

2. Simpson, M.G. (2019). Plant Systematics.
3. Judd, W.S. et al. (2015). Plant Systematics: A Phylogenetic Approach.
4. Radford, A.E. (1986). Fundamentals of Plant Systematics.
5. Heywood, V.H. (2007). Plant Taxonomy: The Systematic Evaluation of Comparative Data.

IND-3202

Biodiversity and Conservation

3(3-0)

Course Learning Outcomes:

By the end of this Course, students will be able to:

- Use basic techniques to assess the factors that influence biodiversity
- Describe strategies for conservation of biodiversity.
- Explain the importance of conservation policies and actions in Protected Areas.

Course Contents:

Biodiversity: Definition of biodiversity as defined in the convention of biological diversity (CBD).

Biodiversity Type and major Threats: Biodiversity types and threats, Threats to Biodiversity; deforestation, over grazing, erosion, desertification, ecosystem degradation, bio invasion, pollution and climate change

Species Interdependence for Survival: Introduction of species on each other for their survival, Extent of known and estimated biodiversity of earth.

Ecological services and Values of Ecosystem: Indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of living resources), Sustainable and unsustainable use of ecosystem resources, consequences of unsustainable use, ecosystem degradation, extinct species, desertification and deforestation.

Global Biodiversity Hotspots: Biodiversity Hot spots of the world.

International treaties on Biodiversity: International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar, Global Biodiversity Information Facility (GBIF)

Conservation vs preservation, Conservation strategies; in situ, ex situ, in vitro conservation and in vivo conservation

IUCN protected areas in Pakistan: IUCN categorized protected areas in Pakistan.

IUCN Red List of Threatened Species: Introduction, objective, categories of threat, criteria for assessment, significance and example of threatened species.

Role of Herbaria and Botanical Garden: Use of herbarium and Botanical Garden in biodiversity and conservation, Concept of pastures and wild life management

Wetlands and sanctuaries protection: The pressures, problems and solutions.

Range land management: Types of rangelands, potential threats, sustainable management.

Lab Outline

1. Comparative Study of Ex Situ and In Situ Conservation Methods
2. Visit to a Botanical Garden/Protected Area for Plant Diversity Study
3. Role of Germplasm in Conservation of Biodiversity
4. Study of the Role and Methods of Seed Banks and Gene Banks in Biodiversity Conservation
5. Survey of Threatened and Endangered Plants in the Local Region

Recommended Books

1. IUCN SSC Plant Conservation Committee
2. Pakistan National Committee (PNC) of IUCN
3. Biodiversity Hotspots: Distribution and Protection of Conservation Priority Areas by Frank E. Zachos and Jan Christian Habel.
4. Falk, D.A. & Holsinger, K.E. 1991. Genetics and Conservation of Rare Plants. Center for Plant Conservation. Oxford University Press, Oxford, UK.

GEN-3204

Introduction to Sociology

Credit Hours: 2(2-0)

Objectives: The course is designed to introduce the students with sociological concepts and the discipline. The focus of the course shall be on significant concepts like social systems and structures, socio-economic changes and social processes. The course will provide due foundation for further studies in the field of sociology.

Course Outline

Unit I: Introduction

- a. Definition, Scope, and Subject Matter
- b. Sociology as a Science
- c. Historical back ground of Sociology

Unit II: Basic Concepts

- a. Group, Community, Society
- b. Associations
 - i. Non-Voluntary
 - ii. Voluntary
- c. Organization
 - i. Informal
 - ii. Formal
- d. Social Interaction
 - i. Levels of Social Interaction
 - ii. Process of Social Interaction
 1. Cooperation
 2. Competition
 3. Conflict
 4. Accommodation
 5. Acculturation and diffusion
 6. Assimilation
 7. Amalgamation

Unit III: Social Groups

- a. Definition & Functions
- b. Types of social groups
 - i. In and out groups
 - ii. Primary and Secondary group
 - iii. Reference groups
 - iv. Informal and Formal groups
 - v. Pressure groups

Unit IV: Culture

- a. Definition, aspects and characteristics of Culture
 - i. Material and non-material culture
 - ii. Ideal and real culture
- b. Elements of culture
 - i. Beliefs

- ii. Values
 - iii. Norms and social sanctions
- c. Organizations of culture
 - i. Traits
 - ii. Complexes
 - iii. Patterns
 - iv. Ethos
 - v. Theme
- d. Other related concepts
 - i. Cultural Relativism
 - ii. Sub Cultures
 - iii. Ethnocentrism and Xenocentrism
 - iv. Cultural lag

Unit V: Socialization & Personality

- a) Personality, Factors in Personality Formation
- b) Socialization, Agencies of Socialization
- c) Role & Status

Unit VI: Deviance and Social Control

- a) Deviance and its types
- b) Social control and its need
- c) Forms of Social control
- d) Methods & Agencies of Social control

Unit VII: Collective Behavior

- a) Collective behavior, its types
- b) Crowd behavior
- c) Public opinion
- d) Propaganda
- e) Social movements
- f) Leadership

Recommended Books:

1. Anderson, Margaret and Howard F. Taylor. 2001. *Sociology the Essentials*. Australia: Wadsworth.
2. Brown, Ken 2004. *Sociology*. UK: Polity Press
3. Giddens, Anthony 2002. *Introduction to Sociology*. UK: Polity Press.
4. Macionis, John J. 2006. 10th Edition *Sociology* New Jersey: Prentice-Hall
5. Tischler, Henry L. 2002. *Introduction to Sociology* 7th ed. New York: The Harcourt Press.
6. Frank N Magill. 2003. *International Encyclopedia of Sociology*. U.S.A: Fitzroy Dearborn Publishers
7. Macionis, John J. 2005. *Sociology* 10th ed. South Asia: Pearson Education
8. Kerbo, Harold R. 1989. *Sociology: Social Structure and Social Conflict*. New York: Macmillan Publishing Company.

Course Contents:

Logic, Logical and Critical Reasoning: Introduction and importance of logic; Inductive, deductive and abductive approaches of reasoning; Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences; Logical fallacies; Venn Diagrams; Predicates and quantifiers; Quantitative reasoning exercises using logical reasoning concepts and techniques.

Mathematical Modeling and Analyses: Introduction to deterministic models; Use of linear functions for modeling in real-world situations; Modeling with the system of linear equations and their solutions; Elementary introduction to derivatives in mathematical modeling; Linear and exponential growth and decay models; Quantitative reasoning exercises using mathematical modeling.

Statistical Modeling and Analyses: Introduction to probabilistic models; Bivariate analysis, scatter plots; Simple linear regression model and correlation analysis; Basics of estimation and confidence interval; Testing of hypothesis (z-test; t-test); Statistical inference in decision making; Quantitative reasoning exercises using statistical modeling.

Recommended Books:

1. Using and Understanding Mathematics: A Quantitative Reasoning Approach by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
2. Discrete Mathematics and its Applications by Kenneth H. Rosen.
3. Discrete Mathematics with Applications by Susanna S. Epp.
4. Applied Mathematics for Business, Economics and Social Sciences by Frank S. Budnick.
5. Elementary Statistics: A Step-by-Step Approach by Allan Bluman.
6. Introductory Statistics by Prem S. Mann.
7. Applied Statistical Modeling by Salvatore Babones.
8. Barrons SAT by Sharvon Weiner Green, M.A and Ira K. Wolf

Course Objectives: The course is developed with the aim to enable the students to meet their real life communication needs by

- Helping them learn and understand basic concepts of communication process
- Practically implementing theoretical aspects in the real life situations

Course Contents:

What is Communication?

- Process of communication, effective steps of communication, basic communication skills

Paragraph Writing;

- Practice in writing a good, unified and coherent paragraphs
- Paragraph writing leading towards the writing of five to seven paragraphs long essay
- Stages of writing (brain storming, researching, drafting and editing)
- Methods of writing (cause and effect, problem solutions, comparison and contrast)

Essay Writing;

- Basic structure of essay, topic sentence, supporting sentence, concluding sentence, thesis statement
- Unity and Coherence, Introduction and Conclusion

CV and Job Application;

- Preparing a Curriculum Vitae
- Writing a formal job application

Translation Skills;

- Urdu to English

(Practice at advanced level)

Study Skills;

- Skimming and scanning, intensive, extensive and speed reading
- Summary and precis writing
- Comprehension (at advanced level)
- (sQ3R and Sq4r methods)

Academic Writing;

- Letter/ Memo writing, Minutes of Meeting, use of Dictionary, Library and Internet

Presentation Skills;

- Personality development (emphasis on content, style and pronunciation)
- Preparation stage, audience analysis, handling and asking questions, managing time, handling non-verbal means, feedback

Academic Writing;

- How to write a research proposal for research paper/term paper?
- How to write a research paper/ term paper?
- (Emphasis on style, content, language, form, clarity , consistency)

Report Writing;

- Technical Report writing
- Progress report writing
- Preparation and planning

E-mail writing;

- Creating e-mail account
- Writing and sending e-mails

Preparing for Interview and Research proposal/ research paper defense

Note: Documentaries to be shown for discussion and review

Recommended Books:

Communication Skills

a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing

- Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
- Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.

2. Reading and Study Skills by John Langan

- Study Skills by Richard York.

d) Speaking

1. Ellen, K. 2002. Maximize Your Presentation Skills: How to Speak, Look and Act on Your Way to the Top
2. Hargie, O. (ed.) Hand book of Communications Skills
3. Mandel, S. 2000. Effective Presentation Skills: A Practical Guide Better Speaking
4. Mark, P. 1996. Presenting in English. Language Teaching Publications

GEN-3207 Understanding of Quran-I 1(0-1)

Course Learning Objectives (CLOs)

By the end of this course, students will be able to:

- Demonstrate understanding of the background, revelation, and preservation of the Holy Quran.
- Interpret selected verses of the Quran with the help of authentic translations.

- Apply basic Arabic linguistic and grammatical features to comprehend Quranic text.
- Recognize major Quranic themes (faith, justice, ethics, mercy, patience, gratitude).
- Reflect on the Quran's guidance for personal conduct, social relations, and contemporary issues.

Course Contents:

Week	Units	Lesson	Assignments/home Task	Linguistic Rules
1	1	1-6	پڑھے گئے اسباق کے قرآنی الفاظ کا معنی لکھیں	معرفہ، مذکر مؤنث
	1	9-14	پڑھے گئے اسباق کے قرآنی الفاظ کا معنی لکھیں	جمع کی دو اقسام ، نکرہ اور و کا معنی
2	1	15-17	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ہذا، ہذہ ذالک ، تلک
	1	18-19 and revision of unit 1	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	لام تاکید ، اسم تفضیل
3	2	1-3	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ان ، لام کئی اور فی کی بحث
	2	4-6	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	حروف جار علی ، من ، الی
4	2	7-9	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	حروف جار "اب"، لام نافیہ ، لام نفی جنس ، ما نافیہ اور الا
	2	10-13 and Revision of Unit 2	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ان ، کان ، حروف النداء
5	Unit 3	1-2	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	صفت ، موصوف
	3	3-5	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	مضاف ، مضاف الیہ
6	3	6-7	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	مضاف ، مضاف الیہ
	3	8-10 And revision of Unit 3	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	اسم فاعل ، اسم مفعول اور مثنی
7	Midterm			
8	Unit 4	1-2	پڑھے گئے اسباق کے قرآنی الفاظ ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر ہو منفصل ، ضمیر متصل

	4	3-4	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	حروف جار، ضمیر متصل
8	4	5-8	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل انت ، ضمیر متصل "ک" مرکب اضافی اور ضمیر متصل
	4			
9	4	9-12	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل ہی ، ضمیر متصل ها
	4	13-16	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل انا ، ضمیر متصل ی
10	4	17 and revision of unit 4	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	حال
	Unit 5	1-2	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	جمع مذکر سالم، جمع مذکر سالم المسبوق بحرف الجر
11	5	3-4	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	جمع مذکر سالم المسبوق بالاضافۃ
	5	5-6	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر ہم منفصل و متصل
12	5	7-8	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	اضافت اور حروف جار
	5	9-11	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل انتم اور متصل کم
13	5	12-14	پڑھے گئے اسباق کے قرآنی الفاظ، قطعے اور جملوں کا ترجمہ لکھیں	ضمیر منفصل نحن، متصل نا
	5	15-16	پڑھے گئے اسباق کے جملوں اور آیات کا ترجمہ لکھیں	حروف جار کو اضافت کے ساتھ ملانا
14	5	17-18	پڑھے گئے اسباق کے جملوں اور آیات کا ترجمہ لکھیں	اسما اشارہ ہؤلاء، اولئک
	5	19-23	پڑھے گئے اسباق کے جملوں اور آیات کا ترجمہ لکھیں	ما/الا، ان/الا، انما، لیس، ما، کان، (الا، الیس، الیوم، یومئذ، سبحان، ما بینہما، قل، اذن، بنس، نعم، کلا، ما ادراک، حسب،

				اعلم ، مصير ، دینا(تمیز)
15	5	Revision unit 5		
	6	1-3	پڑھے گئے اسباق کے جملوں اور آیات کا ترجمہ لکھیں	فعل مضارع، جملہ فعلیہ ، فعل مضارع، صیغہ مفرد
16	6	4-5	پڑھے گئے اسباق کے جملوں اور آیات کا ترجمہ لکھیں	فعل مضارع ، صیغہ مفرد یعلم
	6	6	پڑھے گئے اسباق کے جملوں اور آیات کا ترجمہ لکھیں	فعل مضارع صیغہ جمع یعملون

Text Book

Course book: معلم القرآن از ڈاکٹر عبید الرحمن بشیر (جلد 1 تا 3)

Semester IV

GEN-4401

Introduction to Sociology

Credit Hours: 2(2-0)

Objectives: The course is designed to introduce the students with sociological concepts and the discipline. The focus of the course shall be on significant concepts like social systems and structures, socio-economic changes and social processes. The course will provide due foundation for further studies in the field of sociology.

Course Outline

Unit I: Introduction

- d. Definition, Scope, and Subject Matter
- e. Sociology as a Science
- f. Historical back ground of Sociology

Unit II: Basic Concepts

- e. Group, Community, Society
- f. Associations
 - i. Non-Voluntary
 - ii. Voluntary
- g. Organization
 - i. Informal
 - ii. Formal
- h. Social Interaction
 - i. Levels of Social Interaction

- ii. Process of Social Interaction
 - 1. Cooperation
 - 2. Competition
 - 3. Conflict
 - 4. Accommodation
 - 5. Acculturation and diffusion
 - 6. Assimilation
 - 7. Amalgamation

Unit III: Social Groups

- a. Definition & Functions
- b. Types of social groups
 - vi. In and out groups
 - vii. Primary and Secondary group
 - viii. Reference groups
 - ix. Informal and Formal groups
 - x. Pressure groups

Unit IV: Culture

- c. Definition, aspects and characteristics of Culture
 - iii. Material and non-material culture
 - iv. Ideal and real culture
- d. Elements of culture
 - iv. Beliefs
 - v. Values
 - vi. Norms and social sanctions
- c. Organizations of culture
 - vi. Traits
 - vii. Complexes
 - viii. Patterns
 - ix. Ethos
 - x. Theme
- d. Other related concepts
 - v. Cultural Relativism
 - vi. Sub Cultures
 - vii. Ethnocentrism and Xenocentrism
 - viii. Cultural lag

Unit V: Socialization & Personality

- d) Personality, Factors in Personality Formation
- e) Socialization, Agencies of Socialization
- f) Role & Status

Unit VI: Deviance and Social Control

- e) Deviance and its types
- f) Social control and its need
- g) Forms of Social control
- h) Methods & Agencies of Social control

Unit VII: Collective Behavior

- g) Collective behavior, its types
- h) Crowd behavior
- i) Public opinion
- j) Propaganda
- k) Social movements
- l) Leadership

Recommended Books:

9. Anderson, Margaret and Howard F. Taylor. 2001. *Sociology the Essentials*. Australia: Wadsworth.
10. Brown, Ken 2004. *Sociology*. UK: Polity Press
11. Giddens, Anthony 2002. *Introduction to Sociology*. UK: Polity Press.
12. Macionis, John J. 2006. 10th Edition *Sociology* New Jersey: Prentice-Hall
13. Tischler, Henry L. 2002. *Introduction to Sociology* 7th ed. New York: The Harcourt Press.
14. Frank N Magill. 2003. *International Encyclopedia of Sociology*. U.S.A: Fitzroy Dearborn Publishers
15. Macionis, John J. 2005. *Sociology* 10th ed. South Asia: Pearson Education
16. Kerbo, Harold R. 1989. *Sociology: Social Structure and Social Conflict*. New York: Macmillan Publishing Company.
17. Koenig Samuel. 1957. *Sociology: An Introduction to the Science of Society*. New York: Barnes and Nobel..
18. Lee, Alfred Mclung and Lee, Elizabeth Briant 1961. *Marriage and The family*.New York: Barnes and Noble, Inc.
19. Leslie, Gerald et al. 1973. *Order and Change: Introductory Sociology*Toronto: Oxford University Press.
20. Lenski, Gevbard and Lenski, Jeam. 1982. *Human Societies*. 4th edition New York: McGraw-Hill Book Company.
21. James M. Henslin. 2004. *Sociology: A Down to Earth Approach*. Toronto: Allen and Bacon.

GEN-4402

Civics and Community Engagement

Credit Hours: 2(2-0)

Course Contents:

1. Civics and Citizenship:
 - Concepts of civics, citizenship, and civic engagement.
 - Foundations of modern society and citizenship.
 - Types of citizenship: active, participatory, digital, etc.
2. State, Government and Civil Society:
 - Structure and functions of government in Pakistan.
 - The relationship between democracy and civil society.

- Right to vote and importance of political participation and representation.
3. Rights and Responsibilities:
 - Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973.
 - Civic responsibilities and duties.
 - Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.)
 4. Community Engagement:
 - Concept, nature and characteristics of community.
 - Community development and social cohesion.
 - Approaches to effective community engagement.
 - Case studies of successful community driven initiatives.
 5. Advocacy and Activism:
 - Public discourse and public opinion.
 - Role of advocacy in addressing social issues.
 - Social action movements.
 6. Digital Citizenship and Technology:
 - The use of digital platforms for civic engagement.
 - Cyber ethics and responsible use of social media.
 - Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship.
 7. Diversity, Inclusion and Social Justice:
 - Understanding diversity in society (ethnic, cultural, economic, political etc.).
 - Youth, women and minorities' engagement in social development.
 - Addressing social inequalities and injustices in Pakistan.
 - Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.

Suggested Reading

1. "Civics Today: Citizenship, Economics, & You" by McGraw-Hill Education.
2. "Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman.
3. "Engaging Youth in Civic Life" by James Youniss and Peter Levine.
4. "Digital Citizenship in Action: Empowering Students to Engage in Online Communities" by Kristen Mattson.
5. "Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby.
6. "Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch and Susan M. Omilian.

Course Objectives

By the end of this course, students will be able to:

1. Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding father of Pakistan.
2. Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.
3. Explain about the guiding principles on rights and responsibilities of Pakistan citizens as enshrined in the Constitution of Pakistan 1973.

Course Contents**1. Introduction to the Ideology of Pakistan:**

- Definition and significance of ideology.
- Historical contest of the creation of Pakistan (with emphasis on socio-political religious and cultural dynamics of British India between 1857 till 1947).
- Contributions of founding fathers of Pakistan of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc.
- Contributions of women and students in the freedom movement for separate homeland for Muslims of British India.

2. Two-Nation Theory:

- Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal's Presidential Address 1930, Congress Ministries 1937 Lahore Resolution 1940).

3. Introduction to the Constitution of Pakistan:

- Definition and importance of a constitution.
- Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).

4. Constitution and State Structure:

- Structure of Government (executive, legislature, and judiciary).
- Distribution of powers between federal and provincial governments.
- 18th Amendment and its impact on federalism.

5. Fundamental Right, Principles of Policy and Responsibilities:

- Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28).
- Overview of Principles of Policy (Articles 29-40).
- Responsibilities of the Pakistan citizens (Article 5).

6. Constitutional Amendments:

- Procedures for amending the Constitution.
- Notable Constitutional amendments and their implications

Recommended Books

1. “The Idea of Pakistan” by Stephen P. Cohen.
2. “Ideology of Pakistan” by Javed Iqbal.
3. “The Struggle for Pakistan” by I.H. Qureshi.
4. “Pakistan the Formative Phase” by Khalid Bin Sayeed.
5. “Pakistan: Political Roots and Development” by Safdar Mahmood.
6. “Ideology of Pakistan” by Sharif-ul-Mujahid.
7. “The Struggle for Pakistan: A Muslim Homeland and Global Politics” by Ayesha Jala.
8. “Jinnah, Pakistan and Islamic Identity: The Search for Saladin” by Akbar S. Ahmed.
9. “The Making of Pakistan: A Study in Nationalism” by K.K. Aziz.
10. “Pakistan: A New History” by Lan Talbot.
11. “Pakistan in the Twentieth Century: A Political History” by Lawrence Ziring.
12. “The Constitution of Pakistan 1973”. Original.
13. “Constitutional and Political Development of Pakistan” by Hamid Khan.
14. “The Parliament of Pakistan” by Mahboob Hussain.
15. “Constitutional Development in Pakistan” by G.W. Choudhury.
16. “Constitution-Making in Pakistan: The Dynamics of Political Order” by G.W. Choudhury.

BOT-4404

Cell Biology, Genetics & Evolution

3(2-1)

Aims and Objectives

To understand

1. Structure and functions of cell.
2. Nature of genetic material and hereditary process.
3. Familiarization with evolutionary processes.

Course Contents

a) Cell biology

1. Structures and Functions of Biomolecules Carbohydrates, Lipids, Proteins, Nucleic Acids
2. Cell: Physico-chemical nature of plasma membrane and cytoplasm.
3. Ultrastructure of plant cell with a brief description and functions of the following organelles
Cell wall, Endoplasmic reticulum, Plastids, Mitochondria, Ribosomes, Dictyosomes, Vacuole,
Microbodies (Glyoxysomes and Peroxisomes)
4. Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes,

Karyotype analysis

5. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle
6. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy.
Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

b) Genetics

1. Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.
2. Sex linked inheritance, sex linkage in Drosophila and man (colour blindness), XO, XY, WZ mechanisms, sex limited and sex-linked characters, sex determination.
3. Linkage and crossing over: definition, linkage groups, construction of linkage maps, detection of linkage.
4. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g., lac operon).
5. Transmission of genetic material in Bacteria: Conjugation and gene recombination in E. coli, transduction and transformation.
6. Principles of genetic engineering / biotechnology; Basic genetic engineering techniques.
7. Application of genetics in plant improvement: Induction of genetic variability (gene mutation, recombination), physical and chemical mutagens, selection, hybridization and plant breeding techniques. Development and release of new varieties.
8. Introduction to germplasm conservation

c) Evolution

The nature of evolutionary forces, adaptive radiation, differential reproductive potential, first plant cell, origin of organized structures, early aquatic and terrestrial ecosystem, first vascular plant.

Practical

Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs

1. Measurement of cell size.

2. Study of mitosis and meiosis by smear/squash method and from prepared slides.
3. Study of chromosome morphology and variation in chromosome numbers.
4. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources

Genetics

1. Genetical problems related to the transmission and distribution of genetic material.
2. Identification of DNA in plant material. Carmine/orcein staining.
3. Study of salivary gland chromosomes of *Drosophila*.

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
2. Dyonsager, V.R. (1986). Cytology and Genetics. Tata and McGraw Hill Publication Co. Ltd, New Delhi.
3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
4. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
5. Strickberger, M.V. (1988), Genetics, MacMillan Press Ltd., London.
6. Carroll, S.B., Grenier, J.K. and Welnerbee, S.d. 2001. From DNA to Diversity - Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
8. Strickberger, M. W. 2000 Evolution. Jones & Bartlet Publishers Canada
9. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge UniversityPress.

GEN-4405

Organic Chemistry

Credit Hours: 4(3-1)

Course Contents:

1. Basic Concepts in Organic Chemistry Hybridization of orbitals of carbon atoms in alkanes, alkenes, alkynes and arenes. Hybridization of orbitals of nitrogen, oxygen and sulphur atoms in various functional groups. Localized and delocalized chemical bonding. Conjugation and hyper conjugation. Resonance, rules of resonance, resonance energy, resonance hybrid, factor effecting the resonance; inductive effect, Applications of inductive effect and resonance on various

properties of organic compounds; Steric effect and its applications, Hydrogen bonding and its effect on various properties of organic compounds, Tautomerism.

2. Nomenclature of Organic Compounds: Nomenclature of alkanes, alkenes, alkynes, cycloalkanes, bicycloalkanes, spiroalkanes, monofunctional and polyfunctional derivatives of open chain and cyclic compounds, polysubstituted benzenes, polycyclic hydrocarbons such as naphthalene, anthracene, phenanthrene and their derivatives and heterocyclic compounds.

3. Aromatic Hydrocarbons: Structure of benzene, Resonance energy of benzene, Aromaticity, Criteria for aromaticity, Evidences of aromaticity, Natural sources of aromatic hydrocarbons; Preparation of aromatic hydrocarbons by different methods. Reactions of aromatic hydrocarbons: electrophilic aromatic substitution reactions i.e. nitration, halogenation, Friedal-Crafts reaction and its limitations, sulfonation; Orientation and reactivity of substituted benzenes; Nucleophilic aromatic substitution reactions; reaction such as addition, hydrogenation, Birch reduction, and oxidation reactions of side chain. Polycyclic aromatic hydrocarbons like naphthalene, anthracene and phenanthrene, their resonance structures and relative stabilities. Synthesis of naphthalene, Electrophilic substitution reactions of naphthalene, Oxidation and reduction reactions, Brief description of orientation and reactivity of naphthalenes.

4. Isomerism Conformational Isomerism: conformational analysis of ethane, n-butane, cyclohexane, mono- and di-substituted cyclohexanes. Optical isomerism: optical activity, chirality and optical activity; enantiomers, diastereomers; racemates and their resolution; D, L and R, S conventions; Optical isomerism in cyclohexanes, biphenyls and allenes. Geometrical isomerism: cis and trans isomers; E-Z convention; determination of configuration of the isomers; inter-conversion of geometrical isomers; geometrical isomerism in cyclic compounds.

5. Alkyl halides: Preparation of alkyl halides from alcohols, carboxylic acids; Chemical reactions: Aliphatic nucleophilic substitution reactions, SN1 and SN2 mechanism, effects of the nature of substrates, attacking nucleophile, leaving group and the nature of solvent. Elimination reactions, E1 and E2 mechanisms, orientation of elimination (Hoffmann and Saytzeff rules). Grignard Reagents; synthesis, structure, and reactions with active hydrogen compounds carbonyl compounds such as aldehydes, ketones, esters, acid halides and CO₂; reaction with nitriles, ethylene oxides, sulphur and oxygen.

6. Chemistry of Phenols and Ethers Phenols: Physical properties; Synthesis of phenols, reactions of phenols such as acylation, Friedal-Crafts reaction, Nitration, Sulphonation,

Carbonation, Formylation and Diazo coupling. Ethers: Physical properties, Preparation of ether from alcohols, alkyl halides and alkenes; Reactions of ether, brief introduction of crown ethers and polyethers.

7. Chemistry of Carbonyl Compounds: Preparation of aldehydes and ketones, by pyrolysis of calcium salts of acids, acylation of alkenes and arenes, reduction of acid halides and nitriles. Physical properties of aldehydes and ketones; Structure and reactivity of carbonyl group; Comparison of the reactivity of aldehydes and ketones; Nucleophilic addition of water, alcohols, ammonia and its derivatives, hydrogen cyanide, bisulfite, reduction and oxidation reactions; Aldol condensation and related reactions, Cannizzaro's reaction, Wittig reaction, oxidation reactions, chemical tests of aldehydes and ketones.

8. Chemistry of Carboxylic Acids and their Derivatives: Physical properties of carboxylic acids; Effects of different parameters on the acid strengths of aliphatic and aromatic carboxylic acids. Chemical properties like salt formation nucleophilic acyl substitution, reduction of carboxylic acids, decarboxylation, Hunsdiecker reaction, Kochi reaction, substitution at α -carbon. Preparations, properties and reactions of acid chlorides, acid anhydrides, amides, cyanides and esters; Malonic and acetoacetic esters synthesis.

9. Heterocyclic Compounds: Methods of preparation of pyrrole and pyridine, their aromatic character and comparison with benzene. Important reactions of pyrrole and pyridine.

Recommended Books:

1. M. Younan, A Textbook of Organic Chemistry, Ilmi kitab Khana, Urdu Bazar, Lahore. 2. Khairat M. Ibe Rasa, M.A. Rehman and Abdul Rehman, Organic Chemistry, Caravan Book House, Lahore.

Reference Books:

1. Younas, M., Text Book of Chemistry, Ilmi Kutab Khana, Lahore.
2. Rehman, A., Text Book of organic Chemistry, Karwan Book House, Lahore.
3. Bhatti, H. N. and Rahman, R. 2013. Text Book of Organic Chemistry. Caravan Book House Pakistan.
4. Bahl, A., and B. S. Bhat. "A Text Book of Organic Chemistry, 17th Edn, S." Chand and Company, New Delhi ISBN: 81-219.
5. March, J., Advance Organic chemistry, John Wiley & Sons, New York.
6. I. L. Finar, "Organic chemistry" , Vol. I, Pearson Education, L.P.E.

7. I. L. Finar, , “Organic chemistry” , Vol. II, 5th Edition, L.P.E.
8. Jerry March, “Advanced Organic chemistry, Reaction, Mechanism and Structure” , 5th Edition, Wiley Inter Science.
9. Morison and Boyd, “Organic chemistry” , 6th Edition, Prentice Hall.
10. Seyhan N. Ege, “Organic chemistry Structure and Reactivity”, 3rd Edition, The University of Michijan, A.I.T.D.S. Publishers & Distributors (Redg).

Organic Chemistry Practical

1. Compound Analysis: Identification of organic compounds containing only one functional group with special emphasis on compounds containing following functional groups. - COOH, -OH, C=O, -NH₂ and –CONH₂
2. Preparation of organic compounds: Preparation and techniques of purification of tribromophenol, nitrobenzene, aspirin, ethyl benzoate and benzoic acid from toluene, butyl chloride, acetanilide.
3. Basic Experimental techniques used in organic chemistry: Simple distillation, Solvent extraction, Sublimation, Re-Crystallization.
4. Estimation (Volumetric): Determination of molecular weight of carboxylic acid. Estimation of amide group and glucose.

Recommended Book:

Muhammad Abid Khawaja, Practical Chemistry Note Book, Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore.

GEN-4406

Animal Form and Function-I

Credit Hours: 4(3-1)

Course Objectives:

The Objectives of the courses are:

1. To teach about animals’ diversity adapted in different strategies’ for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functional systems of nutrition, excretion, osmoregulation and reproduction and development for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal’s body.

4. To embrace the phenomena in basic structure of each system that determines its particular function.

Course Learning Outcomes:

1. Acquire the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in t environments e.g. gills in aquatic and lungs in terrestrial environment.
2. Understand that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. Solve of emergence of diversity of forms for the performance of similar function.
4. Analyze the requirements of diverse forms for the performance of similar function in their past and present needs.
5. Evaluate the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. Demonstrate that a form is successfully adapted to perform a function adequately and successfully.

Course Outline:

1. Nutrition and Digestion:
 - a. Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion
 - b. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.
 - c. The mammalian digestive system: gastrointestinal motility and its control
 - d. Oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion.
2. Temperature and Body Fluid Regulation:
 - a. Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals; Heat Production in Birds and Mammals
 - b. Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate

c. Excretory Systems; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations;

Mechanism in Metanephric Kidney Functions. Reproduction and Development

3. Reproduction:

a. Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction;

b. Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction;

sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among

various vertebrate classes;

c. The human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function;

d. The human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the

placenta; milk production and lactation.

4. Descriptive Embryology:

a. Fertilization; embryonic development: cleavage, and egg types; the primary germ layers and

their derivatives;

b. Echinoderm embryology;

c. Vertebrate embryology: the chordate body plan,

d. Amphibian embryology, development in terrestrial environments,

e. Avian embryology, and the fate of mesoderm.

Practicals:

1. Study of excretory system in an invertebrate and a vertebrate representative (Model).

2. Study of digestive system in invertebrate and a vertebrate representative (Dissection).

3. Dissection and study of male and female reproductive system in vertebrates and invertebrates.

4. Study of stages in the development of an Echinoderm.

5. Study of early stages in the development of a frog, chick and a mammal.

Note: Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used.

Books Recommended

1. Pechenik, J.A. 2013. *Biology of Invertebrates*, 4th Ed. (International), Singapore: McGraw-Hill.
2. Arthur, M. M. 2010. *Vertebrate Embryology*.
3. Hickman, C.P., Roberts, L.S., Larson, A. 2004. *Integrated Principles of Zoology*, 11th Ed. (International), Singapore: McGraw-Hill.
4. Miller, S.A., Harley, J.B. 2002. *Zoology*, 5th, 6th, 7th, 8th, 9th, 10th & 11th Ed. (International), Singapore: McGraw-Hill.
5. Campbell, N.A. 2002. *Biology*, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Kent, G.C., Miller, S. 2001. *Comparative Anatomy of Vertebrates*. New York: McGraw-Hill.
7. Hickman, C.P., Kats, H.L. 2000. *Laboratory Studies in Integrated Principles of Zoology*. Singapore: McGraw-Hill.

Year	Semester	Course Code	Course Title	Credit Hrs.
Year-III	6 th	BOT-5601	Principles of Plant Ecology	3(2-1)
		BOT-5602	Plant Systematics	3(2-1)
		BOT-5603	Principles of Plant Biochemistry	3(2-1)
		BOT-5604	Fundamentals of Genetics	3(2-1)
		BOT-5605	Biostatistics	3(2-1)
Total credit hours.			15	

BOT-5601 Principles of Plant Ecology 3(2-1)

Aims and objectives:

To understand the role and interaction of plants with their environment.

Course Contents:

Introduction: History and recent developments in ecology

Soil: Nature and properties of soil (Physical and Chemical). Water in the soil-plant-atmosphere continuum. The ionic environment and plant ionic relations, Nutrient cycling. Physiology and ecology of N, S, P and K nutrition. Heavy metals, salt and drought stress and osmoregulation. Soil erosion

Light and temperature: Nature of light, Factors affecting the variation in light and temperature, Responses of plants to light and temperature, Adaptation to temperature extremes,

Carbon dioxide: Stomatal responses, Water loss and CO₂-assimilation rates of plants in contrasting environments. Ecophysiological effects of changing atmospheric CO₂ concentration. Functional significance of different pathways of CO₂ fixation. Productivity: response of photosynthesis to environmental factors, C and N balance

Water: Water as an environmental factor, Role of water in the growth, adaptation and distribution of plants, Water status in soil. Water and stomatal regulation, Transpiration of leaves and canopies.

Oxygen deficiency: Energy metabolism of plants under oxygen deficiency, Morpho-anatomical changes during oxygen deficiency, post-anoxic stress

Wind as an ecological factor.

Fire as an ecological factor.

Practical:

1. Determination of physico-chemical properties of soil and water.
2. Measurements of light and temperature under different ecological conditions.
3. Measurements of wind velocity.
4. Measurement of CO₂ and O₂ concentration of air and water.
5. Effect of light, temperature, moisture, salinity and soil type on germination and growth of plants.
6. Measurement of ions, stomatal conductance, osmotic potential, water potential, xylem pressure potential, leaf area and rate of CO₂ exchange in plants in relation to various environmental conditions.

Recommended Books:

- Körner, C., 2021. Plant ecology at high elevations. In *Alpine Plant Life* (pp. 1-22). Springer, Cham.
- Körner, C., 2018. Concepts in empirical plant ecology. *Plant Ecology & Diversity*, 11(4), pp.405-428.
- Keddy, P.A., 2017. *Plant ecology*. Cambridge University Press.
- Pugnaire, F. and Valladares, F. eds., 2007. *Functional plant ecology*. CRC press.
- Schultz, J. C. 2005. *Plant Ecology*, Springer-Verlag
- Bazzaz, F.A. 2004. *Plants in Changing Environments: Linking Physiological, Population, and Community Ecology*, Cambridge University Press
- Lambers, H. et al. 2002. *Plant Physiological Ecology*, Springer-Verlag
- Larcher, W. 2003., *Physiological Plant Ecology: Ecophysiology and Stress Physiology of Function Groups* - Springer-Verlag
- Nobel, P.S. 1999, *Physico-chemical and Environmental Plant Physiology*, Academic Press.
- Lambers, H., T. L. Pons and F. Stuart. 2008. *Plant Physiological Ecology*.
- Smith R.L. 1998 *Elements of Ecology*. Harper & Row Publishing.
- Townsend. C.R. Begon. M and J.L Harper. 2002 *Essentials of ecology*. Blackwell Publishing.
- Gurevitch. J. Scheiner, S.M. and G.A Fox. 2006 *The Ecology of Plants*. Sinaur Asssoicate Inc.

BOT-5602

Plant Systematics

3(2-1)

Aims and objectives

To know floral composition/ system of classification focusing on identification, classification, description nomenclature and flora writings, monographs.

Course Contents

Aims and objectives

To know floral composition/ system of classification focusing on identification, classification, description nomenclature and flora writings, monographs.

Course Contents

Introduction: Importance and relationship with other sciences, Phases of plant taxonomy. Origin and radiation of angiosperm, their probable ancestors, when, where and how did the angiosperms evolve, the earliest fossil records of angiosperms.

Nomenclature: Important rules of botanical nomenclature including effective and valid publication, typification, principles of priority and its limitations, author citation, rank of main taxonomic categories, conditions for rejecting names. Classification: Brief history of artificial, natural, phylogenetic and modern classification systems with one example of each system.

Systematics and Genecology / Biosystematics: Introduction and importance, Methodology of conducting biosystematics studies, Various biosystematics categories such as ecophene, ecotype, ecospecies, coenospecies and comparium.

Concept of Species: What is a species? Taxonomic species, biological species, Micro and macro species, Species aggregate. Infra specific categories. Speciation: allopateric, peripatric, sympatric, parapatric, artificial

Taxonomic Evidence: Importance and types of taxonomic evidence: anatomical, cytological, chemical, molecular, palynological, geographical and embryological.

Brief introduction of Numerical taxonomy.

General characteristics, distribution, evolutionary trends, phyletic relationships, and economic importance of the following families of angiosperm:

Apiaceae (Umbelliferae), Juncaceae, Arecaceae (Palmae), Lamiaceae (Labiatae), Asclepiadaceae, Liliaceae, Asteraceae (Compositae), Magnoliaceae, Boraginaceae, Malvaceae, Brassicaceae (Cruciferae), Myrtaceae, Cannaceae, Orchidaceae, Capparidaceae, Papaveraceae, Caryophyllaceae, Poaceae (Gramineae), Casuarinaceae, Ranunculaceae, Chenopodiaceae, Rosaceae, Convolvulaceae, Salicaceae, Cucurbitaceae, Scrophulariaceae, Cyperaceae, Solanaceae, Euphorbiaceae, Fabaceae (Leguminosae), Winteraceae.

Practical:

Technical description of families (of the local flora and their identification up to species level with the help of a regional/Flora of Pakistan

Preparation of indented and bracketed types of keys

Preparation of permanent slides of pollen grains by acetolysis method and study of different pollen characters.

Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination

Field trips shall be undertaken to study and collect plants from different ecological zones of Pakistan.

Recommended Books:

Ali, S.I. and Nasir, Y. 1990-92. Flora of Pakistan. Karachi Univ. Press, Karachi

Ali, S.I. and Qaiser, M. 1992-2007 -todate. Flora of Pakistan. Karachi Univ. Press, Karachi.

Greuter, W., McNeill, J., Barrie, F.R., Burdet, H. M., Demoulin, V., Filguerras, T.S., Nicolson, D.H. Silva, P.C., Skog, J.E., Trehane, P., Turland, N.J. & Hawksworth, D.L., (eds.) 2000. International code of botanical nomenclature (Saint Louis Code) adopted by the Sixteenth International botanical congress St. Louis Missouri, July –August 1999. Koeltz, Konigstein. (Regnum Veg.138.)

Davis, P.H. & Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd, London

Ingrouille, M. 1992. Diversity and Evolution of Land Plants, Chapman & Hall. London

Nasir, E. & Ali, S.I. 1970-89. Flora of Pakistan. Karachi Univ. Press, Karachi.

Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold.

Takhtajan, A. (1986). Flowering Plant: Origin and Dispersal, Oliver and Boyd, Edinburgh

Jones, S. B. and Luchsinger, A.E. 1987. Plant Systematics. McGraw Hill, Inc. New York.

Naik, V.N. 2005. Taxonomy of Angiosperms. Tata McGraw Hill Publishing Company, New Delhi.

BOT-5603

Principles of Plant Biochemistry

3(2-1)

Aims and objectives:

To elucidate the structure and role of primary metabolites in plants

Course Contents:

Carbohydrates:

Occurrence and classification. A general account of ribose, deoxyribose, xylulose, xylose, D-glucose, D-galactose, D-mannose, cellobiose, sucrose, maltose, trehalose, pentosans, fructosans,

starch, cellulose, hemicellulose, amino sugars, derived acids and alcohols, glycosides, mucilages, pectins and lignins.

Lipids:

Occurrence, classification. Structure and chemical properties of fatty acids, triglycerides, phospholipids, glycolipids, sulpholipids, waxes and sterols.

Proteins:

Amino acids and their structure. Electro chemical properties and reactions of amino acids. Classification of proteins. Primary, secondary, tertiary and quaternary structure of proteins. Protein targeting. Protein folding and unfolding. Transport, storage, regulatory and receptor proteins. Protein purification. Protein sequencing. Biological role.

Nucleic Acids:

General introduction. Purine and pyrimidine bases, nucleosides, nucleotides. Structure and properties of DNA and RNA. Types and functions of RNA. Chemical synthesis of oligonucleotides and DNA sequencing. DNA restriction enzymes. Properties of DNA polymerase I, II and III.

Enzymes:

Nature and functions, I.U.E. classification with examples of typical groups. Isozymes, ribozymes, abzymes. Enzyme specificity. Enzyme kinetics. Nature of active site and mode of action. Allosteric enzymes and feedback mechanism.

Practical:

1. Solutions, acids and bases. Electrolytes, non-electrolytes, buffers, pH. Chemical bonds.
2. To perform the qualitative tests for carbohydrates
3. To estimate the amount of reducing and non-reducing sugars in plant material titrimetrically/spectrophotometrically.
4. To perform the qualitative tests for lipids.
5. To determine the amount of crude fat in plant samples.
6. To perform qualitative tests for proteins
7. To estimate soluble proteins by Bradford's method.
8. Extraction of Nucleic acids from plant material and their estimation by UV absorption or colour reactions.
9. To estimate the catalytic property of enzyme catalase or peroxidase extracted from a plant source.

Recommended Books:

1. Buchanan, B. B., Grissem, W., & Jones, R. L. (Eds.). 2015. Biochemistry and molecular biology of plants. John wiley & sons.
2. Conn E E. and Stumpf P.K., 2006. Outlines of Biochemistry, 5th edition. John Wiley and Sons Inc. New York.
3. Lehninger, A L. 1998. Principles of Biochemistry. Worth Publishers Inc.
4. Voet, D., Voet J.G. and Pratt, C.W. 1998. Fundamentals of Biochemistry, John Wiley and Sons, New York.
5. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
6. Smith, E. L., Hill, R L, Lehman, R I., Lefkowitz, R J. Handler and Abraham. 2003, Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw Hill International Book Company.
7. Zubay G .2003, Biochemistry, MacMillan Publishing Co., New York.
8. Chesworth, J.M., Strichbury T. and Scaife, J. R. 1998. An introduction to agricultural biochemistry. Chapman and Hall, London.

9. Mckee, T. and Mckee, J.R. 1999. Biochemistry – An Introduction. WCB/McGraw-Hill, New York, Boston, USA.
10. Lea, P.J. and Leegood, R.C. 1993. Plant Biochemistry and Molecular Biology. Wiley and Sons, New York.
11. Abdes, R.H. Frey, P.A. and Jencks W.P. 2004, Biochemistry, Jones and Bartlet, London.
12. Goodwin T.W. and Mercer, E.I. 1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.
13. Heldt, H-W. 2008. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
14. Bowsher, C. 2008. Plant Biochemistry. Campbell, M.K. and F. Shawn. 2008. Biochemistry 6th Edition.

Aims and Objectives:

This course includes concepts regarding inheritance patterns, recombination in bacteria, linkage and mapping, extranuclear inheritance, developmental and population genetics.

Course Objectives:

To enable the students to understand the structural and functional basis of genes, their inheritance and gene flow in population.

1. Study of Inheritance Patterns: Mendel’s laws of inheritance, extensions of mendelian analysis, dominant and recessive alleles, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity, quantitative inheritance.
2. Linkage and Mapping: Basic eukaryotic chromosome mapping. The discovery of linkage, recombination, linkage symbolism, linkage of genes on the X chromosome, linkage maps, three-point testcross, interference, linkage mapping by recombination in humans, accurate calculation of large map distances, mapping human chromosomes.
3. Genetic Change-Recombination: General homologous recombination, recombination and chromosomal rearrangements.
3. The Nature of the Gene: Structure of gene, how genes work, gene- protein relationships.
4. The Extra nuclear Genome: Extra nuclear genes their inheritance and importance in eukaryotes and prokaryotes.
5. Developmental Genetics: Introduction, basic concepts, a brief description of developmental Genetics in drosophila melanogaster.
6. Population Genetics: Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

Practicals:

- 1.Numerical problems with reference to the basic genetics and population genetics.
- 2.To study Gene Linkage and recombination (Single and Double cross over), Gene mapping in drosophila
- 3.Determination of various Blood group types and Rh-factor in human.

Recommended Readings:

1. S. B. Gelvin. (2000). Plant Molecular Biology Manual. Kluwer Academic Publishers.
2. B. A. Pierca. (2005) Genetics. A conceptual approach, W. H. Freeman and Company, New York.
3. L. Synder and W. Champness. (2004) Molecular Genetics of Bacteria. ASM Press, Washington D.C.
4. W. S. Klug and M. R. Cummings (1997) Concepts of Genetics, Prentice Hall International Inc.
5. N. V. Roth Well (1997) Understanding Genetics, second edition, Oxford University Press Inc.
6. E. J. Gardner (2004) Principles of Genetics, John Willey and Sons, New York.
7. J. Ringo (2004) Fundamental Genetics, Cambridge University Press.
8. A. J. F. Griffiths, S. R. Wessler, R. C. Lewontin, W. M. Gelbart, D. T. Suzuki, and J. H. Miller (2010) Introduction to Genetic Analysis, W.H. Freeman and Company. 11th ed.
9. L. Snyder and W. Champness (2003) Molecular Genetics of Bacteria, ASM Press.

10. D. L. Hartl, and E. W. Jones (2005) *Genetics -Analysis of Genes and Genomes*, Jones and Bartlett Publishers. Sudbury, USA. 11. P. W. Hedrick (2005) *Genetics of Population*. Jones and Bartlett Publisher, Sudbury, USA.

Recommended Books:

1. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. *Plant Metabolism*. 2nd Edition. Longman Group, U.K.
2. Dey, P.M. and Harborne, J.B. 1997. *Plant Biochemistry*. Harcourt Asia PTE Ltd. Singapore.
3. Fitter, A. and Hay, R.K.M. 2001. *Environmental Physiology of Plants*. Academic Press, UK.
4. Heldt, H-W. 2004. *Plant Biochemistry*. 3rd Edition, Academic Press, U.K.
5. Ihsan Illahi, 1991. *Plant Growth*, UGC Press, Islamabad.
6. Ihsan Illahi, 1995. *Plant Physiology, Biochemical Processes in Plants*, UGC Press.
7. Nobel, P.S. 1999. *Physicochemical and Environmental Plant Physiology*. Academic Press, UK.
8. Press, M.C., Barker, M.G., and Scholes, J.D. 2000. *Physiological Plant Ecology*, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.
9. Salisbury F.B. and Ross C.B. 1992. *Plant Physiology*. 5th Edition. Wadsworth Publishing Co. Belmont CA.
10. Taiz, L. and Zeiger, E. 2006. *Plant Physiology*. 4th Edition. Sinauer's Publ. Co. Inc. Calif.
11. W.B. Hopkins. 1999. *Introduction to Plant Physiology*. 2nd Ed. John Wiley and Sons. New York.
12. Epstein, E. and Bloom, A.J. 2004. *Mineral Nutrition of Plants: Principles and Perspectives*. 2nd Edition. Sinauer Associates, California, USA.
13. Kirkham, M.B. 2004. *Principles of Soil and Plant Water Relations*. Elsevier, Amsterdam, Netherlands.
14. Barton, w. 2007. *Recent Advances in Plant Physiology*

BOT-5605

Biostatistics

3(2-1)

Aims and Objectives

The objective of this course is to equip the students with statistical concepts and methods: The emphasis will be on learning how to collect, summarize, analyze, and interpret real-world data in a practical manner.

Course Contents

1. Introduction and scope: Definition: Characteristics, importance and limitations, population and samples.
2. Frequency distribution and probabilities: Formation of frequency table from raw data, histograms. Applications of probabilities to simple events.
3. Measures of central tendencies and dispersion: Arithmetic mean, median, mode, range, variance and standard deviation, standard error of the mean, mean deviation, semi-interquartile range.
4. Tests of significance:
Introduction:
 - 1- t-test: Basic idea, confidence limits of means, significant difference of means.
 - 2- X² – test: Basic idea, testing goodness of fit to a ratio, testing association (contingency table).
 - 3- F-test: Introduction and application in analysis of variance.
 - 4- L.S. D. test, Dancunn Multiple Range Test (for comparison of individual means).
 5. Design of experiment: Concept of design, principles of experiment, planning of an experiment, replication and randomization, Field plot technique, Layout and analysis of completely randomized design, randomized complete block design, Latin square, factorial design, treatment comparison.
 6. Correlation and regression: Brief account of correlation and regression.

Lab Outlines:

1. Probability of simple events.
2. Data collection, arrangement of data in frequency table.
3. Calculation of mean from group and ungrouped data.
4. Calculation of variance and standard deviation from grouped and ungrouped data.
5. T-test.
6. X² – test.
7. Analysis of variance – one factor design
8. Analysis of variance – two-way analysis
9. Analysis of variance – for latin square
10. Analysis of variance – for factorial design.
11. Correlation.
12. Linear Regression.

Books Recommended

- 1- Bailey. N.T.J. 1994. Statistical Methods in Biology, Cambridge University Press.
- 2- Quinn, G. 2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press.
- 3- Wonnacott, T.H. and Wonnacott, R.J. 1990. Introductory Statistics, John Willey and Sons.

Semester VIII

Course Code	Course Title	Lecture Credit's
BOT-6801	Principals of Biotechnology	3(2-1)
BOT-6802	Plant Anatomy	3(2-1)
BOT-6803	Plant Biodiversity and Conservation	3(2-1)
BOT-6804	Genetics-II	3(2-1)
BOT-6706	Thesis/Optional Paper	3(3-0)
Total Credit Hour's		15

BOT-6801**Principles of Biotechnology****3(2-1)****Aims and Objectives**

To understand the basic techniques and principles of tissue culture and DNA Recombinant Technology

Course Contents**1. Introduction****2. Plant tissue culture**

Micro propagation: Explant Sources, Comparison with field multiplication, Virus Elimination, Advantages. Callus culture, Cell culture, Protoplast culture and Somatic hybridization, Regeneration: Organogenesis, Somatic Embryogenesis, Haploid culture

3. Recombinant DNA Technology

Cloning and expression techniques, Cutting and joining DNA molecules, Polymerase Chain Reaction, Molecular Characterization, RFLP, RAPD and AFLP, Microarray, electrophoresis Gene Libraries and cDNA cloning, Analyzing DNA sequences, Restriction Analysis, Sequencing

4. Genetic engineering of plants: -Transformation with the Ti plasmid of *Agrobacterium tumefaciens*. – Biolistics mediated transfer genetically modified crops: species, concerns, future scope

Practical

1. Overview of plant tissue culture/plant biotechnology lab.
2. Preparation of MS medium
3. Micro propagation of potato Initiation and maintenance of callus Organogenesis
4. Isolation and quantification of DNA
5. Agarose gel electrophoresis of DNA
6. SDS PAGE
7. Plasmid isolation
8. RE digestion

Books Recommended

1. Dodds, J. H. and L.W Roberts, 1997. Experiments in Plant Tissue Culture. Cambridge University Press, Cambridge.
2. Old, R.W and S.B. Primerose, 1994. Principles of Gene Manipulation. Blackwell, Oxford, London.
3. Glick, B.R. and J.J. Pasternak. 2003. Molecular Biotechnology: principles and applications of recombinant DNA.

BOT-6802

Plant Anatomy

3(2-1)

Aims and Objectives:

To provide comprehensive knowledge about internal organization and anatomy of vascular plants.

Course Contents

1. The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body.
2. Meristematic tissues: classification, cytohistological characteristics, initials and their derivatives.
3. Apical meristem: Delimitation, different growth zones, evolution of the concept of apical organization. Shoot and root apices.
4. Leaf: types, origin, internal organization, development of different tissues with special reference to mesophyll, venation, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells.
5. Vascular cambium: Origin, structure, storied and non-storied cell types, types of divisions: additive and multiplicative; cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth.
6. Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem with special emphasis on different types of woods, Periderm.
7. Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals.
8. Anatomy of reproductive parts:
 - Flower
 - Seed
 - Fruit
9. Economic aspects of applied plant anatomy
10. Anatomical adaptations
11. Molecular markers in tree species used for wood identification.

Practical:

1. Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures.
2. Study of abnormal/unusual secondary growth.
3. Peel and ground sectioning and maceration of fossil material.
4. Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides.

Recommended Books:

1. Dickison, W.C. 2000. Integrative plant anatomy. Academic Press, U.K.
2. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
3. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
4. Metcalf, C.R. and Chalk, L. 1950. Anatomy of the Dicotyledons. Clarendon Press. Oxford.
5. Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.
6. Vaughan, J.G. 1990. The structure and Utilization of Oil Seeds. Chapman and Hall Ltd. London.
7. Metcalfe, C.R. 1960. Anatomy of the Monocotyledons. Gramineae. Clarendon Press, Oxford.
8. Metcalfe, C.R. 1971. Anatomy of the Monocotyledons.V. Cyperaceae. Clarendon Press, Oxford.
9. Cutler, D.F. 1969. Anatomy of the Monocotyledons. IV. Juncales. Clarendon Press, Oxford.
10. Cutler, D.F. 1978. Applied Plant Anatomy. Longman Group Ltd. England
11. Raymond, E.S. and E. Eichhorn. 2005. Esau's Plant Anatomy; Meristematic cells and tissues of plant body. John Willey Sons.
12. Eames, A.J. and L.H. Mac Daniels. 2002. An introduction to Plant Anatomy. Tat Mac-Graw Hill Publishing Company Limited, New Delhi.

BOT-6803

Plant Biodiversity and Conservation

3(2-1)

Aims and Objectives

To familiarize the students with the diversity of nature. Importance of biodiversity for survival and proper functioning of ecosystems

Course Contents

1. Definition of biodiversity as defined in the convention of biological diversity (CBD).
2. Introduction of species on each other for their survival.
3. Extent of known and estimated biodiversity of earth.
4. Measuring biodiversity: Alpha, Beta, and Gamma diversity, Systematic diversity, functional diversity, taxic diversity.
5. Ecological services, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of living resources).
6. Sustainable and unsustainable use of ecosystem resources, consequences of unsustainable use, ecosystem degradation, extinct species, desertification and deforestation.
7. Biodiversity Hot spots of the world.
8. International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar.
9. IUCN categorised protected areas in Pakistan.
10. Environmental Impact Assessment.
11. Use of herbarium and Botanical Garden in biodiversity and conservation.

Practical

1. Inventory of plant biodiversity in various habitats.
2. Field survey for baseline studies and Impact Assessment.
3. Identification of wild plant species used by local communities in different ecosystems.

Books Recommended

1. Heywood, V. (Ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme. Cambridge University Press, Cambridge, UK.
2. Falk, D.A. & Holsinger, K.E. 1991. Genetics and Conservation of Rare Plants. Center for Plant Conservation. Oxford University Press, Oxford, UK.
3. Frankel, O.H., Brown, A.H.D. & Burdon, J.J. 1995. The Conservation of Plant Biodiversity. Cambridge University Press, Cambridge, UK.
4. IUCN. 1994. IUCN Red List Categories. As Approved by the IUCN Council. IUCN.
5. Leadley, E. and Jury, S. 2006 Taxonomy and Plant Conservation. CUP.
6. Bush, M.B. 1997 Ecology of a changing Planet. Prentice hall. New Jersey.
7. French, H. 2000 Vanishing Borders- protecting the Planet in the age of globalization. W.W. Norton & Co.
8. Swanson, T. 2005 Global Action for Biodiversity. Earth Scan Publication Ltd.

BOT-6804

Genetics II

3(2-1)

Aims and Objectives

To introduce students to recombination of genetic material at molecular levels with emphasis on introduction to biotechnology and genomics

Course Contents

1. Recombinant DNA: Recombinant DNA Technology – Introduction, Basic Techniques, PCR and Rt PCR, Restriction enzymes, Plasmids, Bacteriophages as tools, the formation of recombinant DNA, recombinant DNA methodology, recombinant DNA and social responsibility, Site directed Mutagenesis, DNA sequencing.
2. Application of Recombinant DNA: Applications of recombinant DNA technology using prokaryotes, recombinant DNA technology in eukaryotes: An overview, transgenic yeast, transgenic plants, transgenic animals, screening for genetic diseases, identifying disease genes, DNA typing, gene therapy, genetically modified organisms and apprehensions.
3. Control of Gene Expression: Discovery of the *lac* system: negative control, catabolite repression of the *lac* operon: positive control, transcription: gene regulation in eukaryotes - an overview.
4. Mechanisms of Genetic Change I: Gene Mutation: The molecular basis of gene mutations, spontaneous mutations, induced mutations, reversion analysis mutagens and carcinogens, biological repair mechanisms.
5. Mechanisms of Genetic Change II: Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements.
6. Mechanisms of Genetic Change III: Transposable Genetic Elements: Insertion sequences, transposons, rearrangements mediated by transposable elements, review of transposable elements in prokaryotes, controlling elements in maize.
7. Human Genome Project: Strategies and application, achievement and future prospects.
8. Plant Genome Projects: Arabidopsis, achievement and future prospects. Other plant genome projects
9. Bioinformatics: Application of computational tests to the analysis of genome and their gene products
10. Bioethics: Moral, Religious and ethical concerns

Practical

Problems relating to the theory

1. Isolation and separation of DNA and protein on Gel electrophoresis.

- i. Bacterial chromosome
- ii. Plasmid DNA (minipreps)
- iii. Plant DNA
- iv. Protein

2 DNA Amplification by PCR

Recommended Books

1. Trun, N and Trempy J., 2004, Fundamental Bacterial Genetics, Blackwell Publishing House.
2. Winnacker, E.L. 2003, From Gene to Clones – Introduction to Gene Technology, Panima Publishing Corporation, New Delhi.
3. Beaycgamp T.L. and Walters L., Contemporary Issues in Bioethics, Wadsworth Publishing Company.
4. Brown, T.A., 2002 Genomes, Bios Scientific Publishers Ltd.
5. The Genome of Homo Sapiens, 2003, Cold Spring Harbor Laboratory Press.
6. Ignacimuthu, S. 2005, Basic Bioinformatics, Narosa Publishing House, India.
7. Lwein, B. 2004, Gene VIII, Pearson Education Int.
8. Miglani, 2003, Advanced Genetics, Narosa Publishing House, India.
9. Hartt, D. L, and Jones, E.W. 2005. Genetics, Analysis of Gene and Genomes. Jones and Bartlett Publishers, Sudbury, USA
10. Gelvin, S,B. 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.
11. Primrose, S.B., Twyman, R. M. and Old R.W. 2004. Principles of Gene Manipulation, an Introduction to Genetic engineering (6th edition), Blackwell Scientific Publications.
12. Snyder, L and Champness W, 2003, Molecular Genetics of Bacteria, ASM Press.

LIST OF ELECTIVE COURSES FOR BS-4 YEAR (8th SEMESTER) PROGRAM IN BOTANY

Course code	Course Title	Credit Hrs.
BOT-6805	Bioremediation & Environmental Biotechnology	3(2-1)
BOT-6806	Environmental Issues	3(2-1)
BOT-6807	Medical Microbiology	3(2-1)
BOT-6808	Advances in Molecular Biology	3(2-1)
BOT-6809	Cell and Tissue Culture	3(2-1)
BOT-6810	Virology	3(3-0)
BOT-6811	Methods in Molecular Biology	3(2-1)
BOT-6812	Genomics	3(3-0)
BOT-6813	Biodiversity of Plants and Fungi	3(2-1)
BOT-6814	General Microbiology	3(2-1)
BOT-6815	Recombinant DNA Technology	3(2-1)

BOT-6805 **Bioremediation & Environmental Biotechnology** **3(2-1)**

Aims and Objectives

To remediate various pollutants using advanced biological techniques.

Course Contents

Concept of bioremediation; Bioremediation of heavy metals, xenobiotic compounds and hazardous wastes; techniques used in bioremediation, bioremediation through consortia of microbes and invertebrates; renewable and non-renewable resources; bioleaching and biomining (low grade and sulfide containing ores processing); domestic solid waste and management. Waste water, sludge and sewage management; biological methods of wastes treatment; sample collection and preservation; bioremediation of crude and petroleum oils. Role of yeast in bioremediation. Biological fuel generation; Bioremediations of industrial effluents.

Practical

Bioremediation of heavy metals through invertebrates, consortia of microorganism, mycoremediation.

Recommended Books

1. Environmental Science (Earth as a living planet). 2000. 1st ed. Botkin, D. and Keller, E. John Wiley and Sons Inc. New York, USA.
2. Practical Environmental bioremediation the field guide, 1977. R. Barry. King, Gilbert M. Long John K. Sheldon, Lewis Publishers.
3. General Microbiology, 1995. Schlegel, H.G., Cambridge University Press.
4. Biotechnology, 1996. Smith, J.F., Cambridge University Press.
5. Environmental Biotechnology Principles and Applications, 2000. Puce, R. Hmana, Parry McCarty, McGraw Hill.
6. Biodegradation and Remediation, 1999. Martin Alexander Academic Press Inc.

BOT-6806

Environmental Issues

3(2-1)

Aims and Objectives

This course is designed to provide students with an appreciation for the complexity of environmental issues and an awareness of the tools that can be applied to understand and solve problems involving the environment.

Course Contents

Life a factor of rapid change in the environment, Population increase of diversified life in an ecosystem, Population system in an ecosystem balance; Mechanisms inter-playing in balance, consequences of imbalance, Endangering and extinction of species, decline of biodiversity, consequences of losing biodiversity. Human population: Main actor in an environment, Human population explosion, Technologies in sustaining population and affluence, addressing population problem, population and development. Poverty; integrated approach to alleviate poverty, Life style: Urban sprawl, consequences of ex-urban migration, Health in life style; Environment and health. Food production (Crops and livestock). Land for cultivation and farming. Food production, its distribution, economics and politics, Hunger, malnutrition and famine, Soil, irrigation, Stalinization, Desertification, Losing soil/ground. Pests and pest controls: Need and approach to pest control. Alternate pest control methods. Socio-economic pressure and pest management, Environmental policy in pest management. Water: Water cycle and water management, Human impact on water resources. Pollution. Bi-products of production systems: Sediments, Nutrients and eutrophication, the process and symptoms of eutrophication, combating eutrophication, long term strategies. Sewage pollution: Sewage hazards and potential, sewage management, recycling and impediment to recycling. Hazardous chemical pollution: Nature and chemical risks, pollution sources and control. Major atmospheric changes: Acid deposition, Global warming/cooling, Greenhouse effect, Ozone depletion. Solid wastes (trash): Landfills, combustion, solutions and management. Energy resources (Fuel of production and development): energy sources and uses, fossil fuel, alternate fossil fuel; Nuclear Power, promises and problems, sustainable energy option, solar and other renewable energy sources. Environmental issues of Pakistan: Ecological issues (Soil

erosion, deforestation, issues related to irrigated system, natural hazards), issues related to conservation of habitat and biodiversity (major threats to biodiversity in Pakistan, conservation strategy), pollution and industrial resources (water issues, air issues, soil issues, mineral resources issues, energy issues, food, population issues and socio-economic issues.

Practical:

Review, reports, field trips, discussions on current local, national, regional and global issues. Approaches and strategies, mitigation measures.

Recommended Books

1. Botkin, D.B. and Keller, E.A. 2008. Environmental science (Earth as a living planet). 3rd Ed. John Wiley and Sons Inc. N.Y, USA.
2. Ahmad, R.Z. 2000. Pakistan-A-descriptive Atlas (A comprehensive geopolitics Course). 1st Ed. Ferozsons Pvt. Ltd. Lahore Pakistan.
3. Nebel, B.J. and Wright, R.t. 1998. Environmental Sciences (the way the world works). 1st Ed. Prentice Hall International Inc. London, UK.
4. Gaston, K.J. and Spicer, J.I. 1998. 'Biodiversity (An Introduction), 1st Ed. Blackwell Science Ltd. UK.
5. Brandbury, I.K. 1998. The Biosphere. 2nd Ed. John Wiley and Sons Inc. UK.
6. Mckinny, M.L. and Schoch, R.M 1998. Environmental Science (systems and solutions). Jones and Artlett Publications Inc. USA.
7. Emiliani, C. 1997. Planet Earth (Cosmology, geology and the evolution of life and environment). 3rd Ed. Cambridge. University Press, UK.
8. Khan, F.K. Geography of Pakistan Environment (Environment, People and economy). 1993. Oxford University Press, NY, USA.
9. Hussain, S.S. 1992. Pakistan Manual of Plant Ecology (A text book of plant ecology for degree students). National Book Foundation, Islamabad, Pakistan.
10. Daily newspapers for current issues.

BOT-6807

Medical Microbiology

3(2-1)

Aims and Objectives

Aims of this course are to let the students know about the science of microbiology, to work with microorganisms, their pathogenicity, and various diseases and problems caused by microorganisms. The course may also initiate their interest in agricultural, industrial and/or environmental microbiology. The course will enable the students to identify specific areas in practical life where the science of microbiology is being applied. Thus they can seek different job in various organizations such as clinical, industrial and environmental microbiology sections.

Course Contents

Morphology and fine structure of bacteria: Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, the cytoplasm, nuclear material. Microbiology and Medicine, antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of the infections in the community. Immunological principles, antigen, antibodies and antigen-antibody reactions. Bacterial pathogens and associated diseases. *Staphylococcus*, skin and wound infections. *Streptococcus*, sore throat, scarlet fever, glomeruonephritis. *Pneumococcus*, respiratory infections. *Corynebacterium*. *Diphtheriae* *Mycobacterium tuberculosis*: Pulmonary and other tuberculosis infections. *Actinomyces*. *Neisseria meningitis*, Gonorrhoea, *Salmonella*, *Shigella*, *Escherichia coli*, *Klebsiella proteus*, *Providencia*, *Bacillus anthracis*. *Clostridium tetnai*. Pox viruses, Herpes viruses. Herpes simplex. Cytomegalovirus infections. Adenoviruses. Influenza viruses. Hepatitis viruses. Arbovirus, Rickettsia, Pahtogenic. Fungi and Protozoa.

Practicals

Basic techniques.(Staining of microorganisms: Simple stains, positive staining; negative staining. Demonstration of special structures by stains: Spore stain, Flagella stain. Differential stains: Gram stain, Metachromatic Granule stain, Acid fast stain. Culturing of microorganisms: Preparation and sterilization of culture media, agar slope, agar slab, streak plates, pour plates methods. Isolation of a bacterial culture. Quantitative plating methods) Widal test. Laboratory diagnosis and control of infections: Streptococcus. Corynebacterium, Listeria, Mycobacterium. The Entero bacteriaceae: Salmonella. Escherichia, Klebsiella and Clostridium. Blood tests: TLC, DLC, RBC.

Recommended Books

1. Kenneth Ryan, C. George Ray, Nafees Ahmad, W. Lawrence Drew, James Plorde. (2010). Sherris Medical Microbiology, Fifth Edition. McGraw Hill Publishers, Washington DC
2. Patrick R. Murry, Ken S. Rosenthal, Michael A. Pfaller: Medical Microbiology, 5th edition, Philadelphia: Elsevier/Mosby, 2005.
3. P.K. Murray, Ph.D., K.S. Rosenthal, Ph.D., G.S. Kobayashi, Ph.D., and M.A. Pfaller, MD, 4th Edition, Mosby, Inc. 2002. ISBN #0323012132
4. Sherris medical microbiology: an introduction to infectious diseases C. George Ray, Editor; McGraw-Hill/Appleton and Lange 5th edition, McGraw-Hill/Appleton & Lange, 2003. ISBN#0838585299
5. Microbial Applications (Complete Version) Laboratory Manual In General Microbiology, 1994. Benson, H.J. WMC Brown Publishers, England.
6. Microbiology, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.
7. Brock Biology Of Microorganisms, 1997. Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall, London.
8. Cruickshank, R, Duguid, J.P., Hermion, B.P. and Swain, R.H.A., (2003). Medical Microbiology. Churchill Livingstone, N.Y.
9. The Microbial World, 1986. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. Prentice Hall, London.
10. Foundations in Microbiology. (1998). Talaro & Talaro. WCB Publishers, New York.
11. Microbiology: A Human Perspective, 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher Education

BOT-6808

Advances in Molecular Biology

3(2-1)

Aims and objectives

Objectives of the course are to impart knowledge about the macromolecules in animal cell and their complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms.

Course Contents

Molecular Biology of DNA, RNA, Protein, DNA replication and DNA repair. Transcription. Translation, Gene expression in prokaryotes and eukaryotes. Molecular biology of DNA and RNA viruses and yeast. Molecular immunology, Oncogenes and cancer.

Practical

Quantitative estimation of various macromolecules. Demonstration of properties of macromolecules. Methods of bacterial culture.

Recommended Books

1. Kornberg, A. (1980). DNA Replication, W.H. Freeman, San Francisco.
2. Kornberg, A. (1982). Supplement to DNA Replication, W.H. Freeman, San Francisco.
3. Old, R.W. and Primrose, S.B. (1981). Principles of Gene Manipulation, Blackwell, Oxford.

4. Watson, J.D., Hpkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. (1990). Molecular Biology of the Gene, Benjamin, California.
5. DuPraw, Advances in Cell and Molecular Biology, Academic Press.
6. Bukhari, A.I., Shapiro, J.A., and Adhya, S.L. (1977). DNA Insertion Elements, Plasmids and Episomes, Cold Spring Harbour Laboratories.
7. Stent, G.S., (1971). Molecular Genetics, Freeman, San Francisco.
8. Glass R.E., (1982). Gene Function: E. coli and its Heritable Elements, Croom Helm, London.
9. Adams, R.L.P., Knowler, J.T. and Leaer, D.P. (1986). The Biochemistry of the Nucleic Acids, Chapman and Hall.
10. Davis, R.W., Botstein, D. and Roth, J.R. (1980). Advanced Bacterial Genetics, Cold Spring Harbor Lab., N.Y.
11. Freifelder, D. (1983). Molecular Biology, A Comprehensive Introduction to Prokaryotes and Eukaryotes. Science Books International, Boston.

BOT-6809

Cell and Tissue Culture

3(2-1)

Aims and Objectives:

The aim of this course is to provide students with a thorough understanding of the importance of cell, tissue and organ culture and its application in life sciences.

Course Contents:

Plant cell and tissue culture: requirements for in vitro cultures; culture facilities; sterile techniques; media preparation and handling; callus cultures; cell suspension cultures; protoplast culture; haploid cultures, organ culture; meristem culture for virus elimination; embryo culture and embryo rescue; regeneration of plants and micro-propagation; somaclonal variation; industrial uses of plant cell culture; tissue culture in genetic engineering and biotechnology. Mammalian cell culture: origin and principles of cell culture; qualitative characteristics of cell cultures; cell counting and analysis; cryopreservation; cell banking and subculture (variety of different systems); primary cell culture techniques; development of immortalized cell line; detection of microbial contaminants; animal cells for bioassays and bioproducts; design and operation of animal cell culture bioreactors for therapeutic protein production; growth environment; Stem cell culture

Recommended Books:

1. Setlow JK, 200. Genetic Engineering: Principles and Methods. Kluwer Academic Publishers.
2. Nichol DST, 202. An Introduction to Genetic Engineering. 2nd Edition; Cambridge University Pres.
3. Gale YL, 202. Genetic Engineering.
4. Razdan MK, 203. Introduction to Plant Tissue Culture. 2nd Edition; Intercept, New York, USA.
5. Lanza et al., 200. Principles of Tissue Engineering. 2nd Edition; Academic Pres, California.
6. Ignacimutu S, 197. Plant Biotechnology. Oxford IBH Publisher.
7. Punia MS, 199. Plant Biotechnology and Molecular Biology: A Laboratory Manual. Scientific Publishers.

BOT-6810 Virology

3(3-0)

Aims and Objectives

Aim of this course is to provide a generalized overview of virology as its stands today.

Course Contents

Historical perspective; general properties of viruses; classification and nomenclature; virus structure and assembly; replication cycle and genetics of viruses; animal and plant viruses; propagation, detection and quantification of viruses; pathogenesis and immune response of viral infections; laboratory diagnosis of viral diseases; vaccines and antiviral drugs; epidemiology; tumor viruses; viral vectors and gene therapy; emerging viruses; specific aspects of selected viral diseases

Recommended Books:

1. Flint et al., 209. Principles of Virology. ASM Pres, USA.
2. Lal S, 207. The Biology of Emerging Viruses. Wiley-Blackwel, USA.
3. Carter J Saunders V. Virology: Principles and Applications. First Edition; Wiley.
4. Wagner et al., 207. Basic Virology. Third Edition; Wiley-Blackwel.
5. Flint SJ, 209. Principles of Virology, Vol. 2: Pathogenesis and Control. 3rd Edition; AMS Pres

BOT-6811**Methods in Molecular Biology****3(2-1)****Aims and Objectives**

To acquaint students with the experimental aspects of molecular biology

Course Contents

Introduction to recombinant DNA technology; restriction and modifying enzymes; cloning and expression vectors and their types; expression of recombinant proteins and their purification by affinity chromatography; polymerase chain reaction (PCR) - types; (inverse, touch-down, nested, hemi-nested, pit stop, multiplex, reverse transcriptase, RACE, real-time) and its applications; detection of mutations and/or SNPs; DNA fingerprinting; analysis of nucleic acids by gel electrophoresis – horizontal, vertical, pulse field, denaturing gradient gel electrophoresis; analysis of proteins by native and SDS-PAGE; 2-D gels; generation of antibodies and their uses; enzyme linked immunosorbent assay; Southern, Western, Northern blotting.

Practical:

Preparation of stock and working solutions; isolation of nucleic acids and their quantification; restriction digestion of DNA and preparation of restriction maps; gel electrophoresis; polymerase chain reaction (PCR); detection of mutations by restriction fragment length polymorphism; preparation of chemically competent cells; transformation of bacteria with plasmid DNA; analysis of proteins by SDS-PAGE

Recommended Books

1. Ausubel FM, 205. Short Protocols in Molecular Biology (2 volume set). 5th Edition; John Wiley and Son.
2. Gren MR and Sambrook J, 201. Molecular Cloning: A Laboratory Manual. 3rd Edition; Cold Spring Harbor Laboratory Pres.
3. Primrose SB and Twyman R, 206. Principles of Gene Manipulation and Genomics. 7th Edition; Wiley-Blackwel.
4. Wilson K and Walker J, 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th Editon; Cambridge University Pres.
5. Walker JM and Rapley, 208. Molecular Bio methods Handbook (Methods in Molecular Biology). 2nd Edition; Humana Pres.

BOT-6812**Genomics****3(3-0)****Aims and Objectives**

The overarching goal of this course is to provide students with a thorough overview of both the theoretical and experimental aspects of structural and functional genomics.

Course Contents

Organization and structure of genomes; genetic mapping (RFLP, microsatellite, SNP); high-resolution physical mapping (STS, EST); flow cytometry; somatic cell and radiation hybrids; artificial chromosomes in bacteria and yeast; hierarchical and whole genome shotgun sequencing; DNA sequencing strategies - manual and automated sequencing, pyrosequencing, Solexa, Helicos, Roche 454, real-time and nanopore sequencing; sequence assembly, obstacles and solutions; estimating gene number – over-prediction and under-prediction, homology searches, exon prediction programs, integrated gene-finding software packages; structural variation in the genome and its applications; microarray and RNA interference.

Recommended books:

1. Strachan T and Read AP, 2010. Human Molecular Genetics. 4th Edition; Garland Science.
2. Sacone C and Pesole G, 2003. Handbook of Comparative Genomics: Principles and Methodology. 1st Edition; Wiley-Lis.
3. Town C, 202. Functional Genomics. 1st Edition; Springer.
4. Krebs et al., 2010. Lewin Genes X. 10th Edition; Jones and Bartlet Publishers.
5. Al-Rubeai M and Fuseneger M, 2010. Systems Biology (Cell Engineering). 1st Edition; Springer

BOT-6813 **Biodiversity of Plants and Fungi** **3(2-1)**

Aims and Objectives

To learn about the evolutionary history and phylogenetic relation between plants and fungi.

Course Contents

Introduction: Diversity of life. Arranging the diversity of life into Kingdoms. Prokaryotes and origin of metabolic diversity. The origin of eukaryotic diversity: Eukaryotic origin by symbiosis among prokaryotes. Eukaryotic algae as key producers in aquatic ecosystem. Major characteristics of phyla of kingdom Plant and colonization of land. Plant diversity and evolutionary history of plant kingdom, structural and reproductive adaptation for colonization of land. Plant structure and Growth. Reproduction & Development: Life cycle of plant. Evolutionary adaptation in germination of seeds, methods of reproduction and their role in agriculture, overview of developmental mechanism in plants. Control systems of Plants to cope with environmental stress. Body plan and nutritional modes in Fungi Classification of Fungi.

Practical

1. Study of morphology and reproductive structures of eukaryotes and prokaryotes specimens mentioned in course outline.
2. Identification of various types mentioned from prepared slides and fresh collection.
3. Collection of specimens of plants and their identification.

Recommended Books

1. Schafer, 2006. Photo morphogenesis in plant and Bacteria.
2. Barbara J. E.s., Christine J. C. B. and Thomas N. S. 2010. Microbial Rots Endophytes. Springer.
3. Shely, 2010. Stern's Introductory Plant Biology. McGraw-Hil Sciences.37
4. Ana M. P. and A. Carolina F. 201. Endophytes of forest Tres. Springer.
5. Alexopoulos, 2012. Introductory Mycology.
6. Teij S., Hideki K. et al. 2013. Species Diversity and Community Structure. Springer.

BOT-6814 **General Microbiology** **3(2-1)**

Aims and Objectives

The course is designed to enable the students to work with microorganisms. The basic techniques of sterilization, culturing, isolation and determining different characteristics of the microorganisms are included.

Course Contents

The beginnings of Microbiology: Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology. Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual. **Viruses:** Bacteriophages and phages of other protests. Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses. **Morphology and fine structure of bacteria:** Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material. **The Cultivation**

of Bacteria: Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation. **Reproduction and growth of bacteria:** Modes of cell division, New cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content, Determination of the dry weight of cells, The selection of a procedure to measure growth, Importance of measurement of growth. **Pure cultures and cultural characteristics:** Natural microbial populations, selective methods; Chemical methods, Physical methods, Biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections, Cultural characteristics; Colony characteristics, Characteristics of broth cultures. **Eukaryotic Microorganisms:** Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi. Protozoa: Ecology and importance of protozoa. Classification of protozoa. **Prokaryotic diversity Bacteria:** Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria, Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonas and Chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydiae, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria; Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes. **Prokaryotic Diversity:** Archaea: Extremely Halophilic archaea, Methane producing archaea: Methanogens, Hyperthermophilic archaea, Thermoplasma. **Microbial Ecology:** Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

Practical:

The culture of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates. Isolation of a bacterial culture, Quantitative plating methods. The turbidimetric estimation of microbial growth.

Recommended Books

1. Pelczar, Jr., Chan, E.C.S. and Kreig, M.R. (1986). Microbiology, McGraw Hill, London.
2. Peltler, G.L.A Laboratory Manual of Microbiology.
3. Benson, H.J. Microbial Applications: Laboratory Manual in General Microbiology, 1994. WMC Brown Publishers, England.
4. Madigan, M.T., Martinko, J.M. and Parker, J. Brock Biology of Microorganisms, 1997. Prentice-Hall, London.

BOT-6815

Recombinant DNA Technology

3(2-1)

Aims and Objectives

To elucidate the students the techniques of recombinant DNA technology.

Basic Techniques: Extraction of nucleic acids, measurement of nucleic acids, gel electrophoresis, nucleic acid probes, hybridization of nucleic acids, nucleic acid blotting: southern blotting, northern blotting, dot or slot blots, **Cutting and Joining DNA molecules;** Restriction enzymes, host controlled restriction and modification, types of restriction enzymes, nomenclature, isoschizomers, physical methods of breaking DNA, DNA ligases, linkers, adapters, homopolymer tailing, **Vectors:** Desirable properties of vectors, plasmids vectors, bacteriophage λ vectors, cosmids, m13 vector, phasmids, supervectors: BACs, YACs, HACs.

Polymerase Chain Reaction (PCR); PCR reaction, primers, reverse transcriptase PCR, real time PCR, PCR application: PCR cloning strategies, analysis of recombinant clones, diagnostic application, **Gene transfer to Plants**; *Agrobacterium tumefaciens* mediated transformation, direct nuclear transformation, viral vectors, chloroplast transformation, **Application of Transgenic Plants**; Insecticidal resistance, herbicidal resistance, virus resistance, fungal resistance, delayed ripening, salt tolerance, enhancing production and quality of food

PRACTICAL

1. Plasmid DNA isolation from bacterial cells

2. Chromosomal DNA isolation from bacterial cells

3. Agarose gel electrophoresis of isolated DNA

4. Restriction enzyme digestion of plasmid DNA

5. DNA amplification through PCR

Recommended Books

1. Brown, T.A. 2010. Gene Cloning and DNA Analysis. 6th Edition. Wiley-Blackwell, London.

2. Dale, J.W., and Schantz, M.V. 2007. From Genes to Genomes. 2nd Edition. John Wiley & Sons, Inc., London.

3. Hughes, M.A. 1996. Plant Molecular Genetics. Addison-Wesley Longman, London.

4. Nicholl, D.S.T. 2008. An Introduction to Genetic Engineering. 3rd Edition. Cambridge University Press, London.

5. Primrose, S.B., and Twyman, R.M. 2002. Principles of Genome Analysis. 3rd Edition. Blackwell Science, Oxford.