VIMALA COLLEGE (AUTONOMOUS)

(NAAC Re-accredited (3rd Cycle): A Grade, CGPA-3.50**)**
Affiliated to University of Calicut

MSc. DEGREE PROGRAMME IN

ZOOLOGY

UNDER CHOICE BASED CREDIT SEMESTER SYSTEM
(CBCSS PG – 2020)

SCHEME AND SYLLABUS

2020 ADMISSION ONWARDS

CURRICULUM AND SYLLABUS FOR CHOICE BASED CREDITSEMESTER SYSTEM (CBCSS -2019) M. Sc. ZOOLOGY COURSE w.e.f. 2020 ADMISSION

FIRST SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL1C01- Biochemistry and Cytogenetics	4	30	5
ZOL1C02- Biophysics and Biostatistics	4	30	5
ZOL1C03- Ecology and Ethology	4	30	5

SECOND SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL2C04- Physiology	4	30	5
ZOL2C05- Molecular Biology	4	30	5
ZOL2C06- Systematics and Evolution	4	30	5

FIRST & SECOND SEMESTER- PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL2L01- Biochemistry, Biophysicsand Biostatistics	4	30	5
ZOL2L02- Physiology, MolecularBiology and Cytogenetics	4	30	5
ZOL2L03- Ecology, Ethology,Systematics and Evolution	4	30	5

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
ZOL3C07-Immunology	4	30	5
ZOL3C08- Developmental Biology andEndocrinology	4	30	5
ZOL3E09- Classification and structural organization of animals.	4	30	5

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
ZOL4C10- Biotechnology andMicrobiology	4	30	5
ZOL4E11- Cellular Physiology	4	30	5
ZOL4E12 - Advanced Physiology and Developmental Biology	4	30	5

THIRD AND FOURTH SEMESTER PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL4L04-Immunology, Developmental Biology, Endocrinology, Biotechnology,Microbiology & Microtechnique	4	30	5
ZOL4L05 - Classification and Structural organisation of animals and Cellular Physiology	4	30	5
ZOL4L06- Advanced Physiology and Developmental Biology	4	30	5

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		

1. Practical examination shall be conducted at the end of the second and fourth semesters.
2. 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 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.
3. Weightage for each core and elective theory courses shall be 30 for the external examination and 5 for the internal theory examination.
4. Weightage for each core and elective practical course shall be 30 for the external examination and 5 for the internal core and elective practical examination.
5. Theory examination question paper shall contain 14 short answer questions with

weightage1 each, 7 short essay questions with weightage 2 each and 2 essay questions with weightage 4 each.

6. Weightage for the **external practical examination** can be distributed as follows:

With submission Weightage

Major question (1 number)	14
Minor question (2 numbers)	2x5=10
Spotters (2 numbers)	2x1=2
Submission (slides)	2
Record	2
Total	30

Without submission Weightage

Major question(1number)	14
Minorquestion(2numbers) 2x5=10	
Spotters(4numbers)	4x1=4
Record	2
Total	30

7. No submission is required for the practical in elective course, unless mentioned insyllabus.

8. A candidate has to submit the following at the time of practical examination -

ZOL4L04Whole 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 beawarded.

10. Project report shall be presented using power point option. Credit given for project is limitedto maximum 4 and project and general viva-voce is limited to4.

11. A minimum of two test papers for each course have to be conducted and the average shall becounted for internal evaluation in eachsemester.

12. One seminar for each course is compulsory.

Criteria for the evaluation of dissertations	**Weightage**
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 componentinvolved.

1. Ability enhancement course (AEC) – (In the Isemester)

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

2. Professional Competency Course (PCC) (In the IIsemester)

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

MODEL QUESTION PAPER

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

Branch: Zoology
Course Code**:** Course Name

Time: 3hrs MaximumWeightage: 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 4 of the following (Long essay type questions) (Weightage-5).

15.
16.
17.
18.
19.

2 x 5 = 10

PROGRAMME SPECIFIC OUTCOMES

PSO1	Understand the various biochemical aspects of cell including molecular level regulation
PSO2	Analyse the developmental stages of organisms connecting their physiological reactions and immunological advancements
PSO3	Interpret the various interactions on ecological and ethological level; assess and classify them with biostatistical methods
PSO4	Identify and evaluate the growth and developmental aspects of microbes and utilize them in biotechnology through biophysical methods
PSO5	Develop knowledge on organisms by understanding their general organization and taxonomic status.
PSO6	Understand the concept of cellular physiology and advancements in physiology and developmental biology

FIRST SEMESTER THEORY COURSE

Course: ZOL1C01, Biochemistry & Cytogenetics
Credits: 5L: 2P

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions (appr.)	Lab (Hrs)
CO1	Analyse and understand the chemistry and functions of biomolecules	PSO1	R, U	F, C	3 3	40
CO2	Understand the metabolism and biosynthesis of biomolecules	PSO1	R,U	F, C, P	21	10
CO3	Understand the basic cellular, molecular and genetic concepts of development.	PSO1	U	FC P	30	10
CO4	Understand the structural organization and function of intracellular organelles	PSO1	R,U	F,C,P	6	
Total Hours of instruction					90	60

R-remember, U-understand

***F-factual, C-conceptual**

***P-practical/procedural**

FIRST SEMESTER THEORY

ZOL1C01 - BIOCHEMISTRY AND CYTOGENETICS (90 hrs)

Part A. Biochemistry (54 hrs)

1. Chemistry and functions of Biomolecules- Introduction (2 hrs)

1.1 Macromolecules and their subunits

1.2 Chemical bonds of biomolecules (Covalent and Non-covalent bonds)

2. Carbohydrates (8hrs)

2.1 Classification of carbohydrates with examples –

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

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

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

2.2 Biological roles of monosaccharides.

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

2.4 Hompolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulinand chitin

2.5 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

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

3.2 Amphoteric properties of amino acids

3.3 pK value and Isoelectric point (pI) of amino acids

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

3.5 Structure of protein

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

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

3.7 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, assignals, 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 - Genevan 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

6. Enzymes (7 hrs)

6.1 Classification- (I.U.B. system)

6.2 Mechanism of enzyme action: Formation of enzyme substrate complex- Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Factors influencing enzymeaction

6.3 Enzyme kinetics - Michaelis-Menten equation - derivation; significance of Km and VmaxValues. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.

