For Unit IV)**

Ratledge, C., & Kristiansen, B. (2001). *Basic biotechnology*. London: Cambridge

University Press. **(For Unit I and III)**

Scragg, A. H. (2005). *Environmental biotechnology*. New York: OXFORD university

Press. **(For Unit IV)**

Verma, S., & Verma, M. (2008). *A textbook of plant physiology, biochemistry and*

*biotechnology*. New Delhi: S. Chand Publishing. **(For Unit III to XI)**

**References**

Gupta, P.K. (2000). *Elements of Biotechnology*, Rastogi Publications, New Delhi.

Keshari, A. K., & Adhikari, K.K. (2010). *A Text book of Higher Secondary*

*Biology*. Kathmandu: Vidyarthi Publications. **(Unit I, II, III)**

Purohit, S.D. (2013). *Introduction to Plant Cell, Tissue and Organ Culture*. Delta: PHI

Learning Private Limited.

Singh, B. D. (2010). *Biotechnology*. Kalyani Publishers.

Crueger, W., & Crueger, A. (2017). *Crueger's Biotechnology: A Textbook of Industrial*

*Microbiology*. India: MedTech. **(Unit I)**

Smith, J.E. (1996). *Biotechnology, 3rd Edition.* London: Cambridge University Press.

Cassida, L.E. (1996). *Industrial Microbiology*. New Delhi: New Age Int. Publishers.

Dubey, R.C. (2001). *Textbook of Biotechnology*. New Delhi: S Chand and Company Ltd.

Course Title : **Basic Biotechnology (Practical)**

Course No : Bio. Ed. 536 (P) Nature of the course: Practical

Level : M.Ed. in Biology Credit hours: 1

Semester : Third Teaching hours: 48\*

 Period per week: 3pds/day/week/gr \* \*(P)

* 1. **Course Description:**

This course is practical course and designed to develop knowledge and skills for conducting biotechnology practical. It also provides the knowledge and skill about plant and animal cell/tissue culture and micro propagation techniques. Through field visit to different places students will develop ideas to promote the use of biotechnology in agriculture, horticulture, animal farm, different industries etc.

* 1. **General Objectives:**

The general objectives of this course are as follows:

* To familiarize the students with the lab equipment used in biotechnology lab and describe their functions
* To develop hands on skills of biotechnology laboratory
* To acquaint the students with knowledge and practical skills of different biotechnological techniques
	1. **Specific Objectives and Contents:**

|  |  |
| --- | --- |
| **Specific Objectives** | **Contents (48pds)** |
| * Study and use different sterilization equipment.
* Perform surface sterilization of some plant parts
 | **Unit I: Sterilization Techniques (3x3= 9 pds)*** 1. Different equipment used for Sterilization techniques
	2. Surface sterilization of explant
 |
| * Prepare culture media
* Prepare stock solution media
 | **Unit II: Media and Stock Solution Preparation (4 x 3= 12 pds)*** 1. Preparation of media for different plant tissue culture media
	2. Preparation of stock solution- Murashige and Skoog medium (1962).
 |
| * Perform Micropropagation techniques and other types of tissue culture
 | Unit III: Micropropagation **(2 x 3 = 6 pds)*** 1. Micropropagation technique, organ culture and anther culture
 |
| * Visit to nearby laboratories, treatment and production units, conservation areas, and organizations working in the sector of biotechnology and submit the reports.
 | Unit IV: Field Visit: **(7 x 3 = 21 pds)*** Tissue culture laboratories to study tissue culture methods and their applications
* Universities botany laboratories, biotechnology laboratories, Forensics lab, Department of Food Technology and Quality Control (DFTQC), Biotech companies’ laboratories, Food laboratories
* Waste treatment area, distillery plant, dairy farm,
* Zoo, botanical gardens, conservatories, wildlife reserves, conservatories, Nurseries, farms, wildlife reserves,
* National Agriculture Research Council (NARC), Nepal Academy of Science and technology (NAST),
 |

*Note: Each student must come up with a project work individually or in group but with clear role and responsibility. The teacher and students may decide the project work from the list above or alternative related to the course work.*

* 1. **Instructional Techniques**

The instructional techniques for this course are divided into two groups. First group consists of general instructional techniques applicable to most of the units. The second group consists of specific instructional techniques applicable to specific units.

|  |  |  |  |
| --- | --- | --- | --- |
| **S. N.** | **Title** | **General Instructional Techniques** | **Specific Instructional Techniques** |
| 1. | Study and use different sterilization equipment. | Lecture and discussion methods; power-point presentation | Demonstration method, Group work |
| 2. | Perform surface sterilization of some plant parts | Performing experiments | Demonstration method; Individual laboratory work;  |
| 3. | Prepare culture media | Performing experiments | Collaborative method;Individual laboratory work; Problem solving  |
| 4. | Prepare stock solution media  | Performing experiments | Demonstration method; Individual laboratory work  |
| 5. | Perform Micropropagation techniques and other types of tissue culture | Performing experiments | Demonstrative method; Individual laboratory work; Problem solving and reports  |
| 6 | Visit to any nearby local area | Field visit, Interview and report writing | Collaborative work, field work, problem solving and reports |

* 1. **Evaluation 35 Marks**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nature of course** | **Internal Evaluation** | **External Evaluation** | **Total Marks** |
| Practical | 15 Marks | 20 Marks | 35 Marks |

 **5.1 Internal Evaluation 15 Marks**

Marks distribution for practical internal evaluation will be as following.

|  |  |  |
| --- | --- | --- |
| 1. | Attendance  | 5Marks |
| 2. | Students’ portfolios (Record book and Books and article review etc.) | 5Marks |
| 3. | Participation, collaborative work and construction of teaching learning resources and planning for teaching learning \*\*\* | 5Marks |
|  | Total | 15Marks |

**5.2 External Evaluation 20 Marks**

Marks distribution for practical external evaluation will be as following.

|  |  |  |
| --- | --- | --- |
| 1. | Experiment / project work report and presentation / study reports  | 15Marks |
| 2. | Viva-voce | 5 Marks |
|  | Total | 20Marks |

**Note:**

*Students must pass both in internal as well as external assessment of practical*

*examination*

*\* Practical teaching hours is 3 times more than teaching hours of theory (3x 16 = 48*

*hours)*

*\*\*A group consists of 15 students and one teacher will be assigned for a group.*

*\*\*\*Construction of models, charts, teaching aids, develop concept map etc. Also, the collection of materials / designing science lab, preparation of lesson plan, unit plan, annual plan, preparation of rubrics, developing test items of various levels etc. for teaching learning.*

* 1. **Recommended Books and References for Practical**

Bhattarai, T. (2005). *Experiments on Plant Biochemistry and Plant Biotechnology*.

Kathmandu Bhundipuran Prakashan,

Gamborg, O.L. (2002). Plant Tissue Culture, Biotechnology, Milestones. In vitro cellular

and Developmental Biology- Plant, 38, 84- 92.

Robert, N. T and Dennis J.G. (2000). Plant Tissue culture Concept and Laboratory

Exercises, (2nd edition).   CRC Press.

Smith, R.A. (1992). Plant Tissue Culture. Techniques and Experiments. Academic Press,

Inc., San Diego, CA

Course Title :**Fundamentals of Microbiology**

Course No : Bio. Ed. 537 (T) Nature of the course: Theoretical

Level : M.Ed. in Biology Credit hours: 2

Semester : Third Teaching hours: 32

Periods per week: 2

1. **Course description:**

This course aims to give advanced knowledge on general aspects of microbiology and general concepts on specific aspects of microbiology such as food, medical, environmental and pharmaceutical microbiology. It deals with general characteristics of microorganisms, their impact to human beings on different fields such as food, medicine, environment and pharmaceutics.

1. **General objectives**

The general objectives of this course are as follows:

* To provide detail knowledge on the structure and reproduction of microorganism.
* To familiarize student with the preservation, contamination and spoilage of different food and food products.
* To impart knowledge on disease transmission and immunity of organism against infections.
* To provide knowledge on transmission of microbial diseases, concept of epidemic, endemic, pandemic and sporadic, basic immune system, host parasite relationship.
* To provide knowledge on water, sewage treatment and proper management of solid waste.
* To introduce brief knowledge on antibiotics and their mode of actions on microorganism.
* To impart knowledge on importance of microorganisms in daily life.
1. **Specific objectives and content:**

|  |  |
| --- | --- |
| **Specific objectives** | **Contents** |
| * Define and describe microbiology.
* Explain the characteristics of major

groups of microorganisms.* Discuss the characteristics of prokaryotic and eukaryotic microorganisms.
* Compare and contrast the cellular

 level of Prokaryotes, archaea and  eukaryotes. * Define and describe bacteria.
* Classify bacteria on the basis of Morphology, Motility, Staining, Gaseous requirements, Temperature, pH requirements, Salt requirements, Mode of nutrition.
* Describe intracellular and extracellular structure of bacteria.
* Describe structure and multiplication of bacteria.
* Describe the structure and multiplication and Replication of virus.
* Explain different methods of controlling microorganisms by using different techniques.
* List the physical and chemical controlling agents.
* Compare and contrast Sterilization, disinfection, antisepsis
 | **Unit I General Microbiology (12 hrs.)**1.1 Introduction to microbiology 1.2 Characteristics of major groups of microorganisms (bacteria, archaea, fungi (yeasts and molds), algae, protozoa, and viruses1.3 Characteristics of prokaryotic and eukaryotic microorganisms1.4 Differentiation among prokaryotes, archaea and eukaryotes 1.5 Bacteria 1.5.1 Classification based on morphology, motility, staining, gaseous requirements, temperature, pH requirements, salt requirements, mode of nutrition mostly (photo lithotrophic, chemo lithotrophic, photo organotrophic, chemoorganotrophic),1.5.2 Structure (intracellular and extracellular)1.5.3 Multiplication1.6 Virus (Structure of virus, multiplication)1.7 Control of microorganism by physical agents (temperature**,** radiation, and filtration). and chemical agents (chlorine, formaldehyde, glutaraldehyde, quaternary ammonium compounds, and Ethylene oxide.1.7.1 Definition of Sterilization, Disinfection, Disinfectant, Antiseptic agent, Bacteriostatic agents, Bactericidal agents, antimicrobial agents.  |
| * Explain the principles of food preservation.
* Explain food preservation techniques.
* Describe the basic concept of contamination, spoilage and preservation of canned food, meat, milk and vegetables.
* Food borne diseases.
* Basic concept of food poisoning and food infection.
* Explain different types of Mycotoxins.
 | **Unit II Food Microbiology (5 hrs.)**2.1 Principles of food preservation2.2 Food preservation techniques2.3 Basic concept of contamination, spoilage and preservation of canned food, meat and meat products, milk and milk products and vegetables2.4 Causative agent of food borne diseases, (Staphylococcus aureus and clostridium botulinum food infections) and preventive methods for food borne diseases methods 2.5 Mycotoxins2.6 Types of Mycotoxins, their effects on health and mitigation of mycotoxins |
| * Describe infection
* Explain different modes of transmission of diseases
* Explain normal microbial flora of human body
* State the basic concept of host parasite relationship
* Vector borne diseases
* Define immunity
* Defense mechanism of human body against infections and diseases
* Anatomical and biochemical barriers of immunity
 | **Unit III Medical Microbiology (7 hrs.)**3.1. Infection3.1.1 Generalized infection, Localized infection3.2. Health and Disease 3.2.1 Epidemic, Endemic, Pandemic, Sporadic 3.2.2 Mode of transmission of diseases 3.2.3 Normal microbial flora of human  body 3.2.4 Basic concept of host parasite relationship 3.2.5 Causative agent of vector borne diseases, examples and prevention methods 3.3 Immunity 3.3.1 Basic concept of antigen and antibody 3.3.2 Defense mechanism against infections and diseases |
| * Microbiological, physical and chemical parameters of drinking water
* Describe indicator organisms of water pollution
* Drinking water treatment in household purpose (small scale)
* Describe the of municipal water treatment and sewage treatment process
* Explain the concept of solid waste management
* Air and water borne diseases
 | **Unit IV Environmental Microbiology**  **(5 hrs.)**4.1 Causative agent of air and water borne diseases, (cholera, Salmonellosis, Vibriosis, amebiasis and Giardiasis examples and prevention methods4.2 WHO and Nepal guidelines for drinking water standards4.3 Indicator organisms of water pollution4.4Household water treatment by boiling, chlorination, iodination, filtration, Solar disinfection (SODIS)4.5 Detailed process of municipal water treatment, sewage treatment and solid waste management. |
| * Give the concept of antibiotics
* Describe the types of antibiotics in brief
* Antifungal and antiviral drugs in brief
* Explain the mode of actions of antibiotics in detail
 | **Unit V Pharmaceutical Microbiology**  **(3 hrs.)**5.1. Concept of antibiotics5.2. Types of antibiotics, basis for classification of antibiotics5.3 Definition and examples of antifungal and antiviral drugs 5.4. Mode of action of antibiotics  |

***Note:*** *The figures within parenthesis indicate the appropriate teaching hours allocated to respective units*

1. **Instructional Techniques**

The instructional techniques are divided into two groups. The first group consists of general instructional techniques applicable to most of the units. The second group consists of specific instructional techniques/activities applicable to the specific units.

|  |  |  |
| --- | --- | --- |
| **Units** | **General Instructional Techniques** | **Specific Instructional Techniques** |
| I | * Lecture and discussion methods; Inquiry method, power point presentation, Internet search
 | * Preparation of charts on field and scopes of Microbiology
* Preparation of charts on different classification basis of bacteria
 |
| II | * Lecture and discussion methods; Inquiry method, collaborative method, power point presentation, Internet search
 | * Project work will be given to prepare the report for traditional food preservation techniques of Nepal
* Preparation of report on status of food borne disease occurring in Nepal
 |
| III | * Lecture and discussion methods; Inquiry method, collaborative method, Internet search, power point presentation
 | * Project work will be given to prepare the report on traditional disease healing methods of Nepal
* Preparation of charts on types of communicable and non-communicable disease occurring in community
 |
| IV | * Lecture and discussion methods; Inquiry method, collaborative method, power point presentation, Internet search
 | * Preparation of report on status of water related disease in Nepal
* Preparation of report on ways of house hold water treatment process in community
 |
| V | * Lecture and discussion methods; Inquiry method, Collaborative method, power point presentation, Internet search,
 | * Preparation of charts on commercially available different types of antibiotics, antiviral and antifungal drugs
* Preparation of report on status of antibiotic resistance pattern of microorganisms in Nepal
 |

*Note: Each student must come up with a project work individually or in group but with clear role and responsibility. The teacher and students may decide the project work from the list above or alternative related to the course work.*

**5. Evaluation**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nature of course** | **Internal Assessment** | **Semester Examination** | **Total Marks** |
| Theory | 25 Marks | 40 Marks | 65 Marks |

***Note:*** *Students must pass separately in internal assessment and semester examination.*

**5.1 Internal Evaluation 25 Marks**

Internal evaluation will be conducted by course teacher based on following activities:

|  |  |  |
| --- | --- | --- |
| 1. | Attendance and participation in learning activities | 5 marks |
| 2. | First assignment (written assignment) | 5 marks |
| 3. | Second assignment (report writing and presentation) | 5 marks |
| 4. | Third assignment/ Exam | 10 marks |
|  | Total | 25 Marks |

**Note:** *First assignment/assessment might be book review /article review, quiz, home assignment etc. according to nature of course. Second assignment/assessment might be project work, case study, seminar, survey/field study and individual/group report writing, term paper based on secondary data or review of literature and documents etc. and third assignment will be term exam.*

**5.2 External Evaluation (Final Examination) 40 Marks**

 Examination Division, office of the Dean, Faculty of Education will conduct final

 examination at the end of semester. The marks distribution will be

|  |  |  |
| --- | --- | --- |
| 1. | Objective questions (Multiple Choice Questions 10 x 1mark) | 10 Marks |
| 2. | Subjective questions (6 questions with 2 ‘OR ‘questions x 5 marks) | 30 Marks |
|  | Total | 40 Marks |

1. **Recommended Books**

Aneja, K. R., Jain, P., & Aneja, R. (2008). *A Textbook of Basic and Applied Microbiology*.

New Delhi: New Age International Publishers. **(For Unit I)**

 Atlas, R. M. (1998). *Microbial ecology: fundamentals and applications*. India: Pearson

Education. **(For Unit I)**

Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: a laboratory manual*: Pearson

Education. **(For Unit III)**

Greenwood, D., Slack, R. C., Barer, M. R., & Irving, W. L. (2012). *Medical Microbiology*

*E-Book: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory*

*Diagnosis and Control*: Elsevier Health Sciences. **(For Unit III)**

Denyer, S. P., Hodges, N. A., & Gorman, S. P. (2008). *Hugo and Russell's pharmaceutical*

*microbiology*: John Wiley & Sons. **(For Unit V)**

World Health Organization [WHO]. (2004). *Guidelines for drinking-water quality*

(Vol. 1): World Health Organization. **(For Unit IV)**

Dubey, R. C., & Maheshwari, D. K. (2003). *A Text Book of Microbiology*. New Delhi: S.

Chand & Company. **(For Unit III)**

Frazier, W. C., & Westhoff, D. C. (1986). *Food Microbiology* (3rd ed.). New Delhi: Tata

McGraw-Hill Publishing Company Limited. **(For Unit II)**

Jay, J. M., Loessner, M. J., & David, A. (2005). *Modern food microbiology.* New York:

 Springer Science & Business Media Inc. **(For Unit II)**

 Pelczar, I. L., Gerba, C. P., Gentry, T. J., & Maier, R. M. (2011). *Environmental*

 *microbiology*. New Delhi: Academic press. **(For Unit I, IV)**

 Michael, T. M., & John, M. M. (2006). *Brock biology of Microorganism* (11th ed.). India:

Pearson Education International. **(For Unit I)**

Philip, A. T. (2007). *Clinical Microbiology*. UK: Orient Longman Private. **(For Unit III)**

Pelczar, M. J., Chan, E. C. S., & Kreig, N. R. (2003). *Microbiology* (5th ed.). New Delhi:

Tata McGraw-Hill. **(For All Units)**

Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. *Brock*

*Biology of Microorganisms* (Global Edition, 15th ed.). London: Pearson.

**(For Unit I)**

Course Title : **Fundamentals of Microbiology (Practical)**

Course No : Bio. Ed. 537 (P) Nature of the course: Practical

Level : M.Ed. in Biology Credit hours: 1

Semester : Third Teaching hours: 48\*

 Period per week: 3pds/day/week/gr \* \*(P)

1. **Course Description:**

This course is designed to perform practical activities / experiments on the subject Microbiology. It also includes field studies, laboratory exercises (analysis), and creative activities for developing knowledge and skills for different experiments concerned with the field of microbiology.

1. **General objective:**

The general objectives of this course are as follows:

* To operate and find out working principle of different instruments used in microbiology laboratory.
* To develop hand skills on basic microbiological techniques.
* To isolate microorganism from water, air and food products.
* To make them able to know the importance of hand washing.
* To develop knowledge and skills on basic immunological techniques.
* To visit different industries to gain knowledge on microbiology.
1. **Specific Objectives and Contents:**

|  |  |
| --- | --- |
| **Specific objectives** | **Contents** |
| * Explain the structure and working principles of incubator, autoclave, hot air oven and laminar flow.
 | **Unit I. General Microbiology**  **(5 × 3 = 15pds)*** 1. Structure and working principles of incubator, autoclave, hot air oven and laminar flow
 |
| * Describe some microbial techniques: Smear preparation, wet mount preparation, simple staining technique and cultural technique.
* Preparation of charts and models

  | 1.2 Some techniques used in microbiological studies: a. Smear preparation, b. Wet mount preparation (hanging drop method),c. Preparation of different cultural media,d. Staining technique: Simple staining technique, Gram staining technique1.3 Charts/models preparation on a. Eukaryotic and Prokaryotic cellsb. Life cycle of virusc. Methods of reproduction in bacteria |
| * Perform Methylene blue reduction time test, Resazurin test, acidity test, Clot on Boil (COB) test in milk, starch adulteration test
 | **Unit II. Food Microbiology**  **(4× 3 = 12pds)**2.1 Methylene Blue Reduction Time test (MBRT), Resazurin test and Acidity test in Milk, Clot on Boil (COB) test, starch adulteration test |
| * Enumerate the total number of bacteria in Meat and Meat products
 | 2.2 Total number of bacteria in Meat and Meat products (Coliform, *Salmonella*spp) bya. pour plate and b. spread plate method |
| * Perform some basic serological tests:
1. Antigen detection: Pregnancy test and latex agglutination (sample- urine),

b. Antigen detection: Blood grouping by using anti A, anti B and anti D sera* Study Microbial normal flora in human body
 | **Unit III. Medical Microbiology**  **(2 × 3 = 6pds)**3.1 Some basic serological tests:a. Antigen detection: Pregnancy test by immune chromatography and latex agglutination (sample- urine),b. Antigen detection: Blood grouping by using anti A, anti B and anti D sera3.2 Range of microbial population in healthy human body (skin or nose) |
| * Investigate the air micro flora by plate exposure method (settle plate method)
* Determine the Coliform bacteria in water by Most Probable Number (MPN) method.
* Preparation of charts and models
 | **Unit IV. Environmental Microbiology**  **(2 × 3 = 6pds)**4.1 Enumeration of air bacteria and fungi by Plate Exposure method4.2 Determination of Coliform bacteria in water by Most Probable Number (MPN) method4.3 Charts/models preparation on a. Drinking water and sewage treatment process |
| * Find out the different methods used for controlling microorganism in Dairy or Meat processing factory in the locality
* Visit different localities to observe different methods of solid waste management practiced in the locality and make a report. For e.g. solid waste management through vermi-composting method
* Observe different ways of sewage treatment practiced in the nearby locality and prepare the report
 | **Unit V. Field Studies** **(3 × 3 = 9pds)**5.1 Methods used for controlling microorganism in dairy or meat processing factory in the locality 5.2 Different methods of solid waste management practiced in the localitya. solid waste management through vermi-composting method5.3 Sewage treatment method practiced in the locality |

*Note: Each student must come up with a project work individually or in group but with clear role and responsibility. The teacher and students may decide the project work from the list above or alternative related to the course work.*

1. **Instructional Techniques:**

The instructional techniques for this course are divided into two groups. First group consists of general instructional techniques applicable to most of the units. The second group consists of specific instructional techniques applicable to specific units.

|  |  |  |
| --- | --- | --- |
| **Units** | **General Instructional Techniques** | **Specific Instructional Techniques** |
| I | * Lecture and discussion methods; power point presentation, performing experiments, Record keeping
 | * Handling of equipments, smear preparation, group work, chart preparation
 |
| II | * Lecture and discussion methods; power point presentation, performing experiments, Record keeping
 | * Group work
 |
| III | * Lecture and discussion methods; power point presentation, performing experiments, Record keeping
 | * Group work
 |
| IV | * Lecture and discussion methods; power point presentation, performing experiments, Record keeping
 | * Field trip, Group work, Chart preparation
 |
| V | * Demonstration method, collaborative method, Inquiry method
 | * Field trip, Group work, report preparation
 |

1. **Evaluation 35 Marks**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nature of course** | **Internal Evaluation** | **External Evaluation** | **Total Marks** |
| Practical | 15 Marks | 20 Marks | 35 Marks |

 **5.1 Internal Evaluation 15 Marks**

 Marks distribution for practical internal evaluation will be as following.

|  |  |  |
| --- | --- | --- |
| 1. | Attendance  | 5Marks |
| 2. | Students’ portfolios (Record book and Books and article review etc.) | 5Marks |
| 3. | Participation, collaborative work and construction of teaching learning resources and planning for teaching learning \*\*\* | 5Marks |
|  | Total | 15Marks |

**5.2 External Evaluation 20 Marks**

Marks distribution for practical external evaluation will be as following.

|  |  |  |
| --- | --- | --- |
| 1. | Experiment / project work report and presentation / study reports  | 15Marks |
| 2. | Viva-voce | 5 Marks |
|  | Total | 20Marks |

**Note:**

*Students must pass both in internal as well as external assessment of practical examination*

*\* Practical teaching hours is 3 times more than teaching hours of theory (3x 16 = 48 hours)*

*\*\*A group consists of 15 students and one teacher will be assigned for a group.*

*\*\*\*Construction of models, charts, teaching aids, develop concept map etc. Also, the collection of materials / designing science lab, preparation of lesson plan, unit plan, annual plan, preparation of rubrics, developing test items of various levels etc. for teaching learning.*

1. **Recommended Books**

Collins, C.H., Patricia, M., & Lyne, J.M. (1995). Collins and Lynes Microbiological

Methods 7th edition. Grange, Butter Worth, Oxford.

Cappuccino, J. G., & Welsh, C. T. (2017). *Microbiology: a laboratory manual*: Pearson

Education.

Hurst, C.J. (2001). A Manual of Environmental Microbiology, 2nd edition. ASM

Publications.

Course Title: **Advanced Research Methodology in Science Education (Biology)**

Course No: Bio.Ed.539 (T) Nature of the course: Theoretical

Level: M.Ed. in Biology Credit hours: 3

Semester: Third Teaching hours: 48

Periods per week: 3

1. **Course Description**

This course on "Advanced Research Methodology in Science Education (Biology)" aims to provide an in-depth knowledge into the pursuit of research in qualitative and quantitative approach in science education. It intends to develop their skills on statistical analysis with a focus on science education research, application of descriptive and inferential statistics in analyzing quantitative and qualitative data. It further deals with research proposal including report writing procedures in science education.

1. **General Objectives**

The general objectives of this course are as follows:

* To provide students with an opportunity to understand inquiry-based research with its application.
* To interpret the nature and fundamentals of research in science education.
* To carry out academic research as a cohesive and coherent piece of work.
* To provide the students with hands on experience on statistical tools in data analysis.
* To enable the students to prepare research report using appropriate methods and approaches.
1. **Specific Objectives and Contents**

|  |  |
| --- | --- |
| **Specific Objectives** | **Contents** |
| * Explain the meaning of paradigms and paradigm shift in science education research.
* Illustrate the scientific revolution on the basis of Kuhn's revolution theory.
* Discuss the epistemology, ontology and axiology as philosophical bases for educational research.
* Critically analyze the positivist, post-positivist, social constructivist and pragmatist research world views in science education research.
* Introduce scientific method of research and its types.
* Describe steps of scientific research and its importance.
* Elaborate the meaning of inductionism and deductionism. in terms of science education research.
* Appraise critically the oriental and western philosophy of science and research traditions.
* Discuss the brief history of biology education research (BER).
* Critically analyze the methods and research trends in biology education research.
 | **Unit I. Paradigms and Philosophies of**  **Science Education Research (6hrs.)*** 1. Paradigms in Science Education Research
	2. Scientific revolution and paradigm shift
	3. Kuhn’s scientific revolution theory
	4. Philosophical bases for research
		1. Epistemology, ontology, axiology, methodology
	5. Philosophical world views: Positivist and post-positivist, social constructivist and pragmatist
	6. Scientific research: steps and importance
		1. Types of scientific research methods
	7. Inductionism and deductionism
	8. Oriental and western philosophy in science research traditions
	9. Biology Education Research (BER)
		1. History, methods and research trends
 |
| * Understand the meaning of research design, research approach, research method and research methodology.
* Apply various quantitative research designs and approaches in science education.
* Infer experimental research and apply in science education research.
* Elaborate and use of comparative and co-relational research in science education research.
* Detailed and employ survey research in research on science education.
* Elaborate the meaning of qualitative research design
* Comprehend the process of case study research methodology in science education.
* Examine the methodology of ethnographic research in the field of science education.
* Discuss the process of phenomenological research.
* Discuss narrative approach in science education research.
* Explain Hermeneutics approach in educational research.
* Understand the methodology of participatory action research in science education.
* Describe various types of mixed method research design
* Explain use of mixed method and multi-method research designs in science education research.
 | **Unit II: Research Approaches and Methods (10pds)**2.1 Concept of research design, research  approach, research method, and  methodology in research2.2 Quantitative research in science  Education* + 1. Experimental research
		2. Comparative and correlational research
		3. Survey
	1. Qualitative research in Science Education
		1. Case study
		2. Ethnography
		3. Phenomenology
		4. Narrative
		5. Hermeneutics
	2. Participatory action research in science education
	3. Mixed method and multi-method research in science education
 |
| * Use appropriate statistical tools in research for data management in science education.
* Explain general principles of data analysis.
* Discuss data management and processing such as data checking, editing, coding, recoding and data entry.
* Interpret different approaches of data analysis in quantitative research.
* Use SPSS for calculating and visualizing the descriptive data.
* Interpret the mean, median and standard deviation in the science education research.
* Apply parametric and non-parametric tests in scientific research.
 | **Unit III: Application of Descriptive and**  **Inferential Statistics (16 hrs.)*** 1. Data management and Descriptive statistics
		1. General principles of data analysis
		2. Data management and processing:

 Data checking, editing, coding,  recoding, data entry * + 1. Data entry in SPSS programme
		2. Displaying data in frequency and cross tables, and figures using SPSS
	1. An overview of descriptive statistics
		1. Measures of central tendency
		2. Measures of dispersion
		3. Measures of correlation
		4. Simple regression
	2. Inferential Data Analysis
		1. Parametric tests
			1. Hypothesis testing
			2. t-test
			3. Z-test
		2. Non-parametric test
			1. χ2-test
 |
| 1. Interpret qualitative data analysis process in science education.
2. Explain approaches of qualitative data analysis such as thematic approach and inductive approach.
3. Demonstrate skills and steps required for qualitative data analysis.
4. Describe the use of software in qualitative data analysis.
 | **Unit IV: Qualitative Data Analysis(8hours)*** 1. Concept of qualitative data analysis
	2. Approaches of qualitative data analysis:
		1. Thematic approach
		2. Inductive approach
	3. Steps in qualitative data analysis
	4. Introduction to qualitative data analysis

 software:* + 1. Atlas. Ti
		2. NVivo
 |
| * Outline the format of research proposal in science education research.
* Describe the components of research proposal.
* Prepare research proposal in science education.
* Explain the meaning and application of abstract, background of the study, objectives and research questions, hypothesis and rationale of the study.
* Explain the components of a research report/thesis.
* Interpret the meaning and importance of research design, sampling strategies and philosophical background in research.
* Elaborate the meaning of conceptual, empirical, theoretical and policy review.
* Use APA format (6th and 7th edition) in report/thesis writing.
* Critically review of at least one thesis /dissertation/article related to biology education and present in the class.
 | **Unit V: Research Proposal and Report**  **Writing (8 hrs.)*** 1. Proposal Development
		1. Select appropriate title/problem
		2. Components of research proposal
		3. Development of a research proposal
	2. Report/Thesis Writing Techniques
		1. Format of research report
		2. Steps in research report writing
		3. Techniques of citation and referencing:
			1. APA style
 |

***Note:*** *The figures in the parentheses indicate the appropriate teaching hours for the respective units*.

1. **Instructional Techniques**

The instructional techniques for this course are divided into two groups. First group consists of general instructional techniques applicable to most of the units. The second group consists of specific instructional techniques applicable to specific units.

|  |  |  |  |
| --- | --- | --- | --- |
| **Units** | **Title** | **General Instructional Techniques** | **Specific Instructional Techniques** |
| **I** | Paradigm and Philosophy of Science Education Research | Lecture cum discussionInquiry methodHome assignment Team teaching method | Buzz group and brain stormingGroup activitiesCollaborative method |
| **II** | Research Approaches and Methods | Inquiry methodPresentationDiscussion metho | Report writingGroup activitiesCollaborative method |
| **III** | Application of Descriptive and Inferential Statistics  | Lecture methodDiscussion methodInquiry methodPresentation | Collaborative methodDemonstration methodGroup activitiesPresentationProblem solving method |
| **IV** | Qualitative Data Analysis  | Lecture methodDiscussion Inquiry methodPresentation | Field workFocus group discussionParticipant observationRole play as interviewee and interviewer/Role playCase study method |
| **V** | Research Proposal and Report Writing  | Lecture cum discussion Inquiry methodPresentation method | Field workInterviewFocus group discussionParticipant observationSeminar method |

1. **Evaluation**
	1. **Evaluation (Internal Assessment and External Assessment)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nature of course** | **Internal Assessment** | **Semester Examination** | **Total Marks** |
| Theory | 40 Marks | 60 Marks | 100 Marks |

***Note****: Students must pass separately in internal assessment and semester examination.*

* + 1. **Internal Evaluation 40 Marks**

Internal evaluation will be conducted by course teacher based on following activities:

|  |  |  |
| --- | --- | --- |
| 1. | Attendance  | 5 Marks |
| 2.  | Participation in learning activities | 5 Marks |
| 3.  | First assignment (written assignment) | 10 Marks |
| 4. | Second assignment (Project work/ report writing and presentation) | 10 Marks |
| 5. | Third assignment/ Term exam | 10 Marks |
|  | Total | 40 Marks |

**Note:** *First assignment/assessment might be book review /article review, quiz, home assignment etc. according to nature of course. Second assignment/assessment might be project work, case study, seminar, survey/field study and individual/group report writing, term paper based on secondary data or review of literature and documents etc. and third assignment will be term exam.*

**5.1.2 External Evaluation (Final Examination) 60 Marks**

Examination Division, office of the Dean, Faculty of Education will conduct final

 examination at the end of semester. The marks distribution will be

|  |  |
| --- | --- |
| 1. Objective questions (Multiple Choice Questions 10 x 1mark)
 | 10 Marks |
| 1. Subjective short questions (6 questions with 2 ‘OR ‘questions x 5 marks)
 | 30 Marks |
| 1. Subjective long questions (2 questions with 1 ‘OR ‘questions x 10 marks)
 | 20 Marks |
|  Total | 60 Marks |

1. **Recommended books and references**

**Recommended Books**

American Psychological Association. (2010). *Publication Manual of American Psychological Association* *(6th ed.).* Washington, DC: American Psychological Association. **(For unit IV)**

Best, W. & Kahn V. (2000). *Research in Education (7th ed.).* New Delhi: Prentice Hall of India Pvt. Ltd. **(For unit III)**

Fraser, B. J., Tobin, K. G., & McRobbie, C. J. (2012). *Second international handbook of*

*science education* (Vol. 1). New York, USA: Springer. **(For units I and II)**

Guba, E. & Lincoln, S. Y. (1998). *The landscape of qualitative research: Theories and Issues*. Thousand Oaks: Sage Publication. **(For unit I)**

Joshi, P. R. (2010). *Research Methodology (4th ed.).* Kathmandu, Nepal: Buddha Academic Publishers and Distributors Pvt. Ltd. **(For units I and II)**

# Lederman, N.G., & Abell, S.K. (Eds.). (2014). *Handbook of research on science education*

# *(Vol. II).* New York, NY: Routledge. **(For unit I)**

Singer, S. R., Nielsen, N. R., & Schweingruber, H. A. (2013). Biology education research: Lessons and future directions. *CBE—Life Sciences Education*, *12*(2), 129-132.

**(For unit I)**

**References**

Bordens, K. S., & Abbott, B. B. (2014). Research design and methods: a process approach (9th ed.). New York, NY: McGraw-Hill Education.

Denzin, N. K., & Lincoln, Y. S. (1998). *Strategies of Qualitative inquiry.* Thousand Oaks: Sage Publication. **(For unit I)**

 Gupta, S. C. (1990). *Fundamentals of Statistics* *(3rd edition)*. New Delhi: Vikash Publishing House Pvt. Ltd. **(For unit IV)**

Gupta, S. C. (1990). *Fundamentals of Statistics* *(3rd edition)*. New Delhi: Vikash Publishing House Pvt. Ltd. **(For unit IV)**

Judith S. L., & et. al. (2012). *Teaching and Learning of Nature of Science and Scientific Inquiry: Building Capacity through Systematic Research-Based Professional Development*. Spriner.

Kothari, C. R. (2013). *Quantitative techniques* *(New Format).* New Delhi: Vikash Publishing

House Pvt. Ltd. **(For unit II)**

Ladyman, J. (2002). *Understanding philosophy of science*. New York: Routledge, Taylor and Francis group.

McMahon, et. al. (2006). *Assessment in Science: Practical Experiences and Experiments.* USA : National Association in Research in Science Education, NSTA press.

**(For unit II)**