

**ST. JOSEPH'S COLLEGE (AUTONOMOUS)
IRINJALAKUDA**

M.Sc. DEGREE PROGRAMME

CHOICE BASED CREDIT SEMESTER SYSTEM

ZOOLOGY SYLLABUS

(CBCSS PG 2019)

Under Choice Based Credit Semester System

Effective for 2019 admission

PSO

The students pursuing this course will be having a deep understanding in various aspects of the subject. The working principles, design guidelines and experimental skills associated with different fields of Zoology such as Biochemistry, Biophysics, Biostatistics, Cell and molecular Biology, Developmental Biology, Immunology, Biotechnology, Microbiology, Systematic, Evolution, Physiology, Human Genetics (Clinical, diagnostic & cancer genetics) etc.

**CURRICULUM AND SYLLABUS FOR CHOICE BASED CREDIT SEMESTER SYSTEM (CBCSS -2019) M. Sc. ZOOLOGY COURSE
w.e.f. 2019 ADMISSION**

FIRST SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
SJZOL1C01- Biochemistry and Cytogenetics	4	30	5
SJZOL1C02- Biophysics and Biostatistics	4	30	5
SJZOL1C03- Ecology and Ethology	4	30	5

SECOND SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
SJZOL2C04- Physiology	4	30	5
SJZOL2C05- Molecular Biology	4	30	5
SJZOL2C06- Systematics and Evolution	4	30	5

FIRST & SECOND SEMESTER- PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
SJZOL2L01- Biochemistry, Biophysics and Biostatistics	4	24	5
SJZOL2L02- Physiology, Molecular Biology and Cytogenetics	4	24	5
SJZOL2L03- Ecology, Ethology, Systematics and Evolution	4	24	5

SJ-St. Josephs, ZOL-Zoology, 1-I semester, C- Course Theory, L- Course Practical, 2- II semester

THIRD SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
SJZOL3C07-Immunology	4	30	5
SJZOL3C08- Developmental Biology and Endocrinology	4	30	5
SJZOL3E09- Human Genetics 1: Clinical Genetics	4	30	5

SJ-St. Josephs, ZOL- Zoology C- Course Theory E- Elective Theory 3- III semester

FOURTH SEMESTER – THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
SJZOL4C10- Biotechnology and Microbiology	4	30	5
SJZOL4E11-- Human Genetics II: Diagnostic Genetics	4	30	5

SJZOL4E12-Human Genetics III: Cancer Genetics & Genetic Services	4	30	5
--	---	----	---

THIRD AND FOURTH SEMESTER PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
SJZOL4L04-Immunology, Developmental Biology, Endocrinology, Biotechnology, Microbiology & Microtechnique	4	24	5
SJZOL4L05-Human Genetics I & II	4	24	5
SJZOL4L06- Human Genetics III	4	24	5
SJZOL4P07- Project Work	4	24	5
SJZOL4V08- Viva Voce (Project-2 + General-2)	4	24	5

SJ-St. Josephs, ZOL- Zoology C- Course Theory E- Elective Theory, L – Practical, V – Viva voce, P – Project, 4- IV semester

Total number of theory courses	- 12	Total number of practical courses	- 6
Credit for each theory course	- 4	Credit for each practical course	- 4
Total credits for theory course	- 48	Total credits for practical courses	- 24
Credit for Project work	- 4	Total credit for the course	- 80
Credit for Viva- voce	- 4		

- Practical examination shall be conducted at the end of second and fourth semesters.
- The teacher who gives guidance to project work can select any topic from the syllabi including the elective course and the topic shall be assigned to each student. The research work on this topic shall be carried out by each student under the supervision of the teacher. The report of the research work shall be submitted by each student in the form of a Dissertation which shall be attested by the Head of the Department and shall be submitted for the evaluation. A declaration by the student to the effect that the dissertation submitted by him/ her has not previously been formed the basis for the award of any degree or diploma and a certificate by the supervising teacher to the effect that the dissertation is an authentic record of work carried out by the student under his/her supervision are to be furnished in the dissertation.
- Weightage for each core and elective theory course shall be 30 for the external examination and 5 for the internal theory examination.
- Weightage for each core and elective practical course shall be 24 for the external examination and 5 for the internal core and elective practical examination.
- Theory examination question paper shall contain 7 short answer questions (answer any 4) with weightage 2 each, 7 short essay questions (answer any 4) with weightage 3 each and 4 essay questions (answer any 2) with weightage 5 each.
- Weightage for the external practical examination can be distributed as follows:

With submission Weightage

Major question (1 number)	8
Minor question (2 numbers)	2x5=10
Spotters (2 numbers)	2x1=2
Submission (slides)	2
Record	2
Total	24

Without submission Weightage

Major question (1 number)	8
Minor question (2numbers)	2x5=10
Spotters (4 numbers)	4x1= 4
Record	2
Total	24

- No submission is required for the practical in elective course, unless mentioned in syllabus.
- A candidate has to submit the following at the time of practical examination -SJZOL4L04

Whole mount : 4 numbers

Slides: Histology : 4 numbers
 Slides: Histochemistry : 2 numbers (To test the presence of carbohydrate and protein. (Control not required))

9. **If a candidate fails to submit the field study / tour report, no marks for the record be awarded.**
10. Project report shall be presented using power point option. Credit given for project is limited to maximum 4 and project and general viva-voce is limited to 4.
11. A minimum of two test papers for each course have to be conducted and the average shall be counted for internal evaluation in each semester.
12. One seminar for each course is compulsory.

<u>Criteria for the evaluation of dissertations</u>	<u>Weightage</u>
1. Introduction, review of literature etc.	2
2. Objectives and relevance of the study	3
3. Methodology	4
4. Results	3
5. Discussion and interpretation	4
6. Conclusions	3
7. Involvement of the students	1
8. Style and neatness of the dissertation	1
9. References	3
Total	24

Criteria for the Viva-voce

A. Presentation of project work- (POWER POINT Presentation)	Weightage
1. Quality and correctness of slides	2
2. Clarity of presentation	3
3. Communication skill	3
4. Answers to questions	4
Subtotal	12

B. General Viva-voce	Weightage
5. Knowledge of the student	4
6. Communication skill	3
7. Answers to questions	5
Subtotal	12

Grand Total 24

AUDIT COURSES

Each student will undergo an audit course viz. Ability enhancement course (AEC) and Professional Competency Course (PCC) in the I and II semesters respectively. The student should undergo any one course listed under each category (AEC and PCC) in the respective semesters. Each student will be under the supervision of a faculty who will be responsible for monitoring the course and evaluation. The allotment of the faculty will be decided by the Department Council. The examination and evaluation for Professional competency course should focus on evaluating the skill component involved.

1. Ability enhancement course (AEC) – (In the I semester)

- a) Documentation and scientific writing
- b) Paper review on a topic of choice.
- c) Internship for a minimum of 40 hours.
- d) Industrial or Practical training for a minimum of 40 hours.
- e) Community linkage programme for a minimum of 40 hours.
- f) Seminar presentation on a frontier area of biological research. The topic should be from outside the syllabus.

2. Professional Competency Course (PCC) (In the II semester)

- a) Statistical (SPSS/R/any software relevant to the programme of study) softwares
- b) Museum curation skills (Taxidermy etc.)

MODEL QUESTION PAPER

I/II/III/IV SEMESTER M.Sc. DEGREE EXAMINATION (CUCSS), Month & Year

Branch: Zoology

Course Code: Course Name

Time : 3hrs

Maximum Weightage:30

I. Answer any 4 of the following (Short Answer type questions)

(Weightage-2)

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

4 x 2 = 8

II. Answer any 4 of the following (Short essay type questions)

(Weightage-3)

- 8.
- 9.
- 10.
- 11.
- 12.
- 13.
- 14.

4 x 3 = 12

III. Answer any 2 of the following (Long essay)

(Weightage-5)

- 15.
- 16.
- 17.
- 18.

2 x 5 = 10

COURSE OUTCOMES

SJZOL1C01- BIOCHEMISTRY AND CYTOGENETICS

- Student will be able to explore the chemical process and synthesis of biologically active molecules within and related to living organisms so that they can understand the techniques and also solve biological problems.
- Students can learn the genetic phenomenon through cytological analysis of chromosomes and various interactions between cells.

FIRST SEMESTER THEORY

SJZOL1C01 - BIOCHEMISTRY AND CYTOGENETICS (90 hrs)

Part A. Biochemistry (54 hrs)

Unit - I - Chemistry and functions of Biomolecules

1. Introduction (2 hrs)

1.1 Macromolecules and their subunits

1.1.1. Chemical bonds of biomolecules (Covalent and Non-covalent bonds)

2. Carbohydrates (8hrs)

2.1. Classification of carbohydrates with examples-

2.1.1 Structure of monosaccharides- glucose, fructose, galactose, mannose and ribose .

2.1.2. Methods of representation of sugars (Ball and stick, projection formula and perspective formula)

2.1.3. Isomerism - Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism)- mention epimer, anomer and enantiomer with examples, Mutarotation

2.1.4. Biological roles of monosaccharides.

2.2. Structure and biological roles of maltose, sucrose, lactose, trehalose and cellobiose.

2.3.1. Homopolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

2.3.2. Heteropolysaccharide - Structure and biological roles of hyaluronic acid, chondroitin, chondroitin sulphate, keratan sulphate, heparin and agar-agar.

3. Proteins (6 hrs)

3.1. Amino acids

3.1.1. Classification: (a) on the basis of number of amino and carboxyl group (b) on the basis of the chemical composition of side chain (c) based on the polarity of side chain (R)

3.1.2. Amphoteric properties of amino acids

3.1.3. pK value and Isoelectric point (pI) of amino acids

3.1.4. Peptide bond and peptides (di, tri, tetra, oligo and polypeptide).

3.2. Structure of protein

3.2.1. Primary structure, Secondary structure (Alpha helix, Beta-parallel & antiparallel and Beta-pleated sheet), random coil conformation, Tertiary structure, Quaternary structure.

3.2.2. Brief note on protein domains, motifs, folds and Ramachandran plot.

3.2.3. Biological roles of proteins

4. Lipids (5 hrs)

4.1. Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids.

4.2. Biological roles of lipids - as food reserves (storage lipids), structural lipids in membrane, as signals, as co-factors, as pigments, as insulators, as vitamin carriers etc

4.3. Prostaglandins - Chemical nature and functions.

4.4. Fatty acids - definition; essential fatty acids

4.5. Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids

4.6. Nomenclature of fatty acids - Geneva system

5. Nucleic acids (3 hrs)

- 5.1. Structural organization of DNA (Watson -Crick model)
- 5.2. Structural organization of t-RNA; brief note on micro-RNA
- 5.3. Biological roles of nucleotides and nucleic acids

Unit - II - Enzymes (7 hrs)

1. Classification- (I.U.B. system)
2. Mechanism of enzyme action: Formation of enzyme substrate complex- Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Factors influencing enzyme action
3. Enzyme kinetics - Michaelis-Menten equation - derivation; significance of K_m and V_{max} Values. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.
4. Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition
5. Classification, Structure and functions of Vitamins. Vitamins as co-enzymes.

Unit - III - Bioenergetics (2 hrs)

1. Laws of thermodynamics and biological system- Enthalpy, Entropy, Free energy concept .
2. Energy of activation, Standard free energy change.
3. Role of ATP as a free energy carrier in the biological system.

Unit - IV - Metabolism and biosynthesis of biomolecules

1. Carbohydrate metabolism (8 hrs)

- 1.1. Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate of pyruvic acid
- 1.2. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex
- 1.3. Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain
- 1.4. Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown .
- 1.5. Pentose phosphate pathway (HMP pathway) and its significance
- 1.6. Uronic acid pathway

2. Amino acid metabolism (4 hrs)

- 2.1. Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine, histidine, valine.
- 2.2. Fate of amino acids in the body
- 2.3. Transamination, Decarboxylation and deamination reactions in the biological system.

3. Lipid metabolism (5 hrs)

- 3.1. Oxidation of fatty acids
- 3.2. Biosynthesis of fatty acids
- 3.3. Biosynthesis of cholesterol

4. Nucleic acid metabolism (4 hrs)

4.1. Biosynthesis and degradation of purines and pyrimidines

Part B. Cytogenetics (36 hrs)

1. Introduction to Cytogenetics (1 hr)

2. Membrane structure and function . (4 hrs)

- 2.1. Molecular organization of cell membrane - Lipid bilayer and membrane protein. Molecular models of cell membrane.
- 2.2. Cell permeability-osmosis, diffusion, ion channels, active transport, membrane pumps.
- 2.3. Mechanism of sorting and regulation of intracellular transport.
- 2.4. Electrical properties of membranes.
- 2.5. Microvilli and cell coat.

3. Structural organization and function of intracellular organelles- (6 hrs)

Nucleus, Mitochondria, Golgi complex, Lysosomes, Endoplasmic reticulum, Ribosomes, Peroxisomes and Cytoskeleton.

4. Organization of chromosomes and genes. (6hrs)

- 4.1. Structure of chromatin and chromosomes, heterochromatin, euchromatin –unique and repetitive DNA
- 4.2. Chromosomal changes- euploidy, aneuploidy, chromosomal aberrations- Structural alterations- gene mutations- molecular changes- deletion, duplication, translocation, inversion and sister chromatid exchange.
- 4.3. Interrupted genes and gene families.
- 4.4. Concept of gene- Allele, multiple alleles, pseudoallele, complementation tests.
- 4.5. Extrachromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance.

5. Cellular communication (6 hrs)

- 5.1. General principles of cell communication
- 5.2. Cell-cell interactions – cell adhesion and roles of different adhesion molecules
- 5.3. Intercellular attachments- gap junctions, desmosomes, intermediary and tight junctions.
- 5.4. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.
- 5.5. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

6. Cell signaling (8 hrs)

- 6.1. Signal transduction
- 6.2. Concept of cell-signaling
- 6.3. Signaling through cell surface receptors: G protein linked receptors; signaling via cAMP, PKA, IP3, Ca²⁺/calmodulin, PKC, Ca-MK, Enzyme linked receptors, Receptor tyrosine kinase (RTK), signaling of growth factors, Tyrosine kinase associated receptors, JAK- STAT signaling pathway, Receptor protein tyrosine phosphatase (PTP), Receptor serine/threonine kinase, Receptor guanyl cyclase, cGMP, PKG, Histidine kinase associated receptors
- 6.4. Receptor desensitization
- 6.5. Signaling by nitric oxide, carbon monoxide

6.6. Signaling network

7. Apoptosis and its significance (5 hrs)

7.1 Necrosis; Programmed and induced cell death

7.2 Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis

7.3 Regulation of apoptosis - Extracellular and Intracellular

7.4 Apoptosis in *Caenorhabditis elegans*, *Drosophila*, mammals and bacterial population

7.5 Mechanism of cell death

7.6 Genes involved in apoptosis.

References

Biochemistry

1. David L Nelson & Michael M Cox Lehninger, Principles of Biochemistry, VIth edition, (2013) Mac Millan
2. Robert Harper's Biochemistry, (2012) 29th Edition, K. Murray, Daryl K. Granner, Peter, A. Mayes and Victor, W. Rodwell Appleton and Lange, Prentice Hall of India Private limited, New Delhi,
3. Lubert Stryer,(2011) Biochemistry, VII th edition, W.H. Freeman & Co.
4. Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi, (2007) Outlines of Biochemistry, Vth edition, John Wiley & Sons, Inc.
5. Deb, A.C.(2004) Fundamentals of biochemistry, New Central Book Agency (P) Ltd.
6. Keith Wilson and John Walker (2008) Principles and techniques of Biochemistry and Molecular biology - 6th edn, Cambridge University Press
7. Voet, D. and Voet, J.G. & Pratt (2012). Principles of Biochemistry, John Wiley & sons .
8. Zubay, G (1997). Biochemistry, Mc Graw – Hill Publications
9. Devlin,T.M. (2010). A Text of Biochemistry with clinical correlations, John Wiley& sons.
10. Lenhninger, A. L. (2008). Principles of Biochemistry. (5th edn). CBS Publishers and Distributors, New Delhi.
11. Mathews, H. R., Freeland, R. and Miesfeld, R. L. (1997). Biochemistry: A Short Course – Wiley-Liss, Inc. NY.
12. Mary, K. Campbell (1995) Biochemistry. II Ed. Harcourt Brace and Co. Florida.
13. Murray, Robert, Granner, K. and Harper, Daryl K. (2006). Harper"s Illustrated Biochemistry. Mc Graw-Hill, New York.
14. Nelson, D. L. Cox, M. M. and Lehninger, A. L. (2007). Principles of Biochemistry, 4th Ed. Freeman and Co, NY.
15. Stryer, L. (2011). Biochemistry. 7th Ed. W. H. Freeman & Co. New York.
16. Zubay, G. L., Parson, W. W. and Vance, D. E. (1995). Principles of Biochemistry, Brown Publishers, England.

Cytogenetics

1. Becker, W. M., Reece, J. B. and Poenie, M. F. (1999; 2000). The World of the Cell, 4th edition, Benjamin/Cummings Publishing Co.
2. Benjamin Lewin (2008). Genes IX. Jones & Bartlett Learning Publishers, New York.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter(2002). Molecular Biology of the Cell. 4th Edition, Garland Science, New York.
4. De Robertis, E. D. P. and De Robertis, Jr. E. M. F. (1996). Cell and Molecular Biology, Eighth Edition, B.I. Waverly Pvt Ltd, New Delhi.
5. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York.
6. Kleinsmith, L. J. and Kish, V. M. (1995). Principles of Cell and Molecular Biology (Second Edition). Harper Collins College Publishers, New York.
7. Peter Snustad, D. and Michael J. Simmons (2000). Principles of Genetics. 2nd Ed. John Wiley & Sons Inc.
8. Purves W. K., Orians G. H. and Heller H. C. (1995). Life: The Science of Biology, 4th Edition.

Sinauer Associates, Sunderland.

9. Robert H. Tamarin (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi.
10. Sheeler, Philip and Donald, E. Bianchi. (1987) Cell and Molecular Biology. III Ed. John Wiley.
11. Watson J. D., Hopkins N. H., Roberts, J. W., Steits, J. A. and Weiner, A. M. (1987). Molecular Biology of the Gene 4th Edition. The Benjamin Cumming. Publishing Company. Menlo Park, California.

COURSE OUTCOMES

SJZOL1C02- BIOPHYSICS AND BIOSTATISTICS

- The student studies biological system and biological processes using physics based methods. The student will also be familiar with invented instruments for detecting, purifying, imaging and manipulating biochemicals and materials.
- The student will be able to prove every hypothesis by statistical measurements thus having wide range of interest in research field.

FIRST SEMESTER THEORY

SJZOL1C02 - BIOPHYSICS AND BIOSTATISTICS (90 Hours)

Part A. Biophysics (54 hrs)

1. Colloidal System (3 hrs)

- 1.1. Crystalloids and Colloids,
- 1.2. Properties of colloids- Kinetic, optical and electrical properties- Electrosmosis, Cataphoresis, Coagulation.
- 1.3. Forms of colloids, Suspensions and Emulsions, preparation and properties of emulsions.
- 1.4. Biological importance of colloids.

2. Diffusion and Osmosis (4 hrs)

- 2.1. Fick's laws and diffusion coefficient.
- 2.2. Gibb's Donnan equilibrium.
- 2.3. Application of diffusion processes in biology: haemolysis.
- 2.4. Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.
- 2.5. Vant Hoff's laws
- 2.6. Electrolytic and ionic balance in biological fluid.

3. PH (2 hrs)

- 3.1 Dissociation of water.
- 3.2. Dissociation of a weak acid.
- 3.3. Henderson Hasselbalch equation.
- 3.4. Electrometric determination of pH, pH meter
- 3.5. PH value calculation.
- 3.6. Buffer –Importance of buffers in biology.

4. Bioacoustics (5 hrs)

- 4.1. Characteristics of sound.
- 4.2. Physical basis of hearing.
- 4.3. Physical organization of ear.
- 4.4. Physical aspects of sound transmission in the ear.
- 4.5. Audible sound frequency.
- 4.6. Pitch perception and theories.
- 4.7. Infrasonic and ultrasonic sounds.
- 4.8. Echolocation; receiving and analyzing echoes

5. Radiation Biology (9 hrs)

- 5.1. Radioactivity, different types ionizing radiations and their sources
- 5.2. Radioactive disintegration. Decay curve, half-life.
- 5.3. Biological effects of ionizing radiations – effects at macromolecular, cellular and organ system level, effects of whole body irradiation-Radiation therapy.
- 5.4. Biological applications of radioisotopes.
- 5.5. Radiation dosimetry- dose units and dose measurement.
- 5.6. Radiation Detectors - GM Counter, Solid and Liquid Scintillation Counter, Proportional counter, Semiconductor detectors.
- 5.7. Autoradiography

6. Biophysical methods (Brief account of the following) (5 hrs).

- 6.1. Properties of electromagnetic radiations.
- 6.2. Molecular analysis using UV / visible spectroscopy.
- 6.3. Mass spectroscopy.

- 6.4. NMR and Electron Spin Resonance (ESR) spectroscopy -Applications
- 6.5. Structure determination using X-ray diffraction crystallography.
- 6.6. Circular dichroism.
- 6.7. Surface Plasma Resonance (SPR)
- 7. Electrophysiological methods (Brief) (3 hrs)**
- 7.1. Single neuron recording.
- 7.2. Patch clamp recording.
- 7.3. ECG.
- 7.4. Brain activity recording.
- 7.5. Lesion and stimulation of brain.
- 7.6. Pharmacological testing.
- 7.7. PET (Positron Emission Tomography), MRI, fMRI, CAT.
- 8. Principles and applications of (8 hrs)**
- 8.1. Fluorescent, Interference, Scanning and Transmission electron microscopes (SEM &TEM) .
- 8.2. Resolving powers of different microscopes.
- 8.3. Different fixation and staining techniques for EM (freeze-etch and freeze fracture methods for EM-image processing methods in microscopy).
- 8.4. Laser and its applications in Biology
- 9. Separation Techniques (10 hrs)**
- 9.1. Chromatography - Different types - Adsorption, Partition and Ion exchange chromatography
 - 9.1.1 Column chromatography
 - 9.1.2 Paper chromatography
 - 9.1.3 Thin- layer chromatography
 - 9.1.4 Gel-filtration.
 - 9.1.5. Gas chromatography,
 - 9.1.6 Affinity chromatography,
 - 9.1.7 HPLC
- 9.2. Electrophoresis
 - 9.2.1 Paper electrophoresis
 - 9.2.2 Disc electrophoresis
 - 9.2.3 PAGE, Two dimensional PAGE, Highvoltage Electrophoresis
- 9.3. Isoelectric focusing.
- 10. Influence of gravity (3 hrs)**
- 10.1. Human body posture in the gravitational field
- 10.2. Influence of G force.
- 10.3. sForce of centrifugal acceleration - importance of aviation and space travel
- 10.4. Effect of positive G. Force & negative G. Forces.
- 10.5. Protection against G. Force
- 10.6. Influence of linear acceleration on the body
- 11. Nanotechnology (2 hrs)**
- 11.1. Definition
- 11.2. Nanotechnology and its applications in the field of health care.
- 11.3. Role of nanotechnology in environmental management.

Part B –Biostatistics (36 hrs)

1. Introduction (2 hrs)

- 1.1 Biostatistics: Definition,
- 1.2 Characteristics of Statistics
- 1.3 Importance and usefulness of statistics
- 1.4 Limitations of Statistics

2. Data (5 hrs)

- 2.1. Types of data: classification based on Source of data, Compilation, Variable, Nature .
- 2.2. Methods of data collection and classification.
- 2.3. Types of sampling methods.
- 2.4. Advantages and disadvantages of census and sampling method.
- 2.5. Class intervals- exclusive and inclusive method
- 2.6. Frequency curve (types. skewness, kurtosis, ogive)

3. Statistical Methods: Measures of central tendency and dispersal (4 hrs)

- 3.1. Mean, (raw data, discrete series and continuous series)
- 3.2. Standard deviation, Standard error, degree of freedom (raw data, discrete series and continuous series)
- 3.3. Quartile deviation- Box- whisker plot

4. Probability distributions (4 hrs)

- 4.1. Basic concepts and definition:
- 4.2. Laws of probability
- 4.3. Probability distribution: - Binomial, Poisson and Normal

5. Statistical inference (problems to be discussed) (7 hrs)

- 5.1 Difference between parametric and non-parametric statistics;
- 5.2. Testing of hypothesis
- 5.3. Errors
- 5.4. Confidence interval; levels of significance, Critical region;
- 5.5. Normality test
- 5.6. t-test, chi-square test, F-test, ANOVA
- 5.7. Kruskal-Wallis, Mann-Whitney

6. Correlation and Regression (problems to be discussed) (7 hrs)

- 6.1. Types of correlation.
- 6.2. Methods to measure correlation- Scatter diagram.
- 6.3. Karlpearson's coefficient of correlation, Spearman's correlation
- 6.4. Types of regression analysis
- 6.5. Regression equations
- 6.6. Difference between regression and correlation analysis

7. Ecological data analysis (problems to be discussed) (7 hrs)

7.1. Alpha diversity

Shannon diversity index, Simpsons Dominance index, Pielou's evenness index, Margalef species Richness, Fisher's apha,

7.2. Beta diversity

Morisita Horn index, Sorenson index, Bray-Curtis similarity

References

Biophysics

1. Ackerman, E. (1962). Biophysical Science. Prentice Hall Inc.
2. Alonso, A and Arrondo, J.L.R (2006) - Advanced techniques in Biophysics, Springer
3. Alok Srivastava and Ipsita Roy-(2009)-Bio-Nano- Geo Sciences- The future challenge-Ane Books Ltd.
4. Baker, E.J and Silverton, R.E. (1978) - Introduction to medical laboratory technology, ELBS
5. Bengt Nolting (2006), Methods in modern Biophysics 2nd edn. Springer.
6. Daniel, M (2002), Basic Biophysics for Biologists. Agro Botanics, Bikaner
7. Das, D. (1991) Biophysics and Biophysical Chemistry, Academic Publishers, Calcutta.
8. Ernster, L (1985), Bioenergetics, Elsevier, New York.
9. Frank H. Stephenson (2006)- Calculations for Molecular Biology and Biotechnology-A guide to Mathematics in the laboratory-Academic Press- An imprint of Elsevier.
10. Ghatak.L. (2011). Techniques and methods in Biology. PHI, Learning Pvt. New Delhi.
11. Gupta.A. (2009). Instrumentation and Bio-analytical techniques. Pragati Prakashan, Meerut.
12. Hoppe, W, Lohmann, W, Markl, H and Ziegler, H (1983). Biophysics. Springer Verlag, New York.
13. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology - 6th edn, Cambridge University Press
14. Marshall, A.G. (1978) Biophysical Chemistry, Principles, Techniques and Applications-John Wiley and Sons, New York
15. Mohan P. Arora-(2007), Biophysics -Himalaya Publishing House.
16. Muralidharan.V.S. and Subramania, A (2010)- Nanoscience and Technology- Ane Books Ltd.
17. Narayan, P (2000) Essentials of Biophysics. New age international
18. Nagini.S (2009)- Instant Biochemistry-Ane Books Ltd.
19. Roy, R.N (1996)-A text book of Biophysics-New central book Agency Calcutta.
20. Srivastava, P.K (2006)-Elementary Biophysics, An introduction. Narosa publishing house New Delhi.
21. Subramanian.M.A. (2005). Biophysics: Principles and Techniques.
22. Viswanathan. B (2009)-Nano Materials- Narosa Publishing House.

Biostatistics

1. Agarwal, B.L. (1996) Basic statistics, New Age International(P) Ltd. Publishers, New Delhi.
2. Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stoughton, London.
3. Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
4. Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ika's Publishing House, New Delhi.
5. Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition, New Delhi.
6. Magurran AE. 2004. Measuring Biological Diversity. Blackwell Publishing
7. Stephen W, Looney(2008) Methods in Molecular Biology-Biostatistical Methods Springer International Edition
8. Zar, J.H. (2003) Biostatistical Analysis - Fourth edition. Pearson Education. New Delhi.

COURSE OUTCOMES

SJZOL1C03- ECOLOGY AND ETHOLOGY

- The student learns the information necessary to understand and resolve many of the environmental and ecological issues that confront us. It also helps to develop measures to increase the biological productivity and energy flow in natural ecosystem and maintain sustainable ecosystem.
- The Students start to observe natural processes such as communication, courtship, mating and self- defense and tries to examine instinctive and adaptive nature in early development in organisms

FIRST SEMESTER THEORY

SJZOL1C03 - ECOLOGY AND ETHOLOGY (90 Hours)

Part-A-Ecology (54 hrs)

1. Introduction (3hrs)

1.1. Habitat and niche

1.1.1. Concept of habitat and niche

1.1.2. Niche width and overlap

1.1.3. Fundamental and realized niche

1.1.4. Resource partitioning

1.1.5. Character displacement

2. Ecosystem (9 hrs)

2.1. Structure and function

2.2. Ecosystem energetics

2.3. Primary production

2.4. Energy flow models

2.5. Mineral cycling (CNP)

2.6. Trophic levels, Food chain, food web and secondary production

2.7. Decomposers and detritivores

3. Population Ecology (7 hrs)

3.1. Characteristics of a population

3.2. Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations

3.3 Sampling methods in the study of behaviour, habitat characterization

3.4. Ground and remote sensing methods

3.5. Population growth curves, Life tables, survivorship curves, population regulation, Life history strategies, r and k selection, Demes and dispersal, interdemec extinctions, age structure of populations.

3.6. Growth and regulation of human population

4. Species interaction (5 hrs)

4.1. Types of interactions, interspecific competition

4.2. Herbivory, Carnivory, Pollination, Symbiosis; mutualism, commensalisms and proto co-operation

5. Community Ecology (4 hrs)

5.1. Nature of communities.

5.2. Characteristics of a biotic community.

5.3. Species diversity and latitudinal gradients in diversity.

5.4 Edges and ecotones.

6. Ecological succession (4 hrs)

6.1. Types, mechanisms ,changes involved in succession .

6.2 Concept of climax

7. Biogeography (6 hrs)

7.1. Major terrestrial biomes: (a) Tropical rain Forest (b) Grassland (c) Desert (d) Chaparral (e) Temperate deciduous Forest (f) Temperate boreal forest (g) Tundra (h) Savanna

8. Biogeographical zones of India (4 hrs)

(a) Trans Himalayan zone; (b) Himalayan zone; (c) Desert zone; (d) Semiarid zone; (e) Western Ghats zone; (f) Deccan plateau zone; (g) Gangetic plain zone; (h) North east

zone. (i) Coastal zone; (j) Islands present near the shore line.

9. Applied Ecology (8 hrs)

9.1 Carbon credit, Carbon trading, Blue Carbon

9.2 Green building technology and its ecological importance.

9.3 Discuss the benefits and disadvantages of the idea of (brief)

a. Inter linking of major rivers of India,

b. Sethusamudram ship canal project.

c. Biodiversity with special reference to India-status monitoring and documentation, major drivers of biodiversity change.

10. Conservation Biology (4 hrs)

10.1 Principles of conservation.

10.2 Major approaches to management,

10.3 Indian case studies on conservation & management strategy (concepts of project tiger, Biosphere reserves).

Part B. Ethology (36 hrs)

1. Introduction (1 hr)

2. Concepts of Ethology (4 hrs)

2.1. Ethology as different from the other schools studying animal behavior like behaviourism.

2.2. Behaviour as a reaction to stimuli - sign stimuli, social releasers, Ethograms, super normal stimuli, stimulus filtering.

2.3. Concepts of Fixed Action Patterns (FAP), Innate Releasing Mechanism(IRM), Action Specific Energy(ASE), Concepts of Learning and Imprinting.

3. Motivating factors (3 hrs)

3.1. General factors in motivation; Studies of motivation in guppies;

3.2. Mating systems-parental investment and reproductive success

4. Conflict behaviour- stress-displacement activities- Ritualization. (2 hrs)

5. Instinctive behaviour & reflex action, neural basis of sleep and arousal. (2hrs)

6. Learning- Neural basis of learning, memory, cognition, sleep and arousal (3hrs)

Biological clocks

7. Adaptiveness of behaviour (3 hrs)

JP Scott's categories of
behaviour.

8. External stimulus - circadian rhythms (3 hrs)

8.1- Proximate and Ultimate factors.

8.2-Types of orientation-reafference theory of Von Holst & Mittel

Stadt. 8.3-Navigation & migration

9. Parental care – (6 hrs)

9.1. Mating systems, Parental investment and Reproductive Success.

9.2. Development of behavior.

9.3. Social communication; Social dominance; Use of space and territoriality; domestication and behavioural changes; Social behaviour of termites & Primates;

10. Evolution and adaptiveness of behaviour (4 hrs)

Altruism, Kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour.

11. Hormones and Behaviour- (5 hrs)

Hormones of gonads, adrenal gland , Pituitary gland,-Hormonal effects on different behavioural patterns , Maternal behaviour- mechanism of hormonal action.

References

Ecology

1. Ahluwalia and Sunitha Malhorta-Environmental Science-Ane Books Pvt.Ltd
2. Allan Beebi and Anne Maria Brennan(2006)- First Ecology-Ecological principles and environmental issues-Oxford university press .
3. Archbold, O. W. (1995). Ecology of World Vegetation. New York, NY: Chapman and Hall.
4. Begon,Harper, Townsend- Ecology- Individuals, Populations, and communities- Blackwell Science,Second edition
5. Brewer Richard (1994).The Science of Ecology-Saunders college publishing.
6. Chapman J.L and Reiss.M.J- Ecology principles and applications-Cambridge low price editions
7. Charles J .Krebs- Ecology.The experimental analysis of distribution and abundance .
8. David Quammen. 1997. The Song of the Dodo: Island Biogeography in an age of Extinctions. Scribner. ISBN 0-684-82712-3
9. Dick Neal- Introduction to population Biology- Cambridge University Press
10. Eugene P.Odum- Fundamentals of Ecology- W.B.Saunders Company.
11. Fred, Van Dyke (2003). Conservation biology-foundation concepts, applications-Mc Graw Hill, New Delhi.
12. MacArthur, R. H. and Wilson, E. O.(1967). The Theory of Island Biogeography. Princeton, N.J.: Princeton University Press.
13. Magurran, A. E.(2004). Measuring biological diversity. Oxford: Blackwell Publishing. ISBN 0- 632-05633-9
14. May and Mc Lean- Theoretical Ecology principles and applications-Oxford University Press
15. Peter.S.(2002). Ecology- Theories and Applications. Prentice Hall of India.
16. Whittaker, Robert H. Communities and Ecosystems New York: MacMillan Publishing Company, Inc., 1975.

Ethology

1. Chris Barnard (2003): Animal Behaviour: Mechanism, Development, Function and Evolution, Publisher: Pearson Education.
2. David McFarland (1999): Animal Behaviour: Psychobiology, Ethology and Evolution, 3rd Edition. Publisher: Pearson Education.
3. David Mcfarland (2006) A Dictionary of Animal Behaviour. Publisher: Oxford University Press.
4. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
5. Graham Scott (2004) Essential Animal Behaviour. Publisher: Wiley-Blackwell
6. Lenher, P. (1996) Handbook of Ethological methods. Cambridge Univ.Press, Lond.
7. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.
8. Manning, A. and Dwakins, M.S. (1995) An Introduction to Animal Behaviour. Cambridge Univ. Press, Lond.
9. Martin P. and Bateson .P.(2001). Measuring Behaviour – an introductory guide. Cambridge University Press, UK.
10. Scott, J.P. (1972) Animal Behaviour. Publisher: Univ of Chicago.

FIRST SEMESTER PRACTICALS

SJZOL2L01 - BIOCHEMISTRY

1. Actual acidity and titrable acidity of a strong and a weak acid.
2. Comparison of the buffering capacities of two buffers of same pH
3. Qualitative tests for carbohydrates
 - a) Qualitative tests for monosaccharides (Glucose and fructose)
 - b) Qualitative tests for disaccharides (Lactose, Maltose & Sucrose)
 - c) Qualitative tests for polysaccharides (Dextrin & Starch)
 - d) Identification of unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose, Dextrin & Starch) by suitable tests.
4. Quantitative estimation of carbohydrates
 - 1.1. Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O- Toluidine method)
 - 1.2. Estimation of total carbohydrate by phenol-sulphuric acid method
5. Qualitative tests for proteins
 - a) Colour reactions with proteins (Albumin, Casein, Peptones & gelatin)
 - b) Precipitation reactions with proteins (Albumin, Casein, Peptones & gelatin)
 - c) Identification of unknown protein (Albumin, Casein, Peptones & gelatin)
6. Qualitative tests for non-protein nitrogenous substances (urea, uric acid and creatinine)
7. Identification of unknown carbohydrates, protein and non-protein nitrogenous substances from a given solution.
8. Quantitative estimation of proteins
 - a) Estimation of proteins by Biuret method
 - b) Isolation of casein from cow's milk
9. Quantitative estimation of non-protein nitrogenous substances
 - a) Quantitation of blood urea by diacetyl monoxime method
 - b) Determination of urine creatine by alkaline picrate method
10. Quantitative estimation of lipids
 - a) Estimation of total serum cholesterol by Zak's method
 - b) Saponification number of oils - coconut oil & ground nut oil.
 - c) Iodine number of fats

SJZOL2L02 - CYTOGENETICS

1. Homogenization, cell fractionation and isolation of nuclear fraction.
2. Preparation and maintenance of *Drosophila* larva.
3. Preparation of salivary gland polytene chromosome from *Drosophila* larva.
4. Grasshopper testes- squash preparation to study various meiotic stages.
5. Study of normal human karyotype (male and female) .
6. Study of genetic syndromes- Down's , Klinefelter's , Turner's and Edward's.

References

1. Plummer David, T.(2007). An introduction to practical biochemistry -Tata Mc Graw-Hill, New Delhi.
2. Oser, B.L., (1965) Hawk's Physiological Biochemistry, McGraw Hill Book Co.
3. Sadasivan, S. and Manickam, A., (2005), Biochemical methods, New Age International, New Delhi.
4. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology - 6th edn, Cambridge University Press.
5. Jayaraman, J.(1981) Laboratory Manual in Biochemistry, Wiley Eastern Ltd.
6. Thimmaiah ,S.K.(2004). Standard methods of Biochemical analysis. Kalyani Publishers, Ludhiana.
7. Sawhney, S.K.and Singh Randhir (2006).Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
8. Winchester.A.M.(1964). Laboratory Manual Genetics. Brownca Publishers, Dubuque,Iowa.
9. Neidharth,F.C. and Beyd, R.F.(1965) Cell Biology- A laboratory text . Burgees Publishing Co.

SJZOL2L01 - Biophysics and Biostatistics

Biophysics

1. pH meter and measurement of pH
2. Paper chromatography of amino acids
3. Separation and identification of amino acids in mixtures
4. Thin layer chromatography.
5. Gel electrophoresis.
6. Determination of unknown concentration of coloured solutions by calibration curve using colorimeter.
7. Absorption spectrum and max of a coloured solution (KMnO₄).
8. Drawings using Camera lucida.

Biostatistics

1. Preparation of frequency table with given data
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams. (prepare same graph in Excel and keep print out)
3. Graphic presentation of population distribution in the form of histogram, frequency polygon and frequency curve. (prepare same graph in Excel and keep print.
4. Computation of measures of central dispersion anthropometric data of School children. (prepare same in Excel and keep print outs and add steps for excel)
5. Simulation of binomial and poison distributions .
6. Estimation of mean number of children per family(data from at least 10 families nearby campus) (prepare same in Excel and keep print outs and add steps for excel).
7. Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA. (Prepare same in Excel and keep prints out and add steps for excel).
8. Regression analysis and correlation analysis of a data of height and weight of a group of students. (prepare same in Excel and keep print outs and add steps for excel)

References

1. Daniel, M. (1998). Basic Biophysics for Biologists.. Agri. Botanica, Bikaner.
2. Das, D.(1987). Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.
3. Gasey, E.J.(1962). Biophysical concepts and mechanics. Van Norstrant Reinhold co.
4. Hoppe, W (1988). Biophysics, Springer Veilag.
5. White, D.C.S.(1974).Biological Physics, Chapman and Hall. London.
6. John T (2002) Practical statistics for environmental and biological scientists .John Wiley and Sons.

SJZOL2L03 - Ecology and Ethology

Part A. Ecology

1. Identification of marine planktons.
2. Quantitative estimation of marine planktons.
3. Estimation of BOD in polluted water sample.
4. Estimation of salinity in water samples.
5. Estimation of nitrates-nitrogen in water samples.
6. Separation and identification of soil arthropods using Berlese funnel.
7. Determination of moisture content of soil sample.
8. Determination of water holding capacity of soil sample.
9. Testing the transparency of water using Secchi disc
10. Determination of primary productivity in pond water using light and dark bottle.
11. Study of termitorium / ant colony
12. Principle and application of the following instruments-GPS, Thermo hygrometer, Altimeter, Air samplers, soil samplers, Berlese funnel, Lux meter, anemometer, Rain gauge, Plankton net, Plankton counting chamber, Weather balloon, Secchi disc etc (at least six items)

13. FIELD STUDY-A study tour of at least five days duration (need not be at a stretch) to observe the ecology and behaviour of animals should be under taken. The places of visit include inter tidal region, fresh water bodies, lakes, rivers, hill streams, wetlands, mangroves, forests grasslands, drinking water treatment plants, and sewage treatment plants. A report of the field study is to be included in the practical record to be submitted at the time of examination.

Part B Ethology

1. Studying and reporting the behaviour and ecology of animals in selected fields (Social spider/ Jungle babbler/white headed babbler or Bonnet Macaques)
2. Foraging behaviour of ants.
3. Study of circadian rhythm
4. Behavioural reaction to moisture and light

References:

1. NC Aery, N.C. (2010) - A manual of environmental analysis . Ane books private limited.
2. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
3. Manning, A. (1967). An Introduction to Animal Behaviour. Edward Arnold Pub., London.
4. Manning, A. and Dawkins,M.S.(1995).An introduction to Animal Behaviour, Cambridge Press.
5. Bonnie,J, Plager and Ken Yamkawa (2003). Exploring Animal Behaviour in Laboratory and Field. Academic press.
6. Michael, P.(1984). Ecological methods for field and laboratory investigations. Tata McGraw Hill publishing co.
7. Webber, W.J (1972).Physicochemical Processes for water quality control. Wiley interscience.
8. George,T, Franklin, L. Burton and David, S.H.(2002). Waste water Engineering-Metcalf and Eddy.4th ed. Inc. Tata McGraw Hill publishing co.

COURSE OUTCOMES

SJZOL2C04 - PHYSIOLOGY

- A student studies the anatomy and physiology and the relationships among the physiological functions by different systems of organisms which has practical applications for health and disease management

SECOND SEMESTER THEORY

SJZOL2C04 - PHYSIOLOGY (90 Hours)

1. Nutrition (10 hrs)

- 1.1. Constituents of normal diet and their daily requirements.
- 1.2. Physiological calorie value of food stuffs.
- 1.3. Antioxidant nutrients.
- 1.4. Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation.
- 1.5. The role of hormones and neurotransmitters in the control of gastrointestinal motility.
- 1.6 Energy balance and obesity-causes and consequences.
- 1.7. BMR and its significance.

2. Excretory System (12 hrs)

- 2.1. Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules).
- 2.2. Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus structure, parts and function.
- 2.3. Urine formation (glomerular filtration, tubular reabsorption and tubular secretion)
- 2.4. Regulation of water balance -Mechanism of concentration of urine – Counter Current system (counter current multiplier and counter current exchanger).
- 2.5. Renal regulation of acid- base balance & electrolyte balance.
- 2.6. Structure of urinary bladder, micturition reflex and micturition.
- 2.7. Renal clearance – definition, concept and significance; clearance value of urea, creatinine, phosphate, potassium, chloride and sodium.

3. Respiratory system (10 hrs)

- 3.1. Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia).
- 3.2. Physiological anatomy and histology of respiratory passage and lungs.
- 3.3. Mechanism of pulmonary ventilation (inspiration & expiration) .
- 3.4. Alveolar ventilation, dead space and its effect on alveolar ventilation.
- 3.5. Role of surfactant in alveolar expansion.
- 3.6. Pulmonary volumes and capacities – definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity, total lung capacity).
- 3.7. Exchange of gases- partial pressures involved-lung and tissues.
- 3.8. Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO₂, PCO₂, CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin).
- 3.8. Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

4. Nervous system (21 hrs)

- 4.1. Organisation of human brain.
 - 4.1.1. Cerebrum and cerebral lobe.
 - 4.1.2. Cerebral cortex and its functional areas- Motor cortex, Broca's area , somatosensory cortex and its association area, gustatory cortex, visual cortex and its association area, auditory cortex and its association area, olfactory cortex, wernick's area, Brodman map, cerebral dominance
 - 4.1.3. Cortical white matter- commissures, association fibers, projection fibers, corpus callosum

and fornix, basal nuclei-organisation and function.

- 4.1.4. Brain stem- organisation and function.
- 4.1.5. Cerebellum- structure and function.
- 4.1.6. Diencephalon – organisation and function.
- 4.2. Functional brain systems - Limbic system and reticular formation.
- 4.3. Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function.
- 4.4. Diseased states of brain - schizophrenia, Alzheimer’s disease, Senile dementia & Parkinson’s disease.
- 4.5. Memory- definition, types of memory- short term, intermediate long term and long term memory, consolidation of memory.
- 4.6. PNS and Autonomic nervous system.
- 4.7. Spinal cord – structure.
- 4.8. Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex and golgi tendon organ.

5. Special senses (16 hrs)

5.1. Vision:

- 5.1.1. Structure of eyeball
- 5.1.2. Fluid systems of the eye
- 5.1.3. Layers of Retina and photoreceptors (rods & cones)
- 5.1.4. Brief notes on the neuronal cell types and neural circuitry of the retina and visual pathways from retina to visual cortex
- 5.1.5. Image formation
 - 5.1.5.1. Formation of image on the retina.
 - 5.1.5.2. A brief general account of electrophysiology of vision
 - 5.1.5.3. Photochemistry of vision & colour vision

5.2. Taste:

- 5.2.1. Primary sensations of taste (agents and site of sensation)
- 5.2.2. Taste buds (location, structure, receptors and nerve supply)
- 5.2.3. Physiology of taste (receptor stimulation, generation of nerve impulse by taste buds and its transmission to CNS)

5.3. Smell:

- 5.3.1. Olfactory membrane and receptor cells
- 5.3.2. Physiology of olfaction (stimulation of olfactory cells and transmission of smell signals to CNS)

6. Tactile response: (brief note) (4hrs)

- 6.1.1. Mechanoreceptors and their stimulation
- 6.1.2. Pain receptors and their stimulation
- 6.1.3. Thermal receptors and their stimulation

7. Cardiovascular system (8hrs)

- 7.1. Introduction: Brief description of vertebrate hearts
- 7.2. Structural organization of myogenic heart (in human beings).
- 7.3. Physiological anatomy of cardiac muscle – specialized tissue.
- 7.4. Heart as a pump.
- 7.5. Cardiac cycle.
- 7.6. Neural and chemical regulation of heart function.
- 7.7. Blood volume and blood pressure.
- 7.8. Physiological anatomy of coronary blood flow, coronary blood flow and its control.
- 7.9. Ischemic heart disease – mention causes.

8. Lymphatic System (5 hrs)

8.1. Lymph channels of the body.

8.2. Composition and formation of lymph.

8.3. Functions of lymph and lymphatic system including role of it in controlling Interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure.

9. Environmental Physiology (4 hrs)

9.1. Thermal regulation.

9.1.1. Comfort zone, normal body temperatures (oral, skin & core).

9.1.2. Temperature regulating mechanism (hot & cold), mention the role of hypothalamus, thyroid and adrenal glands.

9.1.3. Acclimatization

References

1. Arthur C. Guyton & John E. Hall (2003): Textbook of Medical Physiology, Saunders (An imprint of Elsevier).
2. William F. Ganong (1999): Review of Medical Physiology, Lange Medical Publications (Appleton & Lange).
3. Jain A.K. (2009): Text Book of Physiology (Vol. I & II), Avichal Publishing Company, New Delhi.
4. Deb, A.C. (2002): Fundamentals of Biochemistry (2002): New Central Book Agency (P) LTD, India.
5. Prosser & Brown. (1973). Comparative Animal Physiology. W.B. Saunders and Co.
6. William S. Hoar. (1966). Comparative Animal Physiology. Prentice Hall, Inc. USA.
7. Kunt-Schmidt-Nielsen. (1994). Animal Physiology, Adaptation and Environment. Cambridge University Press.
8. Jensen D. (1976): Principles of Physiology, Appleton Century Crafts, N.Y.
9. Lonco, G.N. (1993): Physiological Animal Ecology. Longman Scientific and Technical Essex.
10. Oser, B.L. (1965). Haw's Physiological chemistry. Tata McGraw Hill Pub. Co. New Delhi.
11. Shepherd, G.M: Neurobiology-Principles of Neural Science, E. Kandel & P. Schwartz.
12. Campbell *et al.* (1984): Clinical Physiology, 5th Edn. Blackwell Scientific Publications, Oxford.
13. Pragnelli, C.V & Farhi, L.E. (1989): Physiological function of special Environment- Springer-Verlag, N.Y.
14. Davie IV & Lewid S.M. - Practical Haematology, 6th Edn. Churchill, Livingstone, Edinburgh.

COURSE OUTCOMES

SJZOL2C05- MOLECULAR BIOLOGY

- Student learns about the gene structure and functions at the molecular level and to understand the molecular basis of heredity, genetic variation and expression patterns of genes through the interactions of various systems of cells like DNA, RNA and Protein.

SECOND SEMESTER

SJZOL2C05 - MOLECULAR BIOLOGY (90 Hrs)

1. DNA replication (11 Hrs)

- 1.1. Semidiscontinuous synthesis-Okazaki fragments
- 1.2. Replication origin and replication fork
- 1.3. Unit of replication, extra chromosomal replicon of bacterial Ti plasmid
- 1.4. Enzymes/proteins of replication- Primase, Replisomes, Helicase, DNA polymerases, Single strand binding proteins, Topoisomerases and Ligase;
- 1.5. Fidelity of replication
- 1.6. Replication of the ends of eukaryotic chromosome – role of telomerase
- 1.7. Models of DNA replication –Rolling circle model and looped rolling circle model, D-loop model, θ -model.
- 1.8. Inhibitors of DNA replication – Methotrexate and Fluorodeoxyuridylate

2. Safeguard systems of DNA (5 Hrs)

- 2.1. Restriction: significance, role and features of Type I, II & III restriction enzymes
- 2.2. Modification: enzymes and significance
- 2.3. Repair:
 - 2.3.1. Major kinds of damage to DNA and causes
 - 2.3.2. Repair mechanisms: Direct reversal, Mismatch repair, Excision repair, Recombination repair, SOS response

3. Transcription of mRNA in prokaryotes and eukaryotes (10 Hrs)

- 3.1. Structural organisation and life span of mRNA; monocistronic and polycistronic mRNA
- 3.2. Transcription in prokaryotes and eukaryotes
 - 3.2.1. Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites
 - 3.2.2. Transcription factors; Transcription activators and repressors
- 3.3. Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions
- 3.4. Post transcriptional modification of RNA
 - 3.4.1. Capping
 - 3.4.2. Polyadenylation
 - 3.4.3. Splicing
- 3.5. RNA editing: site specific deamination and role of gRNAs
- 3.6. mRNA transport

4. Genetic code (5 Hrs)

- 4.1. Characteristics of genetic code
- 4.2. Start codons and stop codons
- 4.3. Degeneracy of the code: Wobble hypothesis and isoacceptor tRNAs
- 4.4. Special features of the genetic code in mitochondria, mitochondrial tRNA
- 4.5. Variations in the genetic code in *Mycoplasma* and *Tetrahymena*
- 4.6. Point mutations that alter genetic code (missense, nonsense & frameshift)

5. Ribosome: The site of protein synthesis: (2 Hrs)

- 5.1. Structure
- 5.2. Composition; Reconstitution experiments
- 5.3. Active centres
- 5.4. Biogenesis of ribosome in eukaryotes

6. Translation in prokaryotes and eukaryotes: (8 Hrs)

- 6.1. Aminoacylation of tRNA & initiation, elongation and termination of protein synthesis

- 6.2. Aminoacyl tRNA synthetases & initiation, elongation and termination factors
- 6.3. Translational proof-reading
- 6.4. Differences in protein synthesis between prokaryotes and eukaryotes
- 6.5. Translational inhibitors in prokaryotes and eukaryotes – role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin, puromycin and diphtheria toxin
- 6.6. Post- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications
- 7. Control of gene expression at transcription and translation level: (9 Hrs)**
 - 7.1. Regulation of gene expression in Phages – alternate patterns of gene expression for control of lytic and lysogenic cycle in λ phage
 - 7.2. Regulation of gene expression in bacteria – basic features of tryptophan, arabinose and galactose operons
 - 7.3. Regulation of gene expression in eukaryotes –
 - 7.3.1. Role of chromatin in regulating gene expression
 - 7.3.2. Activation and repression of transcription
 - 7.3.3. Regulation of translation by gene arrangement
 - 7.3.4. Regulation of translation by alternate pathways of transcript splicing
 - 7.3.5. Antisense RNA strategies for regulating gene expression
 - 7.3.6. si RNA and mi RNA in regulation
- 8. Eukaryotic genome: (5 Hrs)**
 - 8.1. Special features of eukaryotic genome
 - 8.2. Features, components and reassociation kinetics of Unique, Moderately repetitive and Highly repetitive DNA
 - 8.3. Junk DNA, Satellite DNA and Selfish DNA
 - 8.4. Cot value and complexity of genome
 - 8.5. Organisation of human genome (brief account)
- 9. Interrupted genes (4 Hrs)**
 - 9.1. Definition and explanation
 - 9.2. Organisation and special features of interrupted genes
 - 9.3. Evolution of interrupted genes
- 10. Gene families: (6 Hrs)**
 - 10.1. Definition and concept
 - 10.2. Classification with example
 - 10.2.1. Simple multigene family - organisation of rRNA gene in *Xenopus*
 - 10.2.2. Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in *Drosophila*
 - 10.2.3. Developmentally controlled complex multigene family e.g., globin gene
 - 10.2.3.1. Globin genes and its products
 - 10.2.3.2. Organisation of globin genes and its expression in Man
 - 10.2.3.3. Evolution of globin genes
 - 10.2.4. Concept of an evolutionary clock
 - 10.2.5. Pseudogenes
- 11. Transposable genetic elements - Transposons (6 Hrs)**
 - 11.1. Definition, features and types
 - 11.2. Transposition and mechanism
 - 11.3. Transposons in bacteria
 - 11.3.1. IS elements
 - 11.3.2. Tn family

- 11.3.3. Mu phage as a transposable element
- 11.4. Transposons in eukaryotes
 - 11.4.1. SINE, Alu family; LINE, L1
 - 11.4.2. P elements in *Drosophila*
 - 11.4.3. Transposons in Maize
- 11.5. Retroviruses and transposition
- 12. Molecular mechanisms involved in recombination of DNA: (5 Hrs)**
 - 12.1. Genetic recombination – types with example
 - 12.1.1. Site specific recombination
 - 12.1.2. Non-homologous recombination
 - 12.1.3. Homologous recombination
 - 12.2. Molecular mechanism involved in homologous recombination of DNA in eukaryotes- Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion
 - 12.3. Role of Rec A protein in genetic recombination
- 13. Microbial genetics (5 Hrs)**
 - 13.1. Prokaryotic genome- *Escherichia coli* genome – basic features
 - 13.2. Methods of genetic transfers in bacteria– transformation (in *Streptococcus pneumoniae*), conjugation and sexduction, transduction
 - 13.3. Brief note on mapping genes by interrupted mating (in bacteria)
- 14. Organelle genome (4 Hrs)**
 - 14.1. Chloroplast genome: special features
 - 14.2. Mitochondrial genome
 - 14.2.1. Special features of yeast mitochondrial genome, petite mutants
 - 14.2.2. Special features of human mitochondrial genome.
- 15. Cancer (5 Hrs)**
 - 15.1. Genetic rearrangements in progenitor cells, oncogenes, protooncogenes and tumour suppressor genes
 - 15.2. Virus-induced cancer
 - 15.3. Alteration of cell cycle regulation in cancer
 - 15.4. Interaction of cancer cells with normal cells
 - 15.5. New therapeutic interventions of uncontrolled cell growth (immunotherapy and gene therapy).

References

1. Attwood T.K, Parry-Smith D.J. (2003): Introduction to Bioinformatics. Pearson Education
2. Benjamin Lewin (2008): Genes, Vol. IX, Boston, Jones, Bartlet.
3. Brown, T.A. (2006): Genomes 3. Garland Science, New York.
4. Elliott, W. H and Elliott, D. C. (1997): Advanced Molecular Biology, Viva Books, New Delhi
5. Freifelder, D. (2003): Molecular Biology, Narosa Publishing House, New Delhi
6. Gupta, P. K. (2005): Cell and Molecular Biology, Rastogi Publications, New Delhi
7. Kothekar, V. (2004): Introduction to Bioinformatics. DHRUV Publications, Delhi.
8. Kumar, H. D. (2001): Molecular Biology, Vikas publications, New Delhi
9. Malacinski, G. M. (2005): Essentials of Molecular Biology, Narosa Publishing House, New Delhi
10. Mayers, R.A (Ed) (1995). Molecular Biology and Biotechnology: A Comprehensive Desk Reference. VCH Publishers, Inc., New York
11. Russel, P. J. (2009): Cell and Molecular Biology, Cengage learning
12. Tropp, B. E. (2008): Molecular Biology, Jones and Bartlet.
13. Veer Bal Rastogi (2008): Fundamentals of Molecular Biology, Ane Books India
14. Watson, J. D. (1998): Molecular Biology of the gene, Benjamin Publishing house.
15. Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R.. (2006). Molecular Biology of the Gene, Pearson Education.

16. Benjamin Lewin (2006). Essential Genes, Pearson, London.
17. Brown, T.A.(2000). Essential Molecular Biology. IInd ed. Oxford OUP.
18. Sinden, Richards,R.(2006). DNA structure and function. California, Academic Press,.
19. Snustad, D.P. and Simmons, M.J.(2000). Principles of Genetics. 2nd ed. John Wiley and Sons Inc.

COURSE OUTCOMES

SJZOL2C06- SYSTEMATICS AND EVOLUTION

- Students able to study biological diversity and the evolutionary relationships among organisms, both extinct and modern.
- Student gets the insight into the biological process like speciation and adaptation to environment.

SECOND SEMESTER

SJZOL2C06 - SYSTEMATICS AND EVOLUTION (90 Hours)

Part –A: Systematics (54 Hrs)

1. Introduction (1 hr)

2. Definition and basic concepts in Systematics and Taxonomy (4 hrs)

2.1 Levels of Taxonomy

(a) Alpha, Beta and Gamma taxonomy

2.2 Importance and applications of taxonomy

2.3 Goals of taxonomy

2.4 Definition of systematics

2.5 Definition of classification

3. Species (4 hrs)

3.1 Monotypic species

3.2 Polytypic species

3.3 Ecospecies and Cenospecies

3.4 Morphospecies

3.5 Super species

3.6 Species as a Population Complex

4. Species Concepts (6 hrs)

4.1 Typological Species Concept

4.2 Nominalistic Species Concept

4.3 Biological Species Concept

4.4 Evolutionary Species Concept

4.5 Difficulties in the application of the biological species concept

5. Classification (7 hrs)

5.1 Uses of Classification

5.2 Purpose of Classification

5.3 Theories of Classification

(a) Essentialism (b) Nominalism (c) Empiricism (d) Cladism (e) Evolutionary Classification

5.4 Hierarchy of Categories

5.5 The objectives of classification

6. Taxonomic Collections and the Process of identification (8 hrs)

6.1 Taxonomic collections: Types of collections, Value of Collection

6.2 Purpose of scientific collection

6.3 Preservation of Specimens

6.4 Labeling

6.5 Curating of collections

6.6 Curating of types

6.7 Identification- Methods of identification

6.8 Use of keys, types of keys.

6.9 Merits and demerits of different keys

6.9.1 Description and publication

7 .Taxonomic Characters (6 hrs)

7.1 Nature of taxonomic characters

7.2 Taxonomic characters and adaptation

7.3 Kinds of taxonomic characters

(a) Morphological (b) Physiological (c) Ecological (d) Ethological and (e) Geographical characters

7.4 Taxonomic characters and classification

- 7.5 Taxonomic characters and evolution
- 7.6 Functions of taxonomic characters
- 8. Zoological Nomenclature (6 hrs)**
 - 8.1 Brief History of nomenclature
 - 8.2 International Code of Zoological Nomenclature
 - 8.3 The nature of scientific names
 - 8.4 Species and infraspecies names
 - 8.5 Gender of generic names
 - 8.6 Synonyms and Homonyms
 - 8.7 The Law of Priority
 - 8.8 Rejection of names
 - 8.9 Type method and different kinds of types
- 9. Newer trends in systematics (4 hrs)**
 - 9.1 DNA Bar coding
 - 9.2 Molecular systematics
 - 9.3 Chemo taxonomy and serotaxonomy
 - 9.4 Cytotaxonomy
 - 9.5 Numerical taxonomy
 - 9.6 Cladistics
- 10. Ethics related to taxonomic publications (4 hrs)**
 - 10.1 Authorship of taxonomic papers
 - 10.2 Correspondence
 - 10.3 Suppression of data
 - 10.4 Undesirable features of taxonomic papers
 - 10.5 Taxonomist and user communities
- 11. Taxonomic impediments (4 hrs)**
 - 11.1 Impediments in taxonomic collections and maintenance
 - 11.2 Shortage of man power
 - 11.3 Lack of funding for taxonomic research
 - 11.4 Lack of training and library facilities
 - 11-5 Impediments in publishing taxonomic work
 - 11.6 Solutions to overcome the impediments
 - (a) Improve international co-operation (b) Development of taxonomic centers
 - (c) Need for efficient international networking (d) the desired end product

Part- B Evolution (36 Hrs)

I. Natural Selection: (7 hrs)

- 1.1 Mechanism of natural selection- directional, disruptive and stabilizing selection
- 1.2 Natural selection in islands
- 1.3 Sexual selection; intrasexual and intersexual selection- secondary sexual characteristics-sexual selection hypothesis, good gene hypothesis

2 The Mechanisms (7 hrs)

- 2.1 Population genetics- populations, gene pool, gene frequency, Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift as factors in evolution
- 2.2 Evidence for evolution: DNA evidence, fossil evidence, embryological evidence, geological evidence, evolution in action, imperfection of evolution
- 2.3 Co-evolution: microevolution, macroevolution, convergent evolution (homoplasy), divergent (parallel) evolution

3 Tempo of evolution (5hrs)

- 3.1 Gradualism Vs punctuated equilibrium
- 3.2 Anagenesis Vs Cladogenesis

4 Molecular evolutions (8 hrs)

- 4.1 Neutral theory of molecular evolution

- 4.2 Molecular divergence
- 4.3 Molecular drive
- 4.4 Molecular clocks, genetic equidistance, human mitochondrial molecular clock
- 4.5 Phylogenetic relationships- Homology, homologous sequence of proteins and DNA, orthologous and paralogous evolution, nucleotide sequence analysis
- 5 Evolutionary trends (9 hrs)
- 5.1 Biochemical evolution- Collapse of orthogenesis
- 5.2 Stages in primate evolution including Homo: dry and wet nosed primates, prosimians and simians, human and the African apes, African origin for modern humans, Y chromosome Adam and mitochondrial Eve
- 5.3 Can evolution explain language? Communication, speech, language and self awareness in primates.

References

Part -A Systematics

1. David.M.H, Craig Mortiz and Barbara K.M (1996) Molecular Systematics. Sinauer Associates, Inc
2. David, M.S (2009) DNA bar-coding will frequently fail in complicated groups: an example in wild potatoes. American journal of Botany 96(6) : 1177-1189. Downloadable from [www.vcr.uwisc.edu/spoonerlab/.../Bar Codes %20 and % 20 wild% 20 Potatoes.pdf](http://www.vcr.uwisc.edu/spoonerlab/.../Bar%20Codes%20and%20wild%20Potatoes.pdf)
3. Dalela, R.C. and Sharma, R.S.(1992). Animal Taxonomy and Museology, Jai Prakash Nath & Co Meerut City U.P (India)
4. Kapoor V.C (1998) Theory and practice of animal taxonomy. Oxford & IBH, Publi.Co New Delhi
5. Kipling, W.W; Brent, D.M and Quentin, D.W.(2005) The perils of DNA bar-coding and the need for Integrative Taxonomy. Syst. Biol. 54(5): 844-851, Downloadable from sysbio.oxfordjournals.org/cgi/reprint/54/5/844.pdf
6. Mayr. E (1969) Principles of Systematic Zoology. McGraw Hill Book Company, Inc, New York
7. Narendran, T.C (2008) An introduction to Taxonomy. Zoological Survey of India
8. Sneath P.H.A.(1973) Numerical Taxonomy: The Principles and Practice of Numerical Classification.W.H. Freeman &Co

Part- B Evolution

1. Coyne, J.A and Allen O.H (2004) Speciation. Sinauer Associates Inc. Massachusetts, USA
2. David, M.H, Craig Moritz and Barbara K.M (1996) Molecular Systematics. Sinauer Associates, Inc.
3. David, M.S (2009) DNA bar-coding will frequently fail in complicated groups: an example in wild potatoes. American journal of Botany 96(6) : 1177-1189. Downloadable from [www.vcr.uwisc.edu/spoonerlab/.../Bar Codes %20 and % 20 wild % 20 Potatoes.pdf](http://www.vcr.uwisc.edu/spoonerlab/.../Bar%20Codes%20and%20wild%20Potatoes.pdf)
4. Gould, S.J (1997) Ontogeny & Phylogeny, Belkrap Press. Harvard University Cambridge
5. Kipling, W.W; Brent, D.M and Quentin, D.W.(2005) The perils of DNA bar-coding and the need for Integrative Taxonomy. Syst. Biol. 54(5): 844-851, Downloadable from sysbio.oxfordjournals.org/cgi/reprint/54/5/844.pdf
6. McHenry, H.M (2009) Evolution. In Michael Ruse & Joseph Travis. Evolution: The first four Billion Years. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.p 265.
7. Motoo Kimura (1983) The neutral theory of molecular evolution. Cambridge University Press.
8. Roderick D.M. Page and Edward. C.H. (2000) Molecular Evolution: A Phylogenetic Approach: Blackwell Science.
9. Strikberger, M.W. (2000) Evolution, Jones and Bartett Publishers, London. 38
10. Brain,K.Hall and Benedikt, Hallgrinmson (2008). Strickberger"s Evolution, 4th ed. Jones and Barlett Publishers International ,London.
11. Futuyama, D.J.(2005). Evolution. Sinauer Associates Inc. Sunderland, Massachusetts.

SECOND SEMESTER PRACTICALS

SJZOL2L02 – PHYSIOLOGY

1. Kymograph: working principle and applications
2. Effect of different substrate concentration, pH and temperature on human salivary amylase activity. colorimetric method, plot graphs.
3. Qualitative demonstration of digestive enzymes in cockroach – amylases, lipases, proteases, invertases and controls.
4. Digestion in a vertebrate and calculation of peptic value.
5. Influence of temperature and pH on the ciliary activity in fresh water mussel/mytilus using silver foil. Plot graph
6. Determination of respiratory quotient – estimation of O₂ consumption by an aquatic animal.
7. Determination of the rate of salt loss and gain in an aquatic animal (fish or crab).
8. Estimation of urea and ammonia in human urine. Titrimetric method.
9. Rate of glucose – absorption – calculation of Cori coefficient.
10. Estimation of haemoglobin of Fish/Man – Sahli's method.
11. Blood volume determination by dye dilution method (Vertebrate).
12. Blood: clotting time, bleeding time, rouleaux formation, preparation of haemin crystals.
13. Enumeration of RBCs in human blood.
14. Determination of lactic acid in muscle tissue.
15. Differential count of human WBCs
16. Haematocrit and ESR of human blood.
17. WBC total count

References:

1. Oser B. L.(1965). Hawk's Physiological chemistry, McGraw Hill Book Company
2. Hill R.W., Wyse G.A. (1989), Animal Physiology 2nd edition. Harper Collins Publishers
3. Schmidt-Nielsen, K. (1997), Animal Physiology, adaptation and environment, Cambridge University Press.
4. Dounersberger, Anne.B.Lesak, Anne,C and Timmons, Maichael,J.(1992).A laboratory Text Book Of Anatomy and Physiology. 5th ed. D.C.Heath & Co.

SJZOL2L02- MOLECULAR BIOLOGY

1. Estimation of DNA by Diphenyl Amine method
2. Estimation of RNA by Orcinol method
3. Estimation of Protein by Lowry's method.
4. Isolation of genomic DNA.
5. Isolation of DNA from Liver/Spleen/Thymus.
6. Study of principle and application of DNA finger printing.

References

1. Brown, T.A. (1998): Molecular biology Lab Fax. Vol. 1 and 2, Academic press
2. Brown, T.A. (2007): Essential Molecular Biology – A practical approach Vol. 2, Oxford University Press
3. Wilson & Walker (2006): Principles and techniques of Biochemistry and Molecular biology, Cambridge University Press.

SJZOL2L03- SYSTEMATICS AND EVOLUTION

Systematics

1. Collection, Preservation and Curation of specimens
2. Identification of animals (Fishes/insects/any other) up to family/ generic / species level- minimum 15 specimens.

3. Preparation of dichotomous (simple bracket) keys to selected families with reference
4. to insect orders Orthoptera, Hemiptera, Coleoptera, Diptera and Hymenoptera (minimum five specimens from each order)

Evolution

1. Exercises in convergent evolution.
2. Exercises in divergent evolution.
3. Sympatric and Allopatric speciation.
4. Exercises in co-evolution.
5. Calculation of genotype / gene frequency based on Hardy –Weinberg equilibrium.

FIRST AND SECOND SEMESTER PRACTICALS

SJZOL2L01- BIOCHEMISTRY, BIOPHYSICS AND BIOSTATISTICS

On completion of this course, students will be able to:

- Prepare analytical quality solutions, buffers and dilution series
- Calibrate, or understand principles of calibration of, fundamental laboratory apparatus.
- Provide the skills necessary to analyze chemicals and chemical reactions quantitatively.
- The students acquire theoretical aspects and principles in biophysics and will be able to apply basic methods in the fields of biophysics in order to resolve and critically discuss questions.
- The various design possibilities for a research project, and the important considerations for observational studies and randomized trials
- The types of data generated in research studies and also to interpret their results.

SJZOL2L02- PHYSIOLOGY, MOLECULAR BIOLOGY AND CYTOGENETIC

- Demonstrate laboratory procedures used to examine anatomical structures and evaluate physiological functions of each organ system
- Interpret graphs of anatomical and physiological data.
- Make a connection between anatomy and physiology knowledge and practical applications.
- Apply and exhibit the knowledge base in genetics, cell and molecular biology, and anatomy and physiology
- Demonstrate the knowledge of common and advanced laboratory practices in cell and molecular biology

SJZOL2L03-ECOLOGY, ETHOLOGY, SYSTEMATIC AND EVOLUTION

- Provides students with insight into the quantitative study and use of ecological, physiological and systematic principles in the context of ecology, conservation and environmental science and its applications in conservation biology and environmental management.
- Provide broad competence for careers that involve the biology of animals in relation to their environment.
- Provide the platform on which behaviour is based and, during evolution, natural selection

FIELD STUDY

- Expose students to new experiences and can increase interest and engagement in ecological and ethological studies regardless of prior interest in a topic.
- Result in affective gains such as more positive feelings toward a topic.
- Students experiences memories recalled and useful long after a visit.

COURSE OUTCOMES

SJZOL3C07– IMMUNOLOGY

- Student learns about the underlying principles of body's defense mechanisms and various molecules involved in it so that they able to design the measures (both the reactions and techniques) to eradicate the cause of disease.

THIRD SEMESTER THEORY
SJZOL3C07 IMMUNOLOGY (90 Hours)

1. Introduction (1 hour)
2. Hematopoiesis (7 hours)
 - 2.1. Hematopoiesis – Lymphoid and myeloid lineages.
 - 2.2. Hematopoietic growth factors.
 - 2.3. Genes that regulate hematopoiesis.
 - 2.4. Regulation of hematopoiesis.
 - 2.5. B- Lymphocytes, T- lymphocytes and Antigen presenting cells.
3. Antigens (8 hours)
 - 3.1. Immunogenicity, Antigenicity.
 - 3.2. Factors that influence immunogenicity.
 - 3.3. Adjuvants.
 - 3.4. Haptens.
 - 3.5. Epitopes.
 - 3.6. Properties of B-cell and T- cell epitopes.
4. Immunoglobulins (Antibodies) (10 hours)
 - 4.1. Structure and function of Antibody molecules.
 - 4.2. Generation of Antibody diversity.
 - 4.3. Immunoglobulin gene.
 - 4.4. Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c) Idiotype.
 - 4.5. B-cell receptor (BCR).
 - 4.6. Monoclonal Antibodies.
 - 4.7. Production of Monoclonal Antibodies (Hybridoma technology).
 - 4.8. Clinical uses of Monoclonal Antibodies.
 - 4.9. Antibody Engineering.
5. Antigen Antibody interactions (10 hours)
 - 5.1. Strength of antigen – antibody interactions.(a) Antibody affinity (b) Antibody avidity.
 - 5.2. Cross- reactivity.
 - 5.3. Precipitation reactions.
 - 5.4. Immunotechnics – ELISA, RIA, WesternBlot, Immunoelectrophoresis, Flow cytometry and fluorescence.
6. Generation of B-cell and T-cell responses. (9 hours)
 - 6.1. Humoral immunity.
 - 6.2. Cellular immunity.
 - 6.3. T- Cell receptor, TCR-CD3 complex.
 - 6.4. Activation, maturation and differentiation of B-Cells.
 - 6.5. Activation, maturation and differentiation of T- Cells.
7. Immune effector mechanism. (7 hours)
 - 7.1. Cytokines.
 - 7.2. Properties of cytokines.
 - 7.3. Cytokine antagonists.
 - 7.4. Cytokine secretion by TH1 and TH2-cells.
 - 7.5. Cytokine related diseases. (a) Bacterial septic- shock (b) chaga's disease) (c) lymphoid and myeloid cancers.

- 7.6. Therapeutic uses of cytokines.
- 7.7. Toll- like receptors.
- 8.** The Complement system. (6 hours)
- 8.1. The complement components.
- 8.2. The functions of complement components.
- 8.3. Complement activation (a) Classical pathway (b) Alternate pathway (c) Lectin pathway.
- 8.4. Regulation of complement system.
- 8.5. Biological consequences of complement activation.
- 8.6. Complement deficiencies.
- 9.** Major Histocompatibility Complex (MHC) (8 hours).
- 9.1. General organization and inheritance of MHC.
- 9.2. MHC molecules and genes.
- 9.3. Cellular distribution of MHC.
- 9.4. Antigen- processing and presentation- Exogenous and Endogenous pathways.
- 9.5. Presentation of non- peptide antigens.
- 10.** Transplantation immunology (8 hours)
- 10.1. Auto graft, Allograft, Isograft and xenograft
- 10.2. Immunological basis of graft rejection.
- 10.3. Role of cell- mediated responses.
- 10.4. Transplantation antigens.
- 10.5. General immune suppressive therapy.
- 11.** Hypersensitivity Reactions. (5 hours)
- 11.1. Allergens.
- 11.2. IgE- mediated (type- I) hypersensitivity.
- 11.3. Antibody- mediated cytotoxic (type- II) hypersensitivity.
- 11.4. Immune complex- mediated (type- III) hypersensitivity.
- 11.5. TDTH- mediated (type- IV) hypersensitivity
- 12.** Vaccines. (5 hours)
- 12.1. Active and passive immunization.
- 12.2. Whole organism vaccines.
- 12.3. Recombinant vector vaccines.
- 12.4. DNA vaccines.
- 12.5. Synthetic peptide vaccines.
- 12.6. Multivalent vaccines.
- 13.** Immunity and malnutrition and immune deficiency diseases. (6 hours)
- 13.1. Immunity and malnutrition.
- 13.2. Primary immune deficiency diseases. (a)Burton's disease (b) Di-George syndrome and SCID.
- 13.3. Secondary immune deficiency - AIDS.
- 13.4. Transmission of HIV.
- 13.5. Vaccines to prevent AIDS.
- 13.6. Autoimmunity (systemic and organ specific brief)

References

1. Abdul K Abbas and Andrew H. Lichtman (2004). Basic immunology –Functions and Disorders of the immune system. (second edition, Elsevier Science, USA)
2. Abdul K Abbas and Andrew H. Lichtman (2003). Cellular and Molecular Immunity (fifth edition,

- Elsevier Science, USA).
3. Godkar, P.B (1998): A Text Book of Medical Laboratory Technology. Bhalani Bhalani Publishing House Mumbai.
 4. Janis Kuby (2000) .Immunology. 7th ed. W.H. Freeman & Co. New York.
 5. Joshi K. R and Osamo. N. O (1994) : Immunology. Agro Bios Publishers. Jodhpur.
 6. Chakraborty ,A.K.(2006).Immunology and Immunotechnology.Oxford University Press.
 7. Peter Parham (2004): The immune system (Second edition, Garland, New York).
 8. Ivan .M.Roitt(2002). Essentials of Immunology.ELBS, New Delhi.
 9. Shetty, N (1993) Immunology: Wiley Eastern Ltd, New Delhi.
 10. Richard, Coico and Geoffrey, Sunshine (2009).Immunology- A short course.Wiley Blackwell. C A, USA.
 11. David Male, Jonathan Brastoff, David Roth and Ivan Roitt (2006). Immunology. Mosby, Edinburgh, UK.
 12. Hannigan, B.M., Moore, C.B.T. and Quinn, D.G.(2010). Immunology. Viva Books, New Delhi.
 13. Khan F,H,(2009). Elements of Immunology. Pearson Education ,New Delhi.
 14. Thomas J. Kindt, Barbara, A., Osborne And Richard, A.Goldsby.(2007). Kuby Immunology.6th ed. W.H.Freeman,New York.
 15. Helen Chappel and Moused Harney (2006). Essentials of clinical Immunology. 5th ed. Blackwell Scientific Publications.

COURSE OUTCOMES

SJZOL3C08– DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY

- Student gets a comprehensive idea and rational explanation of the intricate arrangements occurring during prenatal development. Because of this malformations of various kinds can be explained on the basis of departures from usual patterns.
- Student can familiarize different types of hormones, their action at molecular level and their regulation patterns so that can design various solutions for endocrine disorders like diabetes, thyroid issues etc.

THIRD SEMESTER THEORY

SJZOL3C08—DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY (90 Hours)

Part- A - DEVELOPMENTAL BIOLOGY (54hrs)

1. Introduction: Basic concepts of development (6 hrs)
 - 1.1. Cell fate, potency, determination and differentiation.
 - 1.2 Commitment
 - 1.3. Specification - autonomous, conditional, syncytial .
 - 1.4. Genomic equivalence and cytoplasmic determinants
 - 1.5. Morphogenetic gradients
 - 1.6. Genomic Imprinting
 - 1.7. The stem cell concept- Progenitor cells, Adult stem cells, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells, Stem cell therapy.
2. Gametogenesis, fertilization and early development (10 hrs)
 - 2.1. Production of gametes- Spermatogenesis and Oogenesis, Ultra structure of gamates
 - 2.2 Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals)
 - 2.3 Zygote formation-
 - 2.3.1. Encounter of sperm and egg
 - 2.3.2. Capacitation
 - 2.3.3. Acrosome reaction
 - 2.3.4. Activation of ovum
 - 2.3.5 Amphimixis
 - 2.3.6. Prevention of Polyspermy (Fast block and Slow block)
 - 2.4 Cleavage and blastula formation
 - 2.5 Gastrulation and formation of germ layers in amphibia
 - 2.6 Embryonic fields
3. Embryogenesis and Organogenesis (10 hrs)
 - 3.1 Axis formation in amphibians - The phenomenon of the Organizer- Nieuwkoop center, primary embryonic induction, mechanism of axis formation
 - 3.2 Anterior posterior patterning in Amphibians - Hox code hypothesis
 - 3.3 Anterior posterior patterning in *Drosophila* – anterior forming genes (bicoid, hunchback), posterior forming genes (nanos, caudal), terminal forming gene (torso), segmentation genes- gap genes, pair rule genes, segmentation polarity genes, homeotic selector genes, realistor genes
 - 3.4 Dorso- ventral patterning in *Drosophila*- dorsal protein gradient
 - 3.5. Limb development in chick- Formation of the Limb Bud, Generating the Proximal-Distal Axis of the Limb, Specification of the Anterior-Posterior Limb Axis, Generation of the Dorsal-Ventral Axis
 - 3.6. Insect wings and legs formation
 - 3.7. Vulva formation in *Caenorhabditis elegans*.
 - 3.8. Eye lens induction.
4. Cellular and Molecular basis of development (7 hrs)
 - 4.1. Induction and competence- cascade of induction- reciprocal and sequential inductive events, instructive and permissive interactions.
 - 4.2. Epithelial- Mesenchymal interactions- paracrine factors - The Hedhog family, The Wnt family, Juxtacrine signaling and cell patterning, notch pathway.

- 4.3. Cellular interactions concerned in fertilization, blastulation, gastrulation and organogenesis.
- 4.5. Molecular basis of cellular differentiation – Cadherins.
5. Genetic basis of development (8 hrs)
 - 5.1. Differential gene transcription –Promoters and Enhancers, DNA methylation, Transcription factors, Silencers and Insulators.
 - 5.2. Differential RNA processing- X chromosome inactivation- dosage compensation
 - 5.3. Control of gene expression at the level of translation-Differential mRNA longevity, selective inhibition of mRNA translation, Selective activation of mRNA translation, micro RNAs, Control of RNA expression by cytoplasmic localization.
 - 5.4. Post translational regulation of gene expression.
 - 5.5. Models of cell differentiation- hematopoiesis, myogenesis, differentiation of neural crest cells.
 - 5.6. Reversibility of patterns of gene activity-cell fusion, transdifferentiation.
6. Metamorphosis, Regeneration and Ageing (7 hrs)
 - 6.1. Metamorphosis in Amphibians and Insects and their hormonal control
 - 6.2. Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration
 - 6.3. Ageing – The biology of senescence, cellular and extra cellular ageing, Genes and ageing, DNA repair enzymes, Ageing and the insulin signaling cascade, The mTOR pathway, Chromatin modification, Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed ageing .
7. Environmental regulation of animal development (4 hrs)
 - 7.1 Environmental regulation of normal development - types of polyphenism
 - 7.2 Environmental disruptions of normal development (Teratogenesis) Teratogenic agents - Alcohol, retinoic acid, Bisphenol A(BPA), heavy metals, pathogen, Testicular Dysgenesis Syndrome, DES as an endocrine disruptor, Endocrine disruptors as obesogens
 - 7.3. Environmental oestrogens.
 - 7.4. Impact of pesticide on development.
8. Developmental Mechanisms of Evolutionary change- (2hrs)
Heterotopy, Heterochrony, Heterometry, Heterotypy. (Brief)

Part B- ENDOCRINOLOGY (36 hrs)

1. Endocrine glands and their Hormones (Brief account) (5 hrs)
 - 1.1. Hormone secreting organs and tissues -skin, liver, kidney, heart.
 - 1.2. General classes of chemical messengers- Peptide, thyroid, steroid hormones, neurotransmitters and pheromones
 - 1.3. Synthesis and delivery of hormones- storage, secretion and transportation
 - 1.4. Control of hormone secretion.
 - 1.5. Physical characteristics of hormones - latency, post-secretary modification and half- life
 - 1.6. Physiological roles of hormones.
2. General mechanisms of Hormonal action (5 hrs)
 - 2.1. Hormone Receptors and transducers;
 - 2.1.1. Types of receptors- G protein coupled receptors, steroid receptors and nitric oxide receptors,
 - 2.1.2. Regulation of receptor number, receptor activation
 - 2.2. Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol ,
 - 2.3. Receptor signal transduction
 - 2.4. Eicosanoids and hormone action

3. Anatomy of endocrine glands; structure, physiological functions, and control of secretion of their hormones and pathophysiology (13 hrs)

3.1. Hypothalamus

3.2. Hypophysis

3.3. Thyroid

3.4. Parathyroid

3.5. Adrenal

3.6. Pancreas

4. Hormones and male reproductive physiology (7 hrs)

4.1. Synthesis, chemistry, and metabolism of androgens

4.2. Endocrine control of testicular function

4.3. Physiological roles of androgens and estrogens

4.4. Pathophysiology

5. Hormones and female reproductive physiology (3 hrs)

5.1. Synthesis, chemistry, and metabolism of Ovarian steroid hormones

5.2. Physiological roles of Ovarian steroid hormones

5.3. Hormonal regulation of female monthly rhythm

5.4. Hormonal factors in pregnancy, parturition and lactation

6. Neurohormones (3 hrs)

6.1. Gases as neural messengers

6.2. Endorphins- physiological roles, mechanism of action and pathophysiology

6.3. Brain hormones and behaviour

6.4. Neuroendocrine pathophysiology

References

Developmental biology

1. Balinsky, B. I.(1981). An introduction to Embryology. Holt Saunders, Philadelphia
2. Berril, N. J.and Karp.G.(1978). Developmental biology.Tata McGraw Hill., New Delhi.
3. Deuchar, E. M. Cellular interactions in animal development.
4. Gilbert, S. F.(2003). Developmental Biology. 7th ed. Sinauer Associates Inc. Massachusetts.
5. Hodge, R. Developmental Biology: From a Cell to an Organism.
6. Hopper, A. S. & N. H. Hart. Foundation of animal development.
7. Lash, J & J. R. Whittaker. Concepts of development.
8. Muller, W. A. Developmental biology. Springer.
9. Snustad, D. P., J. M. Simmons & J. B. Jenkins. Principles of Genetics.
10. Wolpert, L. Beddington,R.,Jessel,T., Lawrence, P., Meyerowitz,E.and
11. Smith, J.(2002). Principles of Development. Oxford university press, 2nd edition.
12. Slack, J, (2001). Essential Developmental Biology. Blackwell Publishing ,UK.
13. Twyman,R.M.(2001). Instant notes in Developmental Biology. Bios Scientific Publishers Ltd. Oxford.
14. Vasudeva Rao, K.(1994). Developmental Biology-a modern synthesis. Oxford IBH, New Delhi.

Endocrinology

1. Bentley, P. J. (1998). Comparative vertebrate endocrinology.3rd ed.Cambridge University Press
2. Bern, H. A. Text book of comparative endocrinology
3. Bolander, F. F.(2006). Molecular endocrinology, Academic press, New Delhi.
4. Ganong, W. F. (2005). Review of medical physiology, Mc Graw Hill, New Delhi.
5. Hadley, M. E. (2000). Endocrinology, Pearson education, Inc., New Delhi.
6. 6.Harris, G. W. (1995). Neural control of the pituitary gland, Edward Arnold, London.
7. Hazelwood, R. (1990). The endocrine pancreas, EnglewoodCliffs, Prentice Hall, NJ.

8. Horrbin, D. F. Essentials of Biochemistry, endocrinology and nutrition.
9. Prakash Lohr. Hormones and human health
10. Nelson R. J. Introduction to behavioral endocrinology
11. Norris D. O. (2005). Vertebrate endocrinology.
12. Vinzen, G. et al, (1992). Adrenal cortical steroid hormones, Englewood Cliffs, Prentice Hall, NJ.
13. Brown, J. H. and Wet, G.B. (2000).Scaling in Biology. Oxford University Press, New York.
14. Williams, R. H.(1988). Text Book of Endocrinology. W. B. Saunders Company, Philadelphia.
15. Turner,K. and Bagnara, G. (1976). General Endocrinology.W.B. Saunders Company,Philadelphia.
16. Brook, C.G. and Marshall, N.J.(1996).Essential Endocrinology.3rded.Blackwell Science , London.
17. 17.Guyton, A.C. and Hall, J. E. (2001). Text Book of Medical Physiology.10thed. Prism Books, Pvt. Ltd. Harcourt Asia Ltd.India ed.
18. Hadley, M.G. (2000). Endocrinology .3rd ed. Prentice Hall International Inc. New Jersey

COURSE OUTCOMES

SJZOL3E09 -HUMAN GENETICS -- CLINICAL GENETICS

Create the awareness of genetic etiology and gives an idea about clinical management, including prevention, screening and treatment of a wide range of diseases

THIRD SEMESTER THEORY
ELECTIVE COURSE –HUMAN GENETICS -1
SJZOL3E09 - CLINICAL GENETICS (90Hours)

1. Cytogenetics (35 Hrs)

- 1.1** Cell cycle, chromosomal basis of inheritance- Mendelian and Non –Mendelian inheritance in humans- Dominant, recessive, lethal, sex linked, sex influenced, mitochondrial and multifactorial **(12 hrs)**
- 1.2** Cytogenetic techniques: Routine cytogenetic techniques of PBLC and preparation of stained slides and nomenclature, ISCN. , SCE, MN Banding techniques- C, G, Q, R, Acridine orange, NOR and DAPI **(5 hrs)**
- 1.3** Specialized techniques: HRB, fragile sites, PCC, Karyotyping, interpretation (3 hrs)
- 1.4.** Chromosome abnormalities and clinical phenotypes. Abnormalities of Chromosome Number- polyploidy, aneuploidy. Factors causing aneuploidy, non-disjunction. Autosomal aneuploid syndromes- trisomy 21, trisomy 18, trisomy 13. Sex chromosome aneuploid syndromes- Turner, Klinefelter, Triple X, XYY. X - inactivation.

Abnormalities of Chromosome Structure: Duplication, deletion, translocation, reciprocal translocation, Robertsonian translocation, microdeletion and syndromes. Uniparental disomy, Imprinting, ring chromosome, inversion, isochromosome, Chromosome instability syndromes. Spontaneous abortions **(15hrs)**

2. Medical Genetics (20 Hrs)

- 2.1** Hematological disorders- Hemoglobinopathies, disorders of stasis and coagulation disorders **(3 hrs)**
- 2.2** Skeletal disorders: Achondroplasia, Osteogenesis imperfecta **(3 hrs)**
- 2.3** Neuromuscular disorders-Muscular dystrophies, spinal muscular dystrophy, myotonic dystrophy, neurofibromatosis, tuberous sclerosis, Parkinson's disorders, Huntington chorea **(5 hrs)**
- 2.4** Renal disorders- Renal cystic disorders, disorders of urinary tract, nephritic diseases **(2 hrs)**
- 2.5** Respiratory disorders-cystic fibrosis, asthma **(2 hrs)**
- 2.6** Endocrine disorders- thyroid, pancreas, pituitary, gonads **(5 hrs)**

3. Human Biotechnology (25 Hrs)

- 3.1** Introduction to Biotechnology. **(1hr)**
- 3.2.** Recombinant DNA Technology, construction of chimeric DNA, Recombinant DNA technique for Human diseases, Isolation of cloned genes-copying mRNA to cDNA **(5 hrs)**
- 3.3** Applications of r-DNA technology, Nucleic acid sequence as diagnostic tool, metabolic engineering, and genetic changes for overproduction of biomolecules such as insulin, interferon and growth hormones **(5 hrs)**
- 3.4.** PCR- types of PCR- RT-PCR, Fluorescent PCR **(3hrs)**
- 3.5.** Primer designing and purification **(1hr)**
- 3.6.** Somatic cell hybridization and monoclonal antibodies **(4hrs)**

- 3.7. Gene therapy in human-history, different types germ line, zygote and somatic cell gene therapy, SCID (2 hrs)
- 3.8. Signal transduction pathway (4 hrs)
4. Bioinformatics (10 Hrs)
- 4.1 Overview, databanks, techniques of alignment, role of bioinformatics in the analysis of genomic information, genomics, proteomics (5 hrs)
- 4.2 Biological databases - Nucleic acid – GenBank, EMBL, DDBJ. Protein – Swissprot, TrEMBL. Structural – PDB. Submitting sequences to databases – BankIt, SequIn, WebIn, and Sakura. Sequence retrieval by Entrez. (5hrs)

References

1. Muller, Robert F and Young Ian D: Elements of Medical Genetics
2. Lewin Benjamin .(2008). Genes, Vol. IX.ed. Boston,Jones,Bartlet.
3. Dhatolkar AB: Elements of Biomedical Genetics.
4. Lynn B. Jorde and John C.Carvy: Medical Genetics
5. Jack Pastor Nack: Human Molecular Genetics
6. Mahesh ,S. and Vedamurthy: Biotechnology
7. Read Andrew *et al*: New clinical Genetics
8. Phadke Subha R: Genetics for clinicians
9. Gardner Mc Kinley *et al*: Chromosome abnormalities and genetic counselling.
10. Emery, A.E.H. and Rimoin, D.L. Principles and Practices of Medical Genetics Vol I, II & III. Churchill Livingstone.
11. William B. Coleman, Gregory J. Tsongalis.(2002) .The Molecular Basis of Human Cancer. .Humana Press, New Jersey .
12. 12 John Swansbury .(2003). Cancer cytogenetics - Methods and protocols. Humana Press ,New Jersey .
13. Jorde, L.B.; Carey, J.C., White, R.L.(2002). Medical Genetics. Mosby Press.
14. Verma, R.S. and Babu A. (1989). Human Chromosomes - Manual of basic Techniques. Pergamon Press.
15. Mitelman Karger. F. (1995). ISCN- An International System for Human Cytogenetic Nomenclature

THIRD SEMESTER PRACTICALS

SJZOL4L04 – IMMUNOLOGY

1. Study of cells of immune system.
2. Histology of organs of immune system.
3. Bleeding of animals and preparation of serum.
4. Separation of lymphocytes.
5. Demonstration of agglutination reaction.
6. Immuno-electrophoresis.
7. Demonstration of ELISA technique.
8. Production of antibodies.
9. Preparation of antiserum.
10. Titration of antiserum.

References

1. Talwar, G.P. and Gupta, S.K.(2002). A hand book of practical and clinical immunobiology. 2nd ed. CBS Publishers, India.
2. Wilson.K. and Walker,J. (1995). Practical Biochemistry- Principles and Techniques. Cambridge University Press.

THIRD SEMESTER PRACTICALS

SJZOL4L04- Developmental Biology & Endocrinology

1. Induced ovulation in fish.
2. Identification of different developmental stages of frog - Egg, blastula, gastrula, neurula, tadpole external gill and internal gill stage.
3. Vital staining of chick embryo.
4. Preparation of temporary/permanent whole mounts of chick embryo of the following stages to study the extent of development of the circulatory and nervous system in detail in 20, 24, 33, 48 & 72 hours of incubation.
5. Tracing the development of stained parts. Candling, identification of blastoderm, window preparation - staining using stained agar strips and following the development.
6. Preparation of stained temporary/permanent mounts of larvae.
7. Experimental analysis of insect development - *Drosophila*.
8. Regeneration studies in frog tadpole tail.
9. Demonstration of sperm of rat/calotes/frog.
10. Morphological and histological studies of different types of placenta in mammals.
11. Hormones in Amphibian metamorphosis - Thyroxine/Iodine solution.
12. Culture of early chick embryo in vitro.
13. Study of invertebrate/vertebrate larval forms (minimum 7).
14. Observation of the mid-sagittal sections and cross sections of the chick embryo through head/ heart region of 24, 48 & 56 hours of incubation.

References

1. Adamstone, E. B. and Waldo Shumway (1954). 3 Ed. A Laboratory Manual of Vertebrate Embryology. John Wiley & Sons, Inc.
2. Roberts Rugh (1961). Laboratory Manual of Vertebrate Embryology. Indian Ed., Allied Pacific Pvt. Ltd.
3. Browden, L. W., Erikson, C. A., and Jeffery, R. W. (1991). Developmental Biology. Ed., Saunders College Publi., Philadelphia.

4. Zarrow, M. X., Yochim, J. M., Mc Carthy, T. L. and Sanborn, R. C. (1964).
5. Experimental Endocrinology: A source book of basic Techniques. Academic Press, New York.
6. Thomas, J. A. (1996). Endocrine methods. Academic press, New York.
7. Humason, G. L. (1962). Animal Tissue techniques. W. H. Freeman & Co.

THIRD SEMESTER PRACTICAL ELECTIVE COURSE -HUMAN GENETICS PAPER 1

SJZOL4L05 - CLINICAL GENETICS

1. Sterilization, medium preparation.
2. Peripheral blood lymphocyte culture.
3. Banding - G banding, C banding, NOR banding.
4. Karyotyping and reporting- Normal, Down, Edward, Klinefelter, Patau, Turner.
5. Experiments with Spectrophotometer- blood urea, serum creatinine, BUN.
6. Study of hematological disorders- Bleeding time, Clotting time, Prothrombin time.
7. Detections of HbF, HbA.
8. Study of organ system diseases by charts, photographs etc.- Thalassemia, Hemophilia, DMD, Neurofibromatosis, Huntington's chorea, Pituitary dwarfism, Congenital adrenal hyperplasia.

COURSE OUTCOMES

SJZOL4C10- BIOTECHNOLOGY& MICROBIOLOGY

- Student gets an idea about cloning, probe preparation etc. and learns how to use the knowledge in biology as a tool in making new products using plants, animals and microbes; treatments like IVF, gene therapy, tissue replacement etc.
- Student gets the knowledge of microbes in various fields like agriculture (bioremediation, biocontrol, biofertilizers and GM crops), health care (vaccines administration), environmental (pollution control and waste management) and industry (dairy, food, distilleries)

FOURTH SEMESTER THEORY

SJZOL4C10- BIOTECHNOLOGY & MICROBIOLOGY (90 hours)

Part - A. BIOTECHNOLOGY (54 Hrs)

1. Introduction (1 hr)
Definition, branches, scope and importance
2. Vectors (5 hrs)
 - 2.1. Cloning vectors –
 - 2.1.1. Plasmids: pBR322 and pUC
 - 2.1.2. Phages: λ gt10 and M13 vector
 - 2.1.3. Cosmids: general features
 - 2.1.4. Phagemids: general features
 - 2.1.5. Viruses: SV40 and CaMV
 - 2.1.6. Transposones; Ac transposon and Ds transposon of Maize, P-element of *Drosophila*
 - 2.1.7. Artificial chromosomes: BAC, YAC and MAC.
 - 2.2. Shuttle vectors: applications and example
 - 2.3. Expression vectors: mention commonly used promoters in expression vectors (Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter of CaMV, Polyhedrin promoter from Baculovirus)
3. Different steps involved in *in vivo* cloning (3hrs)
 - 3.1. Construction of chimeric DNA (Blunt end ligation, cohesive end ligation, homopolymer tailing, use of linkers)
 - 3.2. Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization
 - 3.3. Amplification – Multiplication, Expression, and integration of the DNA insert in host genome
4. Molecular probes (3 hrs)
 - 4.1. Production
 - 4.2. Labelling
 - 4.3. Applications
 - 4.4. FISH, McFISH and GISH
5. Genomic and cDNA library (4 hrs)
 - 5.1. Construction
 - 5.2. Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity.(Refer unit 4-Molecular Biotechnology by Glick and Pasternak-ASM press)
 - 5.3. Blotting techniques- Southern blot, Northern blot, Western blot, Dot blot and Slot blot.
 - 5.4. Chromosome walking
6. Polymerase Chain Reaction (3 hrs)
 - 6.1. Basic PCR – raw materials and steps involved
 - 6.2. Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR
 - 6.3. Applications of PCR in Biotechnology and genetic engineering
7. Molecular markers: detection and applications (3 hrs)
 - 7.1. RFLP
 - 7.2. AFLP
 - 7.3. RAPD
 - 7.4. Minisatellites (VNTR)
 - 7.5. Microsatellites (SSR)
 - 7.6. SNPs

8. Isolation, sequencing and synthesis of genes (3 hrs)
- 8.1. Isolation (for specific proteins and tissue specific proteins)
- 8.2. DNA sequencing – Maxam and Gilbert’s chemical degradation method, Sanger’s dideoxynucleotide synthetic method.
- 8.3. Synthesis of gene-Chemical synthesis of tRNA gene, Synthesis of gene from mRNA, Gene synthesis machines
9. Transfection methods and transgenic animals (3 hrs)
- 9.1. Definition, Methods - Electroporation, DNA micro injection, Calcium phosphate precipitation, Dextran mediated transfer, shot gun method, virus mediated, lipofection method, engineered embryonic stem cell method
- 9.2. Transgenic animals for human welfare
10. Biotechnology - Animal and human health care (4 hrs)
- 10.1. Vaccines
- 10.2. Disease diagnosis
- 10.3. Gene therapy
- 10.4. Transplantation of bone marrow, artificial skin,
- 10.5. Antenatal diagnosis
- 10.6. DNA finger printing
- 10.7. Forensic medicine
11. *In vitro* fertilization (3 hrs)
- 11.1. *In vitro* fertilization and embryo transfer in human
- 11.2. *In vitro* fertilization and embryo transfer in live stock
12. Animal cell and tissue culture (3 hrs)
- 12.1. Culture media – natural and artificial
- 12.2. Culture methods – primary explantation techniques, various methods of cell and tissue culture
- 12.3. Tissue and organ culture
13. Gene Silencing techniques (2 hrs)
- 13.1. Antisense RNA
- 13.2. RNAi
- 13.3. Gene knockouts and Knock out mouse
14. Cloning- (2 hrs)
- 14.1. Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning) –
- 14.2. Advantages and disadvantages of cloning
15. Environmental biotechnology (3 hrs)
- 15.1. Pollution control – cleaner technologies, toxic site reclamation, removal of oil spill, reducing of pesticides and fertilizers, biosensors, biomonitoring.
- 15.2. Restoration of degraded lands - reforestation using micro propagation, development of stress tolerant plants
16. Agricultural Biotechnology (3 hrs)
- 16.1. Biofertilizers
- 16.2. Insect pest control (Pheromones, hormone mimics & analogues)
- 16.3. Biopesticides (Baculovirus, *Bacillus thuringiensis*, NPV)
16. Intellectual property rights (3 hr)
- 16.1. Intellectual property protection,
- 16.2. Patents, copy right, trade secrets, trademarks
- 16.3. GATT and TRIPS, patenting of biological materials,
- 16.4. International co-operation, obligation with patent applications, implications of patenting-current issues

- 17. The ethical and social implications - (3 hrs)**
- 17.1. Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants- Animals and ethics-
- 17.2. Release of GEOs-Use of herbicide resistant plants-Human genome alterations by biotechnology
- 17.3. Social acceptance of biotechnology-Transgenic crops - Social acceptance of medical biotechnology- Acceptance of GM crops for food and pharmaceutical production, Social acceptance of Industrial biotechnology.

Part-B-MICROBIOLOGY (36 Hours)

- 1. Introduction- (1 hr)**
- 1.1 History and scope of microbiology
- 1.2 Contributions of Louis Pasteur, Robert Koch, Alexander Flemming and Edward Jenner.
2. Microbial Taxonomy and Phylogeny (3 hrs)
- 2.1. Major characteristics (classic and molecular)
- 2.2. Numerical taxonomy
- 2.3. Taxonomic ranks
- 2.4. Phylogenetic studies
- 2.5. Phenetic classification
- 2.6. Bergey's Manuel (mention major groups)
3. Bacterial cell structure and function (5 hrs)
- 3.2. Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid
- 3.3. Bacterial cell wall Peptidoglycan - structure-
- 3.4. Gram positive and gram negative cell wall- Mechanism of gram staining
- 3.5. Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility
4. Microbial nutrition (4 hrs)
- 4.1. Nutritional requirements,
- 4.2. Nutritional types (Auto, Hetero, Chemo, Phototrophs & Obligate parasites)
- 4.3. Culture media and types of media.
- 4.4. Mixed microbial population and pure cultures.
5. Microbial growth (4 hrs)
- 5.1. Growth curve -synchronous growth
- 5.2. Continuous culture
- 5.3. Influence of environmental factors on growth
- 5.4. Measurement of growth
- 5.5. Measurement of cell numbers- Petroff, Hassuer counting Chamber, Spread plate and pour plate techniques
- 5.6. Measurement of cell mass-Turbidity and microbial mass measurement
6. Utilization of energy (3hrs)
- 6.1. Biosynthetic process-peptidoglycan synthesis, amino acid synthesis,
- 6.2. Non synthetic processes -Bacterial motility and transport of nutrients.(biochemical reactions not required).
7. Viruses (3 hrs)
- 7.1. General structural properties
- 7.2. Types: DNA viruses, RNA viruses, and enveloped viruses
8. Microbial diseases (4 hrs)

- 8.1. Human diseases caused by bacteria- Typhoid, Cholera, Tetanus, Leprosy, Tuberculosis and Pneumonia.
- 8.2. Human diseases caused by viruses- AIDS, Rabies, Measles, Swine Flu, Bird flu, SARS
- 8.3. Fungal diseases- Candidiasis
9. Control of microorganisms (4 hrs)
- 9.1. Disinfectants; A - physical- Heat, filtration and radiation. B- Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.
- 9.2. Antibiotics- Penicillin, Cephalosporins, Chloramphenicol, Tetracyclines
- 9.3. Microbial drug resistance.
10. Microbial fermentation (2 hrs)
- 10.1. Lactic acid fermentation - Homolactic and heterolactic fermenters, Mention dairy products -cheese and yogurt
- 10.2. Alcoholic fermentation.
11. Environmental microbiology (3 hrs)
- 11.1 Microbiological analysis of drinking water.
- 11.2. Microbial Bioremediation
- 11.3. Biogas plant.

References

Part- A- Biotechnology

1. Alphey - DNA sequencing-Bios Scientific publishers-
2. Bernard R. Glick and Jack J. Pasternak-Molecular Biotechnology-Principles and applications of recombinant DNA- ASM press Washington D.C.
3. Charles Hardin (2008): Cloning, Gene expression, and Protein purification- Experimental procedures and process rationale - Oxford University Press.
4. Chatterji, A.K.(2007). Introduction to environmental biotechnology-Prentice Hall of India
5. Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge University press.
6. Dale. J.W. and Malcom von Scantz. From genes to genome- Concepts and Applications of DNA Technology
7. Dominic, W.C. Wong-The ABCs of gene cloning-Springer international edition
8. Dubey, R.C. -A text book of biotechnology-S. Chand & Co.
9. Emmanuel. C., Rev. Fr. Ignacimuthu. S. and Vincent. S. Applied Genetics: Recent Trends and Techniques, MJP Publishers, Chennai
10. Gupta. P.K. -Elements of biotechnology-Rastogi publications.
11. Singh, B.D.(2002).Biotechnology-Kalyani publishers.
12. Sobti, R.C. and Suparna, S. Pachauri-Essentials of Biotechnology-Ane Books Pvt. Ltd.
13. Wilson and Walker (2008): Principles and techniques of Biochemistry and Molecular biology- Cambridge low price editions.
14. Ausubel, F.M., Brebt,R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith,J.A. and Struht,K.(2002). Short Protocols in Molecular Biology. John Wiley and Sons, Inc.
15. Alberts,B., Bray, D., Lewis, J., Raff., M, Roberts, K. And Watson, J.D. (2000). Molecular Biology of the cell. Garland Science, New York.
16. Brown .T.A. (2002).Genomes II ed. John Wiley and Sons, New York.
17. Freshney, Ian R.(2006). Culture of Animal Cell. 5thed. Wiley-Liss Publications.
18. Glick,B.R.and Pasternak, J.J.(1998). Molecular Biotechnology-Principles and Applications of Recombinant DNA.

Part B- Microbiology

1. Gandhi-Microbiology and Immunology notes and cases-Blackwell publishing
2. Hans G. Schlegel (2008): General Microbiology-Cambridge low price editions.
3. Chakraborty.P.A.(2009). Text Book of Microbiology. New Central Book Agency. New Delhi.
4. Arora, D.R. and Arora, B.(2008).Text Book of Microbiology. CBS Publishers& distributors. New Delhi.

5. Mansi. Fermentation, Microbiology and Biotechnology-Taylor and Francis
6. Pelczar, M.J, Chan, E.C.S. and Krieg, N.R.(1998)-Microbiology-TMH edition
7. Prescott, L.M., Harley, J. P. and Klein. D.A. (2008). Microbiology. 7th ed. McGraw- Hill Inc. New York.
8. Rao, A.S. - Introduction to microbiology-Prentice Hall of India.
9. Ingraham, J.L. and Ingraham, C.A.(2000).Microbiology. 2nd ed.Brooks/Cole-Thomson Learning, MA, USA.
10. Harvey, R.A.and Champe, P.A.(2001). Microbiology.Lippincott, Williams and Wilkins.
11. Harma, R. and Kanika,J.(2009). Manual of Microbiology.Tools and Techniques.Ane Books Pvt. Ltd, New Delhi.
12. Madigan, M.T., Martinko,J.M.and Parker, J.(2000).Biology of Micro organisms. Prentice Hall International Inc.
13. Talase, Park, Kathelee, N. and Talaro, Arthur.(2002).Foundations of Microbiology. McGraw Hill Higher Education, New York.
14. Wheelis, Mark (2010). Principles of Modern Microbiology. Jones and Barlett Publishers, New York.

COURSE OUTCOMES

SJZOL4E11- DIAGNOSTIC GENETICS

- This Paper helps to understand and aware on common genetic disorders and its diagnostic features, treatment methods etc. and give information about importance of genetic counseling and prenatal diagnosis.

FOURTH SEMESTER ELECTIVE COURSE-HUMAN GENETICS –II

SJZOL4E11- DIAGNOSTIC GENETICS (90 Hours)

1. Biochemical Genetics (25 hrs)

- 1.1. Inborn errors of metabolism -Definition and mode of inheritance
- 1.2. Disorders of carbohydrate metabolism- Galactosemia, essential fructosuria, fructose intolerance, glycogen storage disorders Mucopolysaccharides
- 1.3. Diseases of amino acid metabolism- Phenylketonuria, tyrosinosis, alkaptonuria, albinism, maple syrup urine disease, homocystinuria and histidinuria
- 1.4. Disorders of lipid metabolism- Tay Sach's disease, Goucher's disease
- 1.5. Disorders of nucleic acid metabolism- Primary gout, Leish nyhan syndrome
- 1.6. Mineral metabolism disorders- Wilson disease, Menkes disease
- 1.7. Disorders of porphyrins - inherited porphyrias
- 1.8. Peroxisomal disorders - Zellweger syndrome, X linked adrenoleukodystrophy

2. Developmental Genetics (25 hrs)

- 2.1. Human embryo development- Cleavage, 2 cells, 4 cells, 8 cells, 16 cells, 32 cells, Morula, Blastula, Gastrula, Organogenesis
- 2.2. Gonadal differentiation
- 2.3. Placental types, implantation, developmental features of human foetus- first lunar month to tenth lunar month First, second and third trimester
- 2.4. Formation of extra embryonic tissue
- 2.5. Study of human birth defects- Syndromology, Dymorphology, Neural tube defect, Anencephaly, Meningocele, Spina bifida, Herlequin ichthyosis

3. Reproductive Genetics (5 hrs)

- 3.1. Spermatogenesis, oogenesis
- 3.2. Computer Assisted Semen Analysis (CASA).
- 3.3. Assisted Reproductive Techniques (ART) IUI, IVF, ICSI, ZIFT, GIFT
- 3.4. Pre-implantation Genetic Diagnosis (PGD)

4. Molecular Diagnosis (15 hrs)

- 4.1. DNA fingerprinting.
- 4.2. Linkage analysis - RFLP, blotting techniques (southern, northern and western)
- 4.3. Gene sequencing
- 4.4. Probes- Preparation and classification, in-situ hybridization, FISH, mFISH, fiber FISH, application of FISH.
- 4.5. CGH, SKY, Micro array, Microchips, Comet assay

5. Prenatal Diagnosis. (20 hrs)

- 5.1 Historical perspective
- 5.2 Non-invasive techniques- Ultrasonography, foetal MRI
- 5.3 Invasive techniques- Amniocentesis, chorionic villus sampling, foetal skin sampling,
- 5.4 Chromosome analysis, metabolic disorders, DNA Analysis
- 5.5. Current knowledge of prenataly diagnosed genetic disorders, haemoglobinopathies, coagulation disorders.

5.6 Treatment of genetic disorders

References

1. Devlin, T.M. (1994): Text book of Biochemistry with clinical correlations (3rd edn.) Discovery School: Test Tube Babies –CD
2. Emery, A.E.H. and Rimoin D.L. (1983): Principles and Practice of Medical Genetics, Vol. II, Churchill Livingstone, Chap.99
3. Gardner: Principles of Genetics
4. Griffith, T., Miller, Suzuki. (2002): An introduction to genetic analysis. 7th edition, W.H. Freeman and Co. NY.
5. Griffiths, A.J.F., Gelbart, W.M., Lewontin, R.C. and Miller, J.H. (2002): Modern Genetics analysis, 2nd edition. W.H. Freeman and Co. New York.
6. Hawley, R Scott & Walker MY: Advanced Genetic Analysis Mange, Elaine, Johnson: Basic Human Genetics
7. P.F. Benson, Sna A.H. (1985): Fensom Genetic Biochemical Disorders, Oxford Monograph in Medical Genetics.
8. Pierce Benjamin: Genetics- A Conceptual Approach Purohit, S. S: Biotechnology
9. Scriver *et al.* (2002): The metabolic and molecular basis of inherited diseases. 8th edition, McGraw-Hill.
10. Stratchan, T. and Read, A.P. (2001): Human molecular Genetics. John Wiley, New York
11. Strickberger : Genetics
12. Sushama Bai, S: Clinical evaluation of Newborn Infants and Children
13. Tomarin Robert, H: Principles of Genetics
14. Turnpenny Peter D *et al*: elements of Medical Genetics
15. Vides Julio Collado: Gene Regulation and Metabolism
16. Weatherall, D.J. and Clegg. (1981): The Thalassemia Syndromes (Ed.3).

COURSE OUTCOMES

SJZOL4E12- CANCER GENETICS AND GENETIC SERVICES

- Student will be able to examine the significance of genetic role in the origins of cancer and discuss the application of its genetics and new genetic technologies to be used in management and treatment of this disease.
- This will increase their genetic counseling skills.

FOURTH SEMESTER THEORY
ELECTIVE COURSE - HUMAN GENETICS –III

SJZOL4E12 – CANCER GENETICS AND GENETIC SERVICES (90 Hrs)

1. Cancer Genetics (30 hrs)

- 1.1 Genetic basis of cancer: Neoplasms, Tumorigenesis, Apoptosis (2 hrs)
Classification, diagnosis, prognosis, treatment
- 1.2 Leukemia- ALL, CLL, AML, CML, Philadelphia chromosome, bcr-abl gene fusion, PML-RARA gene fusion (4 hrs)
- 1.3 Solid tumours: Breast cancer, prostate cancer, retinoblastoma, osteosarcoma, Two hit hypothesis (5 hrs)
- 1.4 Reticulo-endothelial system: lymphomas- Burkitt, Non- Hodgkin lymphoma, Multiple myeloma (3 hrs)
- 1.5 Oncogene families: Cancer causing genes, Tumor suppresser genes, Protooncogene, DNA repair gene. Mechanism of oncogene expression, over expression of oncogenes, cellular oncogene producers. (8 hrs)
- 1.6 Telomeres and Telomerases- Introduction and function of telomeres and telomerases, steps involved, DNA repair and damage. Regulation of telomere length, genetic disorders and telomeres (Progeria, Ataxia Telangiectia) (3 hrs)
- 1.7. Genomic instability and cancer. Mutation rates in normal and neoplastic cells, mutation and genomic instability, common DNA damaging agents (environmental, chemical, physical, biological). Chemotherapy and mechanism of anticancer drugs. (5 hrs)

2. Genetic Counseling (15 hrs)

- 2.1 Definition, Indication for genetic counseling, Steps in genetic counseling (5 hrs)
- 2.1 Premarital genetic counseling (3 hrs)
- 2.2 Psychological aspects of genetic counseling, Special considerations in genetic counseling (4 hrs)
- 2.3 Pre-natal counseling and Population screening (3 hrs)

3. Genetic engineering (10 hrs)

- 3.1 Introduction- Molecular tools of genetic engineering (1 hr)
- 3.2 Vectors- methods of gene transfer (2 hrs)
- 3.3 Gene cloning strategies- DNA amplification, Gene libraries, site `directed mutagenesis, and protein engineering- manipulation of gene expression in host . (4 hrs)
- 3.4. Basic techniques in genetic engineering (2 hrs)
- 3.5. Agarose gel electrophoresis, Counter clamped homogenous electric field electrophoresis (CHEF), PAGE, SDS – PAGE (1 hr)

4. Gene Mapping and cloning (5 hrs)

- 4.1 Physical mapping, gene mapping, linkage analysis, recombination frequencies, LOD score, linkage equilibrium, linkage disequilibrium (2 hrs)
- 4.2 Human Genome Project: Objectives, achievements and applications Positional cloning, Sequence tagged sites, Genomic library. (2 hrs)
- 4.3 Chromosome walking, chromosome jumping (1 hr)

5. Ethics (10 hrs)

- 5.1 Medical ethics in India and Abroad (2 hrs)
- 5.2 Organ banks, human cloning, genetic registries (2 hrs)
- 5.3 IVF ethics (3 hrs)
- 5.4 PND act, MTP act (2 hrs)
- 5.5 ELSI of new genetics (1 hr)

6 Immunogenetics (5 hrs)

- 6.1 Major Histocompatibility Complexes - General organization of MHC and disease association. (1 hr)
- 6.2 Blood group system- Genetics of ABO and Rh factor, Rh incompatibility (1 hr)
- 6.3 Immune system in health and diseases-Immune response to infectious disease, Primary and secondary deficiencies, autoimmunity, SCID, Wiskott Aldrich syndrome, Agamaglobulinemia (3 hrs)

7. Radiation Genetics (5 hrs)

- 7.1 Biological effect of radiation, dosimetry 2hrs
- 7.2 Radiation sensitizers, radio protectors and other factors. Radiation protection – radiation safety, maximum permissible doses. Clinical applications of radiation biology – in therapeutic radiology, diagnostic radiology and nuclear medicine. (3 hrs)

8. Population Genetics (10 hrs)

- 8.1 Twin studies (1 hr)
- 8.2 Dermatoglyphics- qualitative and quantitative parameters. Dermatoglyphics in medical disorders (2 hrs)
- 8.3 Epidemiology- descriptive and analytical methods (3 hrs)
- 8.4 Hardy Weinberg equilibrium- Properties of equilibrium populations Selection favouring and against heterozygotes (2 hrs)
- 8.5 Non random mating in human populations- consequences of inbreeding, Genetic load (2 hrs)

References

1. Brown, T. A. (1995). Gene Cloning –3rd Ed, Chapman and Hall publications.
2. Primrose, S., Twyman, R. and Old, B. (2001)-. Principles of Gene manipulation 6th Edition Blackwell Scientific Publication.
3. Sambrook J. *et al* (2000).Molecular Cloning – A Laboratory Manual Cold-Spring Harbor Lab Press.
4. Stefan Suzycki.(2003). Human Molecular Biology-A Laboratory Manual Black Well Publishing Company.
5. Campbell, A.M. and Heyercold,L.J.(2002). Discovering Genomics, Proteomics and Bioinformatics. Spring Harbor Lab Press.
6. Arthur M.Lesk (2002) – Introduction to Bioinformatics – Oxford University press.
7. Andreas D.Baxevas and Francis Ouellette, B.F. (2001) – Bioinformatics – John Wiley & sons.
8. Mount (2001) – Bioinformatics – Cold Spring Harbor Laboratory Press.
9. Kilbey *et al*.(1984). Handbook of Mutagenicity test procedures. Elsevier , Amsterdam.
10. Venitt, S and Parry, J.M. (1984). Mutagenicity testing- A practical approach, IRL Press.
11. Umadevi. P, Nagarathnam. A and Satish Rao. B.S.(2000). Introduction to radiation biology. Churchill Livingstone, Pvt. Ltd., New Delhi.
12. Tubiana. M, Dutereix. J, and Wambersie. A .(1990). Introduction to Radiobiology. Taylor & Francis, London, NY.
13. Obe. G and Natarajan. A.T. (1994). Chromosomal Alterations – Origin and significance, springer – verlag, Berlin, Heidelberg.
14. A.E.H. Emery and D.L. Rimoin: Principles and Practice of Medial Genetics, Vol. III, Churchill Livingston,
15. Kowles Richard: Solving Problems in Genetics
16. Banerlee Pranab Kumar: Problems in Genetics, Mol. Genetics and evolutionary Genetics

17. Xion Jin: Essential Bioinformatics
18. Harper Joyee C: Preimplantation GeneticDiagnosis.
19. Harper Peter S: Practical Genetic Counseling

FOURTH SEMESTER PRACTICALS

SJZOL4L04 BIOTECHNOLOGY

1. Isolation of plasmid DNA.
2. Isolation of total RNA from tissues
3. Separation of DNA by electrophoresis.
4. Bacterial transformation.
5. PCR
6. Cell immobilization.

SJZOL4L04 – MICROBIOLOGY

1. Selective isolation and enumeration of bacteria.
2. Bacterial staining technique
 - a. Simple staining of bacteria.
 - b. Negative staining
 - c. Hanging drop technique.
 - d. Gram staining.
 - e. Endospore staining.
3. Turbidity test for contamination of milk.
4. Preparation of media and sterilization.eg: Nutrient agar, mac conkey agar,
5. Cultivation of yeast and molds
6. Bacteriological analysis of water e.g., fecal pollutants.
7. Antibiotic sensitivity test.
8. Maintenance of *E. coli* culture (shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.

SJZOL4L04 - MICROTÉCHNIQUE AND HISTOCHEMISTRY

1. Preparation of stained and unstained whole –mounts.
2. Identification of the various tissues of animals in serial sections prepared using nuclear and cytoplasmic stains.
3. Processing a few types of tissues for the histochemical staining-Staining of serial sections to show the presence of
 - a) Carbohydrates by PAS method
 - b) Proteins by Mercuric bromophenol blue method
 - c) Fats by Sudan Black B method
 - d) DNA by Feulgen Technique.

Submission:

Stained/unstained Whole mounts	– 4 numbers
Double stained serial histology slides	- 4 numbers
Histochemical slides	- 2 numbers

References

1. Ausubel, F.M., Brebt R, Kingston, R.E., Moore, D. D., Seidman, J. G., Smith, J.A. and Struht, K. (2002): Short protocols in Molecular Biology. John Wiley & Sons, Inc.
2. Sambrook, J. & Russel, D.W.(2001): Molecular cloning: A laboratory Manual. CSHL Press, NY
3. Kannan, N.(2003). Lab Manual in General Microbiology. Panima Publishing Company,India.
4. Cappuccino,J.G. and Sherman,N. (2007). Microbiology-A laboratory Manual Benjamin- Cummings Publishing Company.USA.

HUMAN GENETICS -II

SJZO 4 EP 05 - DIAGNOSTIC GENETICS

(Practical classes to be conducted during fourth semester)

1. Clinical tests for inborn errors of metabolism
2. Urine spot test for Mucopolysaccharides
Urine spot test for Cystinuria and Homocystinuria
3. Lysosomal Enzyme assays (Arylsulfatase A and B)
4. Estimation of serum cholesterol, proteins, triglycerides, lipids
5. Stages of human development-
(Demonstration with video of with slides, models or charts, visits to labs
Cleavage, 2 cells, 4 cells, 8 cells, 16 cells, 32 cells, Morula, Blastula, Gastrula,
Organogenesis
6. Developmental features of human fetus- first lunar month to tenth lunar month
7. Human birth defects- Spina bifida, Meningocele, neural tube defect
8. ART- IVF, ICSI, GIFT, ZIFT, Semen analysis
9. PGD- FISH, PCR based analysis
10. Amniocentesis, CVS - demo by video

References:

1. Devlin, T.M. (1994): Text book of Biochemistry with clinical correlations (3rd edn.).
2. Emery, A.E.H. and Rimoin, D.L. (1983): Principles and Practice of Medical Genetics, Vol. II, Churchill Livingstone, Chap.99.
3. Weatherall, D.J. and Clegg. (1981): The Thalassaemia Syndromes (Ed.3)

FOURTH SEMESTER PRACTICALS ELECTIVE
COURSE - HUMAN GENETICS – III

SJZOL4L06 - CANCER GENETICS AND GENETIC SERVICES

1. Problems in genetic counseling
2. Agarose gel electrophoresis
3. Preparation of human genomic DNA
4. Blood grouping and cross matching
5. Experiments with PCR
6. Estimation of CA/MN on cells
7. SCE, Micro Nucleus Assay
8. Study of Ph1 chromosome, FISH in genetics, bcr-abl gene fusion, PMLRARA fusion
9. Qualitative and quantitative analysis of Ig., ELISA, Western blotting.
10. Experiments with ELISA Reader- FSH, LH, T3,T4,TSH, Testosterone
11. Study of radiation induced chromosomal aberrations
12. Study of dermatoglyphic features
13. Calculation of gene frequencies of dominant and recessive autosomal alleles.

THIRD SEMESTER AND FOURTH SEMESTER PRACTICALS

SJZOL4L04- IMMUNOLOGY, DEVELOPMENTAL BIOLOGY, ENDOCRINOLOGY, BIOTECHNOLOGY, MICROBIOLOGY, AND MICRO TECHNIQUES

- Recall advanced knowledge of the underlying principles of immunology and its application in solving problems in biological systems.
- Approach experimentally to the study of embryonic development and the characteristics of the principal experimental models.
- Have an awareness of some current research activities in the field and possible applications of this knowledge.
- To create general practical understanding about microorganisms (students will be familiar with microbial culturing).
- To inform students about the different histological tools & techniques
- To be able to describe the preparation of permanent slides of animal tissues.
- To be able to describe the methods of whole mount and maturation.
- To be able to explain the principles of histochemistry.

SJZOL4L05-HUMAN GENETICS I & II

After completion of the course the candidate should:

- Understand, and perform, the important methods in genetics.
- Differentiate between normal and abnormal karyotyping

SJZOL4L06– HUMAN GENETICS III

- Understand the genetic approach used in research relevant for understanding the diagnosis of human diseases
- Comprehensive, detailed understanding of the heredity via pedigree analysis.
- Comprehensive and detailed understanding of genetic methodology and how quantification of heritable traits in families and populations

SJZOL4P07- Project Work

- Formulate and carry out independent and collaborative research projects
- Students will be able to demonstrate the objective, methods, results and conclusions of a research project.
- Students will use techniques to plan and carry out experiments.
- They will generate and test hypotheses, analyze data using statistical methods where appropriate, and appreciate the limitations of conclusions drawn from experimental data.
- Students will analyze primary literature. This will include evaluation of experimental techniques
- Critically analyze experimental data.
- Students will construct a research thesis, and present the results of that thesis to an audience of peers and faculty at regional or all college events, and be able to defend their results to other students and faculty.
- Provide an introduction to preparing scientific reports and documents.

SJZOL4V08- Viva Voce

- Students will be able to recollect all knowledge gathered during their course and canasses themselves
- Provide a platform to face questions critically.