6.4 Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition (distinguishkinetically), suicide inhibition and feedback inhibition

6.5 Classification, Structure and functions of Vitamins.Vitamins as co-enzymes.

7. Bioenergetics (2 hrs)

7.1 Laws of thermodynamics and biological system- Enthalpy, Entropy, Free energy concept .

7.2 Energy of activation, Standard free energy change.

7.3 Role of ATP as a free energy carrier in the biological system.

8. Metabolism and biosynthesis of biomolecules

8.1 Carbohydrate metabolism (8 hrs)

a. Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate ofpyruvic acid

b. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenasecomplex

c. Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotichypothesis; inhibitors of electron transport chain

d. Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis andbreakdown .

e. Pentose phosphate pathway (HMP pathway) and its significance

f. Uronic acid pathway

8.2 Amino acid metabolism (4 hrs)

a. 2.1 Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine, methionine,tryptophan, isoleucine, histidine, valine.

b. Fate of amino acids in the body

c. Transamination, Decarboxylation and deamination reactions in the biological system.

8.3 Lipid metabolism (5 hrs)

a. Oxidation of fatty acids

b. Biosynthesis of fatty acids

c. Biosynthesis of cholesterol

8.4 Nucleic acid metabolism (4 hrs)

a. Biosynthesis and degradation of purines and pyramidines

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. Molecularmodels 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)

3.1 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 andrepetitive DNA

4.2 Chromosomal changes- euploidy, aneuploidy, chromosomal aberrations- Structural alterations- gene mutations- molecularchanges- 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, maternalinheritance.

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 andhemidesmosomes.

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

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Cytogenetics

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9. Robert H. Tamarin (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi.
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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: ZOL1C03, Biophysics and Biostatistics
Credits: 5L:1P

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions(appr.)	Lab (Hrs)
CO1	Observe and understand the matter and mechanism of cells and study offunctional systems, structural rganization and physical basis of sound transmission in the ear	PSO4	R,U	F, C,	12	4
CO2	Observe and understand the workingprinciple of different Separation techniques, biophysical methods, electrophysiological methods and microscopy	PSO4	R,U	F,C,P	28	15
CO3	Analyse and understand the applications of biostatistics in research and study about the varioustype of statistical methods	PSO4	U	F,C, P	35	16
CO4	Understand the basic concept of gravitation force, nanotechnologyand radiation biology	PSO4	R,U	F,C	15	
Total Hours of instruction					90	35

***R-remember, U-understand**

***F-factual, C-conceptual**

***P-practical/procedural**

FIRST SEMESTER THEORY

ZOL1C02 – 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)

3.1Dissociation 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 organsystem level, effects of whole body irradiation-Radiation therapy.

5.4 Biological applications of radioisotopes.

5.6 Radiation dosimetry- dose units and dose measurement.

5.7 Radiation Detectors – GM Counter, Solid and Liquid Scintillation Counter, Proportionalcounter, Semiconductor detectors.

5.8 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

9.2 Column chromatography

9.3 Paper chromatography

9.4 Thin- layer chromatography

9.5 Gel-filtration.

9.6 Gas chromatography,

9.7 Affinity chromatography,

9.8 HPLC

9.9 Electrophoresis

9.10 Paper electrophoresis

9.11 Disc electrophoresis

9.12 PAGE, Two dimensional PAGE, Highvoltage Electrophoresis

9.13 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 Force 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 andcontinuous 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

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

7.3 Beta diversity

7.4 Morisita Horn index, Sorenson index, Bray-Curtis similarity

References

Biophysics

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18. Nagini.S (2009)- Instant Biochemistry-Ane Books Ltd.
19. Roy, R.N (1996)-A text book of Biophysics-New central book Agency Calcutta.
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21. Subramanian.M.A. (2005). Biophysics: Principles and Techniques.
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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 Stongtton, London.
3. Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
4. Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ikas 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 InternationalEdition
8. Zar, J.H. (2003) Biostatistical Analysis - Fourth edition. Pearson Education. New Delhi.

Course: ZOL1C03, Ecology and Ethology

Credits: 5L: 0T:2P

	Course Outcome	Os/ PSOs	CL	KC	Class Sessions (appr.)	Lab (Hrs)
CO1	Analyse and understand the natural history of Indian subcontinent, various terrestrial biomes, biogeographical zonesand island biogeography	PSO3	R,U	F,C	16	
CO2	Understand the basic conceptsand levels of organisation in ecology	PSO3	R,U	F, C,P	49	40
CO3	Study of animal behaviour andits evolution	PSO3	R,U	F,C,P	22	
CO4	Observe and understand social behaviour of termites andprimates	PSO3	R,U	F,C,P	3	20
Total Hours of instruction					90	60

***R-remember, U-understand**

***F-factual, C-conceptual**

***P-practical/procedural**

FIRST SEMESTER THEORY

ZOL1C03 - ECOLOGY AND ETHOLOGY (90 Hours)

Part-A-Ecology (54 hrs)

1. Introduction (3hrs)

1.1 Habitat and niche

1.2 Concept of habitat and niche

1.3 Niche width and overlap

1.4 Fundamental and realized niche

1.5 Resource partitioning

1.6 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, indirectand remote observations

3.3 Sampling methods in the study of behaviour, habitat characterization

3.4 Ground and remote sensing methods

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

3.6 Growth and regulation of human population

4. Species interaction (5 hrs)

4.1Types of interactions, interspecific competition

4.2Herbivory, 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.

5.3Species 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)

8.1 describe different biogeographical zones of India

(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) Coastalzone; (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 driversof 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 normalstimuli, stimulus filtering.

2.3 Concepts of Fixed Action Patterns (FAP), Innate Releasing Mechanism(IRM), ActionSpecific 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.

7. External stimulus - circadian rhythms (3 hrs)

7.1 Proximate and Ultimate factors.

7.2 Types of orientation-reafference theory of Von Holst & Mittel Steadt.Navigation & migration

8 Parental care – (6 hrs)

8.1 Mating systems, Parental investment and Reproductive Success.

8.2 Development of behavior.

8.3 Social communication; Social dominance; Use of space and territoriality; domestication andbehavioural changes; Social behaviour of termites & Primates;

9 Evolution and advaptiveness of behaviour (4 hrs)

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

10 Hormones and Behaviour- (5 hrs)

10.1 Hormones of gonads, adrenal gland, Pituitary gland,-Hormonal effects on different behaviouralpatterns, Maternal behavour- 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 andenvironmental 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-BlackwellScience,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 priceeditions
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
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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 PublishingCompany, Inc., 1975.

Ethology

1. Chris Barnard (2003): Animal Behaviour: Mechanism, Development, Function andEvolution, 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 UiversityPress.

4. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. JohnWiley 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.
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10. Scott, J.P. (1972) Animal Behaviour. Publisher: Univ of Chicago.

FIRST SEMESTER PRACTICALS

ZOL2L01 - 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)

a) Identification of unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose,Dextrin & Starch) by suitable tests.

4. Quantitative estimation of carbohydrates
    a) Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O-Toludinemethod)
    b) 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 froma 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 monoxine 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

ZOL2L02 - 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’ and Edwar’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.
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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 PublishingHouse, 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.

ZOL2L01 - 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 usinga colorimeter.
7. Absorption spectrum and a 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 piediagrams. (prepare the same graph in Excel and keep print out)
3. Graphic presentation of population distribution in the form of histogram, frequencypol,ygon and frequency curve. (Prepare the same graph in Excel and keep print.
4. Computation of measures of central dispersion anthropometric data of Schoolchildren.(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 nearbycampus) (prepare printouts 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. Gassey, 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.

ZOL2L03 - ECOLOGY AND ETHOLOGY

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.

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 Aerry, 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 Wileyand 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.
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6. Michael, P.(1984). Ecological methods for field and laboratory investigations. Tata McGraw Hillpublishing 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.4thed. Inc. Tata McGraw Hill publishing co.

Course: ZOL2C04,
Physiology
Credits: 5L:0T:2P

	Course Outcome	**POs/ PSOs**	**CL**	**KC**	**Class Session**	**Lab (Hrs)**
CO1	Interpret and analyse nutrition andutilization of energy from biomolecules	PSO2	R,U	F, C,	12	
CO2	Study of functional systems and disorders of nervous and cardiovascular systems	PSO2	R,U	F,C,P	56	50
CO3	Understand the structure and functions of sense organs	PSO2	U	F,C, P	17	
CO4	Understand the thermoregulation mechanisms and acclimatization	PSO2	R,U	F,C	5	
Total Hours of instruction					90	50

***R-remember, U-understand**

***F-factual, C-conceptual**

***P-practical/procedural**

SECOND SEMESTER -THEORY

ZOL2C04 - PHYSIOLOGY

(90 Hours)

1. Nutrition(10hrs)

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 anddefecation.

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 animalgroups (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, gillsand 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 (PO_2, PCO_2, CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin andalso myoglobin).

3.9 Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

4. Nervous system (21 hrs)

4.1 Organisation of human brain.

4.2 Cerebrum and cerebral lobe.

4.3 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 .

4.4 Cortical white matter- commissures, association fibers, projection fibers, corpus callosumand fornix, basal nuclei-organisation and function.

4.5 Brain stem- organisation and function.

4.6 Cerebellum- structure and function.

4.7 Diencephalon – organisation and function.

4.8 Functional brain systems - Limbic system and reticular formation.

4.9 Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brainbarrier and its function.

4.10 Diseased states of brain - schizophrenia, Alzheimer's disease, Senile dementia & Parkinso'sdisease.

4.11Memory- definition, types of memory- short term, intermediate long term and long termmemory, consolidation of memory.

4.12 PNS and Autonomic nervous system.

4.13 Spinal cord – structure.

4.14 Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex andgolgi tendon organ.

5. Special senses (16 hrs)

5.1 Vision:

Structure of eyeball

- Fluid systems of the eye
- Layers of Retina and photoreceptors (rods & cones)
- Brief notes on the neuronal cell types and neural circuitary of the retina and visualpathways from retina to visual cortex
- Image formation
    - Formation of image on the retina.

A brief general account of electrophysiology of vision

Photochemistry of vision & colour vision

5.2 Taste:

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

5.3 Smell:

- Olfactory membrane and receptor cells
- Physiology of olfaction (stimulation of olfactory cells and transmission of smell signalsto CNS)

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

6.1 Mechanoreceptors and their stimulation

6.2 Pain receptors and their stimulation

6.3 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 fluidprotein concentration, interstitial fluid volume and interstitial fluid pressure.

9. Environmental Physiology (4 hrs)

9.1 Thermal regulation.

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

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

References

1. Arthur C.Guyton & John E. Hall (2003): Textbook of Medical Physiology, Saunders (An imprint ofElsevier).
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.Sauders 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 UniversityPress.
8. Jensen D. (1976): Principles of Physiology, Appleton Century Crafts, N.Y.
9. Lonco,G.N.(1993):PhysiologicalAnimalEcology.Longman Scientific and Techhnical Essex.
10. Oser,B.L.-(1965).Haw‟s Physiological chemistry. Tata McGraw Hill Pub. Co. New Delhi.
11. 11.Shepherd, G.M: Neurobiology-Principles of Neural Science, E. Kandel & P. Schwartz.
12. Campbell *et al*. (1984): Clinical Physiology, 5th Edn. Blackwall Scientific Publications, Oxford.
13. Pragnelli,C.V& Farhi, L.E. (1989): Physiological function of special Environment-Springerverlag,N.Y.
14. Davie IV & Lewid S.M.- Practical Haematology, 6th Edn. Churchill, Livingstone, Edinburgh.

Course: ZOL2C05, Molecular biology
Credits: 5L:0T:1P

	Course Outcome	**Os/ PSOs**	**CL**	**KC**	**Class Session (appr.)**	**Lab (Hrs)**
CO1	Explain replication, transcription and translation of genetic material	PSO1	R,U	F, C,P	50	
CO2	To study the role of gene families and transposable genetic elements	PSO1	R,U	F, C,P	12	
CO3	Understand eukaryotic and organelle genome	PSO1	U	FC P	13	10
CO4	Understand the molecular mechanism involved in eukaryotic genome and cancer	PSO1	R,U	F,C,P	15	
Total Hours of instruction					90	10

***R-remember, U-understand**

***F-factual, C-conceptual**

***P-practical/procedural**

SECOND SEMESTER

ZOL2C05 - 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,

1.5 Single strand binding proteins, Topoisomerases and Ligase;

1.6 Fidelity of replication

1.7 Replication of the ends of eukaryotic chromosome – role of telomerase

1.8 Models of DNA replication –Rolling circle model and looped rolling circle model, D-loop model, θ-model.

1.9 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:

a. Major kinds of damage to DNA and causes

b. 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 organization and life span of mRNA; monocistronic and polycistronic mRNA

3.2 Transcription in prokaryotes and eukaryotes

3.3 Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites

3.4 Transcription factors; Transcription activators and repressors

3.5 Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions

3.6 Post transcriptional modification of RNA

a) Capping
b) Polyadenylation
c) Splicing

3.7 RNA editing: site specific deamination and role of gRNAs

3.8 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 Composition

5.1 Reconstitution experiments

5.2 Active centrecenters

5.3 Biogenesis of ribosome in eukaryotes

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

6.1 Aminoacylation of tRNA & initiation, elongatio,n 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- taranslational modification of proteins: protein folding (role of chaperones) andbiochemical 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 controlof lytic and lysogenic cycle in λ phage

7.2 Regulation of gene expression in bacteria – basic features of tryptophan, arabinose andgalactose 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

8.5Organisation of human genome (brief account)

9.Interrupted genes (4 Hrs)

9.1Definition and explanation

9.2Organisation and special features of interrupted genes

9.3Evolution of interrupted genes

10.Gene families: (6 Hrs)

10.1 Definition and concept

10.2 Classification with example

10.3 Simple multigene family - organisation of rRNA gene in *Xenopus*

10.4 Complex multigene family – organisation of histone genes in sea urchin and tRNA genes in *Drosophila*

10.5 Developmentally controlled complex multigene family e.g., globin gene

a) Globin genes and its products
b) Organisation of globin genes and its expression in Man
c) Evolution of globin genes

10.6 Concept of an evolutionary clock

10.7 Pseudogenes

11.Transposable genetic elements - Transposons (6 Hrs)

11.1Definition, features and types

11.2 Transposition and mechanism

11.2.1 Transposons in bacteria

11.2.2 IS elements

11.2.3 Tn family

11.2.4 Mu phage as a transposable element

11.3 Transposons in eukaryotes

11.3.1 SINE, Alu family; LINE, L1

11.3.2 P elements in *Drosophila*

11.3.3 Transposons in Maize

11.4 Retroviruses and transposition

12 Molecular mechanisms involved in recombination of DNA: (5 Hrs)

12.3 Genetic recombination – types with example

12.3.1 Site specific recombination

12.3.2 Non-homologous recombination

12.3.3 Homologous recombination

12.4 Molecular mechanism involved in homologous recombination of DNA in eukaryotes-Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion

12.5 Role of Rec A protein in genetic recombination

13 Microbial genetics (5 Hrs)

13.1Prokaryotic genome- *Escherichia coli* genome – basic features

13.2Methods of genetic transfers in bacteria– transformation (in *Streptococcus pneumonia*),conjugation and sexduction, transduction

13.3Brief note on mapping genes by interrupted mating (in bacteria)

14 Organelle genome (4 Hrs)

14.1Chloroplast genome: special features

14.2Mitochondrial genome

14.2.1Special features of yeast mitochondrial genome, petite mutants

14.2.2Special features of human mitochondrial genome.

15 Cancer (5 Hrs)

15.1Genetic rearrangements in progenitor cells, oncogenes, protooncogenes and tumoursuppressor genes

15.2Virus-induced cancer

15.3Alteration of cell cycle regulation in cancer

15.4Interaction of cancer cells with normal cells

15.5New therapeutic interventions of uncontrolled cell growth (immunotherapy and genetherapy).

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1. Attwood T.K, Parry-Smith D.J. (2003): Introduction to Bioinformatics. Pearson Education
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12. Tropp, B. E. (2008): Molecular Biology, Jones and Bartlet.
13. Veer Bal Rastogi (2008): Fundamentals of Molecular Biology, Ane Books India
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15. Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R.. (2006).MolecularBiology 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, Richars,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: ZOL2C06, Systematics and Evolution
Credits: 5L: 0T:1P

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions (appr.)	Tutorial (if any) (Hrs)	Lab (Hrs)
CO19	Understand the definition and basic concept of taxonomy, classification, procedures, species concept and different type of taxonomic characters of organisms.	PSO1	R,U	F, C	27		10
CO20	Study the Zoological nomenclature,newer systematic trends, ethics in taxonomy and taxonomic impediments.	PSO1	R,U	F, C, P	18		15
CO21	Understand natural selection evolution	PSO1	U	F,C, P	25		8
CO22	To study molecular evolution and evolutionary trends of organisms	PSO1	R,U	F,C,P	20		7
Total Hours of instruction					90		40

R-remember, U-understand

***F-factual, C-conceptual**

***P-practical/procedural**

SECOND SEMESTER

ZOL2C06 - SYSTEMATICS AND EVOLUTION (90 Hours)

Part –A: Systematics (54 Hrs)

I. Introduction (1 hr)

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

- 2.1 Levels of Taxonomy
  - -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
  - (b) (d) Cladism (e) EvolutionaryClassification
- 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
- 6.10 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
  - (b) (d) Ethological and (e) Geographicalcharacters

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)

1. 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-
a) secondary sexual characteristics
b) Sexyson hypothesis
c) 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

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.vcru.wisc.edu/spoonerlab/.../ Bar Codes %20 and % 20 wild% 20 Potatoes.pdf
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4. Kapoor V.C (1998) Theory and practice of animal taxonomy. Oxford & IBH, Publi.Co New Delhi
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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 NumericalClassification.W.H. Freeman &Co

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.vcru.wisc.edu/spoonerlab/.../ Bar Codes %20 and % 20 wild % 20 Potatoes.pdf
4. Gould, S.J (1997) Ontogeny & Phylogeny, Belkrap Press. Harvard University Cambridge
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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
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11. Futuyama, D.J.(2005). Evolution. Sinauer Associates Inc. Sunderland, Massachusetts.

SECOND SEMESTER PRACTICALS

ZOL2L02 – PHYSIOLOGY

1. Kymograph: working principle and applications
2. Effect of different substrate concentration, pH and temperature on human salivary amylaseactivity. 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 usingsilver 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 UniversityPress.
4. Dounersberger, Anne.B.Lesak, Anne,C and Timmons, Maichael,J.(1992).A laboratory Text Book OfAnatomy and Physiology. 5th ed. D.C.Heath & Co.

ZOL2L02- MOLECULAR BIOLOGY

1. Estimation of DNA by Diphenyl Amine method
2. Estimation of RNA by Orcinol method
3. Estimation of Protein by Lowry‟ 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 UniversityPress
3. Wilson & Walker (2006): Principles and techniques of Biochemistry and Molecular biology,Cambridge University Press.

ZOL2L03- 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 fivespecimens 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.

Course: ZOL3C07, Immunology
Credits: 5L:0T:2P

	Course Outcome	**POs/ PSOs**	**CL**	**KC**	**Class Sessions (appr.)**	**tutorial (if any) (Hrs)**	**Lab (Hrs)**
CO23	Explain cells, and organs involved in immunity	PSO2	R,U	F, C,P	5		10
CO24	Explain the role of molecules involved in immune mechanism	PSO2	R,U	F, C,P	25		40
CO25	Understand maturation of Immunological cells leading to immune response.	PSO2	U	FC P	30		
CO26	Understand the role of MHC in immune response	PSO2	R,U	F,C,P	10		
CO27	Explain immunological disorders	PSO2	R,U	F,C,P	20		10
Total Hours of instruction					90		60

***R-remember, U-understand**

***F-factual, C-conceptual**

***P-practical/procedural**

THIRD SEMESTER THEORY

ZOL3C07 – 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 cytometryand 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)

7.6 lymphoidand myeloid cancers.

7.7 Therapeutic uses of cytokines.

7.8 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 (c) 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 theimmune 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 Laboratoy Technology.Bhalani Bhalani PublishingHouse 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.
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8. Ivan .M.Roit (2002). Essentials of Immunology.ELBS, New Delhi.
9. Shetty, N (1993) Immunology: Wiley Eastern Ltd, New Delhi.
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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. BlackwellScientific Publications.

Course: ZOL3C08, Developmental Biology & Endocrinology
Credits: 5L:1P

	Course Outcome	POs/ PSOs	CL	KC	Class Session (appr.)	Lab (Hrs)
CO1	Understand the basic cellular, molecular and genetic concepts ofdevelopment.	PSO2	R,U	F, C,	24	
CO2	Analyse and understand the developmental stages of various organisms along with the factors influencing them.	PSO2	R,U	, C, P	31	25
CO3	Understand the structure of endocrine glands, synthesis and secretion of hormones, mode of action, control	PSO2	U	FC P	20	10
CO4	Understand the pathophysiology of hypo and hyper secretions of endocrine glands	PSO2	R,U	,C,P	15	
Total Hours of instruction					90	35

***R-remember, U-understand**

***F-factual, C-conceptual**

***P-practical/procedural**

THIRD SEMESTER THEORY

ZOL3C08–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. Commitment

1.2 Specification - autonomous, conditional, syncytial.

1.3 Genomic equivalence and cytoplasmic determinants

1.4 Morphogenetic gradients

1.5 Genomic Imprinting

1.6 The stem cell concept-

a) Progenitor cells, b) Adult stem cells, c) Mesenchymal stem cells, d) Multipotent adult stem cells, e) Pluripotent Embryonic stem cells, f) Stem cell therapy.

2. Gametogenesis, fertilization and, early development (10 hrs)

2.1 Production of gametes-

a) Spermatogenesis and Oogenesis, b) Ultrastructure of gametes

2.2 Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals)

2.3 Zygote formation-

a. Encounter of sperm and egg

b. Capacitation

c. Acrosome reaction

d. Activation of ovum

2.4 Amphimixis

2.5 Prevention of Polyspermy (Fast block and Slow block)

2.6 Cleavage and blastula formation

2.7 Gastrulation and formation of germ layers in amphibia

2.8 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)

4.1Induction 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 Wntfamily, Juxtacrine signaling and cell patterning, notch pathway.

4.3 Cellular interactions concerned in fertilization, blastulation, gastrulation and organogenesis.

4.4 Molecular basis of cellular differentiation – Cadherins.

5. Genetic basis of development (8 hrs)

5.1 Differential gene transcription –Promoters and Enhancers, DNA methylation, Transcriptionfactors, 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.

5.6 Models of cell differentiation- hematopoiesis, myogenesis, differentiation of neural crest cells.

5.7 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 extracellular aging

6.4 Genes and aging,

6.5 DNA repair enzymes, The mTOR pathway,Chromatin modification

6.6 Ageing and the insulin signaling cascade

6.7 Wear and tear,

6.8 Oxidative damage, Mitochondrial genome damage,

6.9 Genetically programmed aging

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)

7.3 Teratogenic agents - Alcohol, retinoic acid, Bisphenol A(BPA), heavy metals, pathogen,

7.4 Testicular Dysgenesis Syndrome,

7.5 DES as an endocrine disruptor,

7.6 Endocrine disruptors as obesogens

7.7 Environmental oestrogens

7.8 Impact of pesticide on development.

8. Developmental Mechanisms of Evolutionary change (Brief)- (2hrs)

8.1 Heterotopy

8.2 Heterochrony

8.3 Heterometry

8.4 Heterotypy.

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;

2.2 Types of receptors- g protein coupled receptors, steroid receptors and nitric oxide receptors,

2.3 Regulation of receptor number, receptor activation

2.4 Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol,

2.5 Receptor signal transduction

2.6 Eicosanoids and hormone action

3. Anatomy of endocrine glands; structure, physiological functions, and control of secretionof 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

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2. Bern, H. A. Text book of comparative endocrinology
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9. Prakash Lohr. Hormones and human health
10. Nelson R. J. Introduction to behavioral endocrinology
11. Norris D. O. (2005). Vertebrate endocrinology.
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Course: ZOL3E09, Classification and Structural organization of animals (90 Hrs)
Credits: L 5: 2 P

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions (appr.)	Lab (Hrs)
CO1	Understand the Biosystematics	PSO5	R,U	F,C,P	15	10
CO2	Understand the General organization and classification of major phylum	PSO5	R,U	F,C,P	30	15
CO3	Understand the Affinities andsystematic position of minor phyla	PSO5	R,U	F,C,P	5	5
CO4	Understand the General organization and classification of Phylum Chordata	PSO5	R,U	F,C,P	30	15
CO5	Understand the Phylogenetic interrelationships of animals	PSO5	R,U	F,C,P	10	5
Total Hours of instruction					90	50

***R-remember, U-understand**

***F-factual, C-conceptual**

***P-practical/procedural**

THIRD SEMESTER THEORY

ELECTIVE COURSE

ZOL3E09- CLASSIFICATION AND STRUCTURAL ORGANIZATION OFANIMALS (90 Hours)

1 Biosystematics (15 Hrs)

1.1 Principles and rules of Taxonomy.

1.2 Importance of taxonomy.

1.3 Three domain concept in systematics.

1.4 Two, Five and Six kingdom classification.

1.6 Concepts of Taxon, holotype, paratype, topotype etc.

1.7 Methods of biosystematics: Typological, Phenetics, Evolutionary, Phylogenetic and Taxonomic characters.

1.8 Practice of taxonomy: Ethics in taxonomy- Authorship, suppression of data, undesirable practices in taxonomy.

1.9 Molecular basis of animal taxonomy: Genetic polymorphism, Electrophoretic variations, Amino acid sequencing for variety of proteins, DNA-DNA and DNA- RNA hybridization.

1.1 Molecular phylogeny, Phylogenetic tree, Phylocode, Tree of life, Cladistic analysis and Cladograms.

1.11 Molecular systematics

1.12 Molecular Markers: Different molecular markers like allozymes, mitochondrial DNA, micro satellites, RFLP (Restriction Fragment Length Polymorphism), RAPD (Random amplified polymorphic DNA), AFLPs (Amplified Fragment Length Polymorphism), single nucleotide polymorphism- SNP, DNA Micro array or DNA chips, ESTs are used in analysis.

1.13 DNA barcoding, DNA Fingerprinting

2. General organization and classification of phylum Protozoa to Echinodermata up to orders. (30 Hrs)

2.1 Phylum Protozoa: Eg. *Noctiluca, Ceratium, Trypanosmagambiense, Euglena, Amoeba, Monocyctis, Balantidium*

2.2 Phylum Porifera: Eg. *Leucosolenia, Sycon, Hyalonema, Euspongia*

2.3 Phylum Coelenterata: Eg. *Hydra, Valella, Aurelia, Gorgonia, Pennatula, Astraea, Metridium, Fungia, Favia*

2.4 Phylum Platyhelminthes: Eg. *Schistosoma*

2.5 Phylum Aschelminthes: Eg. *Ascaris* (Male & Female), *Enterobius*

2.6 Phylum Annelida: Eg. *Aphrodite, Tomopteris, Chaetopterus, Pheretima, Haemadipsa, Polygordius*

2.7 Phylum Arthopoda: Eg. *Limulus, Lepas, Balanus, Macrobrachium, Odontotermis,* butterfly - Southern bird wing (*Troides minos)*, Atlas moth *(Attacus caprobonica*), *Aedes, Musca, Bombyx*

2.8 Phylum Mollusca: Eg. *Patella, Cypraea, Murex, Aplysia, Doris, Mytilus, Pecten, Unio, Loligo, Octopus, Nautilus*

2.9 Phylum Echinodermata: Eg. *Neometra, Cucumaria, Thyone, Echinarachnius, Echinocardium, Asterias*

2.10 Phylum Hemichordata: Eg. *Balanoglossus*

3. Affinities and systematic position of minor phyla: (5 Hrs)

a). Lopophorates, b). Phoronida, c) Ectoprocta, d) Brachiopoda,

d). Pogonophora, e).Chaetognatha, f).Acanthocephala, g) Entoprocota and d) Sipunculida.

4. General organization and classification of Phylum Chordata. (Brief account of each example expected) (30 Hrs)

4.1 Sub-phylum Urochordata Eg. *Ascidia, Doliolum, Oikopleura*

4.2 Sub-phylum: Cephalochordata Eg. Branchiostoma

4.3 Sub-phylum Vertebrata:

4.4 Division 1 Agnatha: Class Cyclostomata Eg. *Petromyzon, Myxine*

4.5 Division 2 Gnathostomata

4.6 Super Class 1 Pisces: *Narcine, Chimaera, Protopterus, Acipenser, Lepidosteus, Exocetus, Hippocampus, Echineis, Sardinella*

4.7 Super Class 2 Tetrapoda:

4.8 Class 1 Amphibia: *Gegeneophis, Salamandra, Hyla, Nasikabatrachus sahyadrensis*

4.9 Class 2 Reptila: *Hylonomus, Chelone, Varanus, Daboia, Bungarus, Hydrophis, Alligator*

4.10 Class 3 Aves: Wetland birds: *Ardeola grayii* (Indian pond heron), *Egretta garzetta* (Little egret)

4.11 Aquatic birds: *Anas* (Duck), *Anhinga* (Oriental Darter)

4.12 Terrestrial birds: *Struthio camelus* (Ostrich), *Pavo cristatus* (Peafowl)

4.13 Migratory birds: *Grus leucogeranus* (Siberian Crane), *Phoenicopterus roseus* (Greater Flamingo)

4.14 Mammalia: *Tachyglossus, Macropus* (Kangroo), *Cynocephalus (*Flying lemur), *Erinaceus* (Hedgehog), *Loris, Elephas maximus indicus* (Indian Elephant), *Megaderma* (Vampire bat), *Pangolin, Sorexaraneus* (Common shrew), *Pantera leo* (Lion), *Odobenus rosmarus* (Walrus), *Sus* (Pig), *Bos* (Cow)

5: Phylogenetic interrelationships of animals (10 Hrs)

5.1 Proteospongia (Protozoa - Porifera),

5.2 Peripatus (Annelida - Arthropoda),

5.3 Neopilina (Annelida - Mollusca),

5.4 Balanoglossus (Protochordata - Chordata),

*5.5 Lepidosiren (*Pisces - Amphibia)

5.6 Latimeria chalumnae (Pisces - Land Vertebrates),

5.7 Archeopteryx (Reptilia - Aves),

5.8 Ornythorhynchus (Reptilia - Mammalia)

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11. Barrington, E.J.W.1967. Invertebrate Structure and Function, Nelson, London.

THIRD SEMESTER PRACTICALS

ZOL4L04 – 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. Immunoelectrophoresis.
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.
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THIRD SEMESTER PRACTICALS

ZOL4L04- 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, windowpreparation - 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 VertebrateEmbryology. 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., SaundersCollege 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.
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7. Humason, G. L. (1962). Animal Tissue techniques. W. H. Freeman & Co.

THIRD SEMESTER PRACTICALS - ELECTIVE COURSE
ZOL4L05 -CLASSIFICATION AND STRUCTURAL ORGANIZATION OF ANIMALS

1. Study of museum specimens – 50 invertebrate and 20 vertebrate specimens. (Brief description ofeach specimen required)
2. Development of dichotomous key using appropriate software or online tools.
3. Study of larval forms (any10 larvae from different taxa).
4. Preparation of dichotomous key of 5 specimens up to family (insects/fishes/snakes of any threetaxa.
5. Preparation of cladogram based on the specimens provided (at least 5 museum specimens)
6. Construction of phylogram/cladogram using MESQUITE software.
7. Preparation of distribution map using QGIS software.
8. Response of fish to three temperatures (normal and $\pm$ 5^{O}C) in a microenvironment and preparationof an ethogram.
9. Study of the skull pattern of reptiles/ mammals.
10. Mounting of any three larval forms. (Diversity should be maintained in accordance to the numberof students and one specimen should be submitted by each student for the practical examination).

Course: ZOL4C10 Biotechnology and Microbiology (90 Hrs)

Credits: L 5: 2 P

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions (appr.)	Lab (Hrs)
CO1	Study of history and scope of Microbiology and its taxonomy	PSO4	R,U	F,C,P	15	10
CO2	Understand bacteria, virus,its pathological effects and their control measures	PSO4	R,U	F,C,P	30	13
CO3	Understand bacterial metabolism	PSO4	R,U	F,C,P	5	5
CO4	Understand the role of microbes in fermentation, waste water treatment, bioremediation biogas plant and generation of energy sources	PSO4	R,U	F,C,P	20	12
CO5	Understand DNA sequencing, Genetic Engineering, gene silencing and cloning techniques	PSO4	R,U	F,C,P	10	5
CO6	Interpret biotechnology in animal health care and environment	PSO4	A	F,C,P	10	5
Total Hours of instruction					90	50

***R-remember, U-understand, A- Analyse**

***F-factual, C-conceptual**

***P-practical/procedural**

FOURTH SEMESTER THEORY

ZOL4C10- 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: λgt10 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, homopolymertailing, use of linkers)

3.2. Selection of transformed cells –blue white selection method, colony hybridization, Plaquehybridization

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, Genesynthesis 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. Antisence 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)

17. Intellectual property rights (3 hr)

17.1. Intellectual property protection,

17.2. Patents, copy right, trade secrets, trademarks

17.3. GATT and TRIPS, patenting of biological materials,

17.4. International co-operation, obligation with patent applications, implications of patenting- current issues

18. The ethical and social implications - (3 hrs)

18.1. Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants-Animals and ethics-

18.2. Release of GEOs-Use of herbicide resistant plants-Human genome alterations bybiotechnology

18.3. Social acceptance of biotechnology-Transgenic crops - Social acceptance of medical biotechnology- Acceptance of GM crops for food and pharmaceutical production, Socialacceptance 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 andmotility

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 pourplate 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 reactionsnot 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 andPhenolic 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

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.
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6. Dale. J.W. and Malcom von Scantz. From genes to genome- Concepts and Applications of DNATechnology
7. Dominic, W.C. Wong-The ABCs of gene cloning-Springer international edition
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12. Sobti, R.C. and Suparna, S. Pachauri-Essentials of Biotechnology-Ane Books Pvt. Ltd.
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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& distributers. NewDelhi.
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. Prescot, L.M., Harley, J. P. and Klein. D.A. (2008). Microbiolgy. 7th ed. McGraw- Hill Inc. NewYork.
8. Rao, A.S. - Introduction to microbiology-Prentice Hall of India.
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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: ZOL4E11, Cellular Physiology (90 Hours)

Credits: L 5: 2 P

Course outcomes:

COs	Course Outcome Statements
CO1	The student gain a solid understanding of the molecular basis of how eukaryotic cells function in the context of whole organisms and also gain a conceptual clarity related to mammalian cell functions and relate them to cell structure.
CO2	Students will be able to perform critical thinking and integrative writing skills required for cellular and physiological research by a thorough understanding of different levels of regulations of the body, system biology starting from the cellular or tissue levels
CO3	The student will recognize and discuss the main types of cell communication, including the signal molecules (ligands/transmitters) integral to these main types, and understand the importance of cell signaling in biology and diseases and to be able apply this knowledge in designing drug targets

FOURTH SEMESTER THEORY-ELECTIVE

ZOL4E11- CELLULAR PHYSIOLOGY

(90 hours)

1. Basic Cellular Physiology (10 HRS)

1.1 Cell diversity, Cell Specialization and cell polarity in mammals

1.2 Motor Proteins and Cytosketal Dynamics

1.3 Vesicular transport process, Synaptic transmissions and the Secretory Apparatus

1.4 Physiological regulation of Endosomes, lysosome and phagocytosis

2. **Transport across biological membranes (15 Hrs)**

2.1 Osmolarity, Osmolality, Nernst equation, Gibbs – Donnan membrane equilibrium, Goldman equation Dehydration, overhydration, etc.

2.2 Transport across biological membranes: molecular structures, biophysics and regulation of physiological process

2.3 Membrane voltage-gated ion channels: molecular structure, biophysics and regulation of physiological process

2.4 Membrane Proteins and Translocation into the ER and Nucleus

2.5 Cellular Physiology of Muscle

2.6 Neuronal Microenvironmen, Physiology of Neurons

2.7 Alterations in the cellular physiology in disease conditions, oxidative damage and neurodegenerative diseases (Alzheimers, parkinsons diseases)

3. **Intercellular and Intra cellular communications (20 Hrs)**

3.1 Cell adhesion molecules, Extracellular matrix proteins junctional complexes and their role in cell migration, recognition, metastasis and wound healing.

3.2 Cellular receptors, Types and mechanism of ligand activation, and mitochondrial communication

3.3 Neuronal signaling, endocrine signaling, and signaling events during development and Morphogenesis.

3.4 Mention Major intracellular signaling pathways and their physiological significance

3.5 The cellular Clock, intrinsic physiological mechanisms by which cells function as autonomous circadian oscillators

4. Cellular and tissue Mechanobiology (20 Hrs)

4.1 Cellular mechanics of Static and dynamic cell processeslike Cell adhession and migration.

4.2 Cellular Mechanotransduction: Intracellular signaling relating to physical Force, Molecular mechanisms of force transduction

4.3 Mechanics of biomembranes; The cytoskeleton and cortex; Models of cell mechanics. Nucleo-cytoskeletal linkages, Nuclear pore biomechanics. Microrheological properties and their implications

4.4 Mechanics of the Cellular Adhesion

4.5 Electromechanical and physicochemical properties of tissues; Physical regulation of cellular metabolism

4.6 Applications of mechanobiology in Cancer, Regenerative medicine and Cardiac diseases

5. Cell-to-cell signaling, physiology and disease (15 Hrs)

5.1 Alterations or aberrations in molecular signaling events in Cancer (Brief)

5.2 Changes in the cellular physiology during disease conditions with special reference to inflammation and autoimmunity

5.3 Changes in the physiology in cellular and tissue levels in altered Insulin Signaling and its regulation.

5.4 Physiological alterations in cardiovascular, nervous and immune systems in Type 1 and type 2 Diabetes.

5.5 Alterations in physiology during Infections. (Mention Viral and bacterial Infections; influenza and Mycobacterium as examples)

6. Cellular physiology of stress, aging and diseases (10 Hrs)

6.1 Fluid balance and homeostasis in the Cellular level

6.2 Cellular Physiology of stress, and senescence

6.3 Causes and Effects of stress on various organs and systems.

6.4 Pathophysiology of stress. Stress related diseases and Biochemical markers of stress.

References

1. Guyton. A. Rext Book of Medical Physiology, Elsevier Publication
2. Ganong, W.F.Reviews of Medical Physiology Lange Publication
3. Khurana I, Text Book of Physiology
4. Berne V Principal of Physiology Elsevier Mosby Publication
5. A. K. Jain Text Book of Physiology
6. B. K. Jain Practical Physiology
7. C. L. Ghai Practical Physiology
8. Neurophysiology Kandel
9. Human Physiology from cells to system auralee Sherwood
10. Human Physiology Best and Tylo
11. Alberts et al. Molecular Biology of the Cell, 6th ed, 2014, Garland Publishing. (Optional.
12. Highly recommended for those who consider graduate study in the field of cell biology and developmental biology)
13. Applications of Mechanobiology
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6135919

14. Grodzinsky, A. *Fields, Forces and Flows in Biological Systems*. Garland Science, 2011. ISBN: 9780815342120. [Preview with Google Books]
15. Boal, D. *Mechanics of the Cell*. Cambridge University Press, 2001. ISBN: 9780815342120.
16. Lodish, H., D. Baltimore, et al. *Molecular Cell Biology*. W. H. Freeman & Company, 2012. ISBN: 9781464109812.
17. Dill, K., S. Bromberg. *Molecular Driving Forces: Statistical Thermodynamics in Chemistry & Biology*. Garland Science, 2003. [Preview with Google Books] ·
18. Howard, J. *Mechanics of Motor Proteins and the Cytoskeleton*. Sinauer Associates, 2001. ISBN: 9780878933334.
19. Phillips, R., J. Kondev, et al. *Physical Biology of the Cell*. Garland Science, 2008. ISBN: 9780815341635.

Course: ZOL4E12, Advanced Physiology and Developmental Biology (90 Hrs)

Credits: L 5: 2 P

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions (appr.)	Lab (Hrs)
CO1	Understand the advances in nerve physiology and endocrinology	PSO6	R,U	F,C,P	15	10
CO2	Study of respiratory. Renal, gastro intestinal and reproductive systems	PSO6	R,U	F,C,P	20	12
CO3	Corelate the physiological aspects to health and wellness	PSO6	A	F,C,P	5	5
CO4	Understand the advancements in the procedure in cell lineage progression, evolutionary aspects of development with refernce to different model organisms	PSO6	R,U	F,C,P	20	13
CO5	Interpret the concept of the stem cells and its application in medical field.	PSO6	A,	F,C,P	10	5
CO6	Study the mammalian embryology and sex determination mechanisms in organisms.	PSO6	A	F,C,P	20	5
Total Hours of instruction					90	50

***R-remember, U-understand A- Analyse**

***F-factual, C-conceptual**

***P-practical/procedural**

FOURTH SEMESTER THEORY-ELECTIVE
ZOL4E12- ADVANCED PHYSIOLOGY AND ADVANCED DEVELOPMENTAL BIOLOGY
(90 Hours)

Part A – ADVANCED PHYSIOLOGY (45 hours)

.1. The basis of advanced physiology (5hrs)
1.1 Structure related to function
1.2 Homeostasis, Equilibrium, and the Steady State
1.3 Physiological Gradients
1.5 Physiological Reflexes
1.6 Negative and positive feedback mechanisms.

2. Integrated Physiological Responses (6hrs)
2.1 Hypovolemic Hypotension
2.2 Baroreceptor Reflexes and Cardiac Output
2.3 Vasomotor Responses and Blood Pressure
2.4 Renal Response and the Renin-Angiotensin System
2.5 Blood Flow and Its Distribution and Redistribution during Hypotension
2.6 Long-Term Responses to Hypotension

3. Physiology of Sleep and wakefulness (6 Hrs)
3.1 Theories of sleep.
3.2 Physiological effects of sleep
3.3 changes In EEG
3.4 Common sleep disorders.
3.5 Dementia, Alzheimer's disease, Schizophrenia, Epilepsy -causes, symptoms, treatments.

4. Stress and health (6 Hrs)
4.1. Stress – Meaning, Nature, and Types
4.2 .Physiology of stress
4.3. Responding to Stress- Emotional, Behavioural, and Physiological Response.
4.4. Effect of Stress on Physical Health
4.5. Psycho-Physiological Disorders - Headache, Asthma, Digestive System Diseases.
4.6. Stress and Cardio-Vascular Disorders.
4.7. Modifiers of Stress – Social Support, Resilience.
4.8. Drug addiction & alcoholism, biogenic amines, Mood elevators.

5. Physiology of pregnancy (6 Hrs)
5.1. Fertilization, implantation. Placenta, hormones of placenta and functions.
5.2. Maternal changes during pregnancy.
5.3 Parturition: initiation and onset of labor.
5.4 Lactation - Role of estrogen and progesterone in the development of breasts.
5.5. Role of prolactin and oxytocin in milk ejection process,
5.6. Physiological basis of different methods of contraception

6. Environment and physiology (10 Hrs)
6.1 Influence of environment on animals
6.2 Adaptations to extreme environments
6.3 Life in hot environment, cold environment, high altitude & high atmospheric pressure.
6.4 Animal navigation and migration- physiological basis,

6.5 Biological Clocks- internal biological clocks; circadian rhythms.

7. Sports physiology (6 Hrs)

7.1 Muscles in exercise – Physiology of muscle contraction, effect of athletic training
7.2 neurobiological effects of physical exercise, physical fitness and its components,
7.3 cardiovascular changes & adaptaion to exercise, pulmonary adaptation, effect on body fluids & salts,
7.4 Dope test, drugs and athletes 12.3. Fitness test, Anabolic steroids
7.5 Yoga – yoga in daily life, Physiological effects of yoga, yoga in Health & diseases.

PART B: ADVANCED DEVELOPMENTAL BIOLOGY (45 Hours)

1. Approaches to developmental biology (Chapter 4 & 5, essential of developmental biology, JMW Slcak, Wiley-Blackwell). **12 hours**

1.1 Normal development, the fate map, clonal analysis, developmental commitment, cytoplasmic determinants of development, Induction and competence, lateral inhibition, Stochasticity in development, and Criteria for proof.

1.2 Microscopic techniques in developmental studies (Differential Interference Contrast, Total internal reflection fluorescence microscopy, confocal microscopy, Selective plane illumination microscopy (SPIM), Light sheet microscopy, Super-resolution microscopy), Forster resonance energy transfer (FRET).(https://doi.org/10.1091/mbc.e15-02-0088).

1.3Histological methods: Immuno-staining, Immunohistochemistry & immunocytochemistry, in situ hybridization (FISH, CISH and GISH)

1.4 Applications of qRT-PCR, Microarray tools, Deep sequencing methods, Chromatin immune precipitation, Reporter gene assays, and Microinjectionin developmental biology. Cell labeling methods: Extracellular and intracellular labels, genetic labels.

1.5 Advanced gene editing techniques: clustered regularly interspaced short palindromic repeats (CRISPR)-CRISPR-associated protein 9 (Cas9); transcription activator-like effector nucleases (TALENs); zinc-finger nucleases (ZFNs); homing endonucleases or meganucleases (https://dx.doi.org/10.1101%2Fcshperspect.a023754)

2. Stem cells (Essentials of Stem Cell Biology (3rd Ed), Robert Lanza Anthony Atala) **4 hours**

2.1 Concept of stemness, types of stem cells, Isolation and Characterization of Human Embryonic and adult Stem Cells, and Future Applications in Tissue Engineering Therapies in cancer therapy and regenerative medicine; Haematopoetic stem cells, Stem cell markers, Pluripotent Stem Cells and Induced pluripotent stem cells (IPSC), Stem cell culture.

3. Brain growth **5 hours**

3.1 Neuroanatomy of the developing central nervous system, Developmental mechanisms regulating brain growth, Development of the human brain (Refer Chapter 14 Scot F. Gilbert, 11th Ed).

4. Development in Health and Diseases **5 hours**

4.1 Sexual differentiation & developmental abnormalities – male & female, Menstrual disorders – