**SEMESTER II**

**GBMB-201 MICROBIAL GENETICS**

**Course Objective:**

"On the completion of this course the students will be able to describe following subject matters: 1. Cycle: Mitosis and Meiosis: Control points in cell-cycle, Law of segregation & Principle of independent assortment. 2. This course is designed to understand the role and composition of various body fluids with reference to human body. 3. Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. 4. Control of Microorganisms: By physical, chemical and chemotherapeutic Agents. 5. Preservation of various types of foods. Fermented Foods."

**Course Content:**

**UNIT I**

Modes of genetic recombination in Bacteria: Conjugation- distinct sexes in *E.coli*, F-factor, conjugal transfer process, interrupted mating and time of entry mapping, high frequency recombination (hfr) strains.

**UNIT-II**

Transformation- competence, DNA uptake by competent cells.Mechanism of transformation.Gene mapping by transformation.

Transduction- types of transduction, mechanism of generalized transduction, abortive transduction, formation of specialized transduction particles, transfection.

**UNIT III**

Mutation and mutagenesis: phenotypes and genotypes, auxotrophic mutants, conditional and lethal mutants.

Spontaneous Mutation- the random nature of mutations, evidences for spontaneous mutations,mutation rate, the origin of spontaneous mutations. Induced Mutation- chemical mutagens,alkylating agents (EMS and nitrosoguanidine), intercalating agents (acridine orange) and physical agents.

**UNIT-IV**

Plasmids and Transposable elements: Types of plasmids, detection of plasmids, F-Plasmids in *E.coli*, conjugative and non conjugative plasmids. Control of plasmid copy number, plasmid amplification incompatibility, plasmid DNA, replication, curing of plasmids.

Transposable Sequences- insertion sequences (IS), composite transposons (Tn10, Tn5), Phage Mu as transposon, conjugative transposons.

**UNIT V**

Genetics of Bacteriophages: Lytic and Lysogenic cycle, expression of phage genes in regulation of lytic and lysogenic circuit. Maintenance of lysogen by autogenous circuit, repressor structure and repressor synthesis.

**SUGGESTED READING**

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings.
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning.
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings.
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and FriefelderD(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

**GBMB 202 MOLECULAR BIOLOGY**

**Course Objective:**

This course is designed as such to target the knowledge and understanding of Nucleic acids and the experiments related to Genetics.

**Course Content:**

**UNIT I**

Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Keyexperiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

**UNIT II**

The Structures of DNA and RNA : DNA ;Miescher to Watson and Crick, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation. DNA topology-linking number, topoisomerases;

Organization of DNA ,Prokaryotes, Viruses, Eukaryotes. RNA Structure, DNA – mitochondria and chloroplast DNA.

**UNIT III**

Genome Structure, Chromatin and the Nucleosome: The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Organization of Chromosomes.

**UNIT IV**

The Replication of DNA (Prokaryotes and Eukaryotes): Chemistry of DNA synthesis, generalprinciples - bidirectional replication, Semiconservative, Semi discontinuous, RNA priming, Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory protein.

**Recommended Books**

1.Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition.John Wiley &Sons.Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006).Cell and Molecular Biology.VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009).The World ofthe Cell.VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press,Pearson Pub.

**GBMB-203 MICROBIAL PHYSIOLOGY & METABOLISM**

**Course Objective:**

1. Microbial physiology and metabolism provide information on sources of energy and its utilization by microorganisms. Microorganisms play important role in environment as producers, consumers and decomposers. 2. This diverse metabolic activity is generally not observed in any other group of living organisms. 3) Bioenergetics, pH, salts, acid and base, buffers, Carbohydrates and polymers, Lipid classification and uses, Enzyme classification and its activity. 4 The course will enhance the insight of students on mechanism of enzyme regulation, measurement & expression of enzyme activity, enzyme assay and techniques for studying mechanisms of action.

**Course Content:**

**UNIT I**

Metabolite Transport: Passive and facilitated, Primary active and secondary active transport,Group translocation (phosphotransferase system), symport, antiport and uniport,electrogenic and electro neutral transport, transport of Iron.

**UNIT II**

Chemolithotrophicmetabolism:Physiological groups of aerobic and anaerobic chemolithotrophs, Hydrogenoxidizingbacteria and methanogens.

Phototrophic metabolism:Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenicand oxygenic photosynthesis, photosynthetic pigments: action and absorptionspectrum, type, structure and location, physiology of bacterial photosynthesis: lightreactions, cyclic and non-cyclic photophosphorylation.Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.

**UNIT III**

Microbial Energetics: Concept of aerobic respiration, anaerobic respiration and fermentation.Central metabolic pathways: EMP pathway, ED pathway, PP pathway, and TCAcycle. gluconeogenesis, glyoxylatecycle.Mitochondrial and bacterial electron transport.Oxidation-reduction potential andenergetic of electron transport.

**UNIT IV**

Nitrogen Fixation: Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction,biological nitrogen fixation.

**Recommended Books**


1. Devlin RM. (1975).*Plant Physiology*.3rd edition, Willard Grant Press.
2. Gottschalk G. (1986). *Bacterial Metabolism*.2nd edition. Springer Verlag
3. Madigan MT, Martinko JM and Parker J. (2003). *Brock Biology of Microorganisms*.10th edition.Pearson/ Benjamin Cummings.
4. Moat AG and Foster JW. (2002). *Microbial Physiology*.4th edition.John Wiley &Sons.
5. Reddy SR and Reddy SM. (2005). *Microbial Physiology*.Scientific PublishersIndia.
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987).*GeneralMicrobiology*.5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ.(2008). *Prescott, Harley andKlein's Microbiology*.7th edition.McGraw Hill Higher Education.


**Lab Course GBMB 201, 202,203**

1. To perform study of transformation of the desired bacterial strain
2. To study the somatic and gamete chromosome number of common plans and animals.
3. To study mitosis and meiosis in plant cell.
4. To study Mendelian inheritance.
5. To isolate plant DNA by CTAB method.
6. Islotation of genomic DNA.
7. Plasmid isolation
8. To perform whole blood DNA extraction.
9. To perform agrose gel electrophoresis.
10. Quantification of DNA by spectrophotometer.
11. Quantification of RNA by spectrophotometer.

**GBMB-204 BOTANY II**
**(Fungi, Bryophytes, Pteridophytes)**

Course Objective:

"1. What are the gymnosperms and General characters of pteridophytes, affinities with bryophytes & gymnosperms? 2. What is Life histories of Selaginella- (Heterospory and seed habit), Equisetum gymnosperms, classification, economic importance. 3. Geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms. 4. Life histories of Cycas &Pinus"

**Course Content:**

**UNIT I**

1. General features of fungi, mycelia modifications, structure of a typical fungal cell and staining methods.2. Salient features and life cycle of *Aspergillus* (*Eurotium*), *Mucor*and*Alternaria*.3. Plant Quarantine system in India, Koch's Postulates.

**UNIT II**

1. Host-pathogen interaction, Disease cycle and general symptoms. 2. Chemical and biological control methods of the plant diseases. 3. The cycle of pathogens causing following significant diseases and its control measures: White rust of Crucifers, Late blight of potato, Black rust of wheat, Red rot of sugarcane

**UNIT III**

1. General Characters of Bryophytes.Comparative account of the morphology and mode of reproduction in *Riccia* and *Marchantia*, alternation of generation in bryophytes.2. A brief account of *Anthoceros* and *Funaria*.3. Economic importance of Bryophytes.

**UNIT IV**

1. General characters of Pteridophytes. 2. A comparative account of morphology and mode of reproduction in *Rhynia*and*Adiantum*.

**UNIT V**

1. A brief account of Stelar system and its evolution. 2. Heterospory and seed habit in Pteridophytes.
3. Apogamy and apospory in ferns.

**List of Practical**

1. Study of fungal cultures and staining methods.
2. Study and identification of fungal disease symptoms.
3. Study and demonstration of permanent fungal slides.
4. Analysis of bio-control methods of fungal plant pathogens.
5. Preparation of suitable sections & staining methods to study pathogenesis in White rust of Crucifers.
6. Preparation of suitable sections & staining methods to study pathogenesis in Late blight of potato.
7. Preparation of suitable sections & staining methods to study pathogenesis in Black rust of wheat.
8. Preparation of suitable sections & staining methods to study pathogenesis in Red rot of sugarcane.
9. Collection, identification and characterization of specimen Bryophytes.
10. Collection, identification and characterization of specimen Pteridophytes.

**Books recommended:**

1. Parihar, NS,The Biology and Morphology of Bryophytes. Central Book Depot, Allahabad.
2. Puri P. Bryophytes. Atma Ram and Sons, New Delhi.
3. Vashista BR. A Text Book of Fungi,S.Chand& Co. New Delhi.
4. Parihar NS. Pteridophytes, Central Book Depot, Allahabad.
5. Pandey SN. A Text book of Pteridophytes
6. Smith. Cryptogamic Botany Vol. II
7. Eams. Morphology of Vascular Plants- Pteridophytes.

**GBMB-205 ZOOLOGY II**
**(Invertebrate Zoology)**
**Course Objectives:**

"1. On the completion of this course, the students will be able to describe the characters and origin of Protochordates and Chordates. 2. This course will help to gain knowledge about the unique characters of Pisces and parental care of amphibians. 3. This course is designed to aware the students about reptilian origin, geological eras, flight adaptation in Aves, and evolutionary origin of mammals".

**Course Contents:**

**UNIT I**

**Introduction to Invertebrate:** General Principles of Taxonomy and Animal classification. Salient features and classification up to classes in non-chordates.

**UNIT II**

**Phylum-Protozoa, Porifera and Coelentrata:** General characters of Protozoa: Type study of *Plasmodium vivax.* Protozoa and Human diseases.Origin of Metazoa, metamerism and symmetry.Type study of *Sycon,* with reference to reproduction and development.Polymorphism, Corals and Coral reef.

**UNIT III**

**Phylum-Platyhelminthes and Nemathelmithes, Annelida:** General characters, typestudy of *Taeniasolium.*Parasitic adaptations. Type study of *Ascarislumbriocodies.*Types and significance of Coelom, Study of Nephridial system in annelids.

**UNIT IV**

**Phylum Arthropoda, Mollusca, Echinodermata and Minor Phyla:** General characters of Arthropoda, Mollusca& Echinodermata. Social insects and their life cycle, Torsion and detorsion in gastropods, General Characteristics, life history and development of *Asterias* (star fish). General introduction of minor phyla with examples.

**Practical**

1. Study of different types of microscopes.
2. Phylum Protozoa: Study of *Amoeba*, *Paramecium*, *Euglena*, *Plasmodium* (signet ring).
3. Phylum Porifera: Study of *Sycon*, *Leucosolenia*, *Hyalonema*, *Euspongia*, *Poterion*.
4. Phylum Cnidaria: Study of *Metridium*, *Physalia*, *Aurelia*, *Pennatulam*, slides of *Hydra*, *Obelia* colony and medusa.
5. Phylum Platyhelminthes: Study of *Fasciola* Larva stages, miracidium, cercaria, redia and metacercaria.
6. Nematoda: Animal Parasitic nematode - *Ascaris*, Plant Parasitic nematode, Free-living nematode.
7. Phylum Annelida: Dissection of Earthworm (*Pheretimaposthuma*) nerve and ovary. Study of *Nereis*, Leech.
8. Phylum Arthropoda: Dissection of Cockroach (*Periplanetaposthuma*)mouth parts and digestive system.
9. Study of Prawn, Hermit, Julus, Honeybee, Limulus, Scorpion, peripatus.
10. Phylum Mollusca: Study of Chiton, Pila, Dentailum, Unio, Octopus, Sepia.
11. Phylum Echinodermata: Study of *Antendon*, *Echinus*, *Asterias*, *Ophiderma*.
12. Preparation of temporary mount of polytene chromosomes from *Chironomous* larva, *Drosophila* larva.

**Recommended Books**


1. Barnes, R. S . K., 2001. The invertebrates: a synthesis. Blackwell Science.
2. Brusca, R. C. ,Brusca, G. J., 2003. Invertebrates. Sinauer Associates; Palgrave.
3. Dawkins, R., Wong, Y., 2005. The ancestor's tale: a pilgrimage to the dawn of life. Phoenix, London.
4. Gullan, P. J., The insects: an outline of entomology. Wiley-Blackwell, Oxford.
5. Hickman, C. P., 2008. Animal diversity. McGraw-Hill.
6. McGavin, G. ,Lewington, R., 2001. Essential entomology: an order-by-order introduction. Oxford University Press.
7. Moore, J., Overhill, R., 2006. An introduction to the invertebrates. Cambridge University Press.
8. Naylor, P., 2005. Great British marine animals. Sound Diving Publications.
9. Pough, F. H., Janis, C. M., Heiser, C. B., 2005. Vertebrate life. Prentice Hall.
10. Ruppert, E. E., Fox, R. S., Barnes, R. D., 2003. Invertebrate zoology. Brooks/Cole.
11. Tudge, C., 2002. The variety of life: a survey and a celebration of all the creatures that have ever lived. Oxford University Press.
12. R.L. Kotpal-Modern Textbook of Zoology-Invertebrates.


**GBMB-206 CHEMISTRY II**

**Course Objective:**

"(i) After the completion of this course, the student will understand the modern view of atomic structure, and learn to fill configuration of elements (ii) The students will learn the physical chemistry concepts in gaseous states and its applications. (iii) The student will be able to understand the homogenous non-crystalline substance, generate application of colloids and nano-materials and their real-world applications."

**Course Contents**

1. ***Chemical Bonding*** **:** (i) ***Ionic Bond*** – Types of ionic solids, radius ratio effect and coordination number, limitations of radius ratio, lattice defects, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability, Fajan's rules.

(ii) ***Covalent Bond*** **:** Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions such as NH3, H3O+, SF4, ClF3 $ICl2^{-}$, and H2O by valence shell electron pair repulsion (VSEPR) theory, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals. Applications of MO theory to explain the stability of homo and hetero dinuclear diatomic molecules, multi-centre bonding in electron-deficient molecules.

(iii) ***Bond Energy*** **:**Dissociation and average bond energies – determination, periodic trends and applications. Metallic Bond : Free electron, valence bond and band theories. Weak Interactions: Hydrogen Bond – experimental evidence, van der Waal's forces.

2. ***s-Block Elements*** **:** Hydride (classification, general methods of preparation and salient features), hydration energies, solvation and complexation tendencies of alkali and alkaline-earth metals, principle of metallurgical extraction, Chemistry of Li and Be, their anomalous behaviour and diagonal relationships, alkyls and aryls; role in biology.

3. ***p-Block Elements*** **:**Comparative study (group-wise) of group 13 & 14 elements with respect to periodic properties. Compounds such as hydrides, halides, oxides and oxyacids; diagonal relationship; preparation, properties, bonding and structure of diborane, borazine and alkalimetalborohydrides. Preparation, properties and technical applications of carbides and fluorocarbons.Silicones and structural principles of silicates.

4. ***Chemical Kinetics*** **:** Order and molecularity of a chemical reaction, basic kinetic laws of first and second order reactions, analysis of kinetic data for the determination of the rate constant and order, effect of temperature on reaction rates (Arrheninus equation), collision theory of rates of bimolecular reactions.

5. ***Thermodynamics*** **:** Introduction of different terms and processes in thermodynamics : [systems (isolated, closed, open) and surrounding, macroscopic properties (extensive and intensive), kinds of processes], First Law of thermodynamics and internal energy, state and state functions (exact differential), sign convention for heat and work, nature of work, path dependence of work and heat. Enthalpy, heat changes at constant volume and constant pressure, heat capacities ( Cv , Cp ) and relation between them for ideal gases. Reversible and irreversible processes, maximum work, thermodynamic quantities (w, q, DU, DH) for isothermal and adiabatic reversible expansion of ideal gases.Ideal gas law for adiabatic reversible expansion, comparison of adiabatic and isothermal reversible expasion. Change in internal energy (DU) and enthalpy (DH) of chemical reactions, relation between DU and DH, variation of heat of reaction with temperature (Kirchhoff's equation).

**6. Solid State Chemistry:** Crystal lattice and unit cell, crystal system, lattice plane, x-rays, diffraction of x-rays by crystals, miller indices, Bragg equation, packing, type of crystals, Defects in crystals.

**Recommended Books:**


1. *"A New Concise Inorganic Chemistry",* **J. D. Lee**, 5th Edition (1996), Chapman & Hall, London.
2. *"Modern Inorganic Chemistry",* **R. C. Aggarwal**, 1st Edition (1987), KitabMahal, Allahabad.
3. *"Basic Inorganic Chemistry",* **F. A. Cotton, G. Wilkinson, and Paul L. Gaus,** 3rd Edition (1995), John Wiley & Sons, New York.
4. *"Organic Chemistry",* **R. T. Morrison and R. N. Boyd**, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
5. *"Organic Chemistry",* **S. M. Mukherjee, S. P. Singh, and R. P. Kapoor**, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
6. *"Organic Chemistry – Structure and Reactivity",* **Seyhan N. Ege**, 3rd Edition (1998), AITBS Publishers and Distributtors, Delhi.
7. *"Organic Chemistry",* **Paula Y. Bruice**, 2nd Edition , Prentice-Hall InternattionalInc, New Jersey, International Edition (1998).
**8**. *"Physical Chemistry",* **P. C. Rakshit,** 5th Edition (1988), 4th Reprint (1997), Sarat Book House, Calcutta.
**9.** *"Principles of Physical Chemistry",* **B. R. Puri, L. R. Sharma, and M. S. Pathania,** 37th Edition (1998), ShobanLalNagin Chand & Co., Jalandhar.
**10.***"Physical Chemistry",* **K. J. Laidler and J. M. Meiser**, 3rd Edition, Houghton Mifflin Comp., New York, International Edition(1999).
**11.** "Principle of Nanoscience and Nanotechnology", (2010), **M. A. Shah and Tokeer Ahmad,** Narosa Publishing House, New Delhi.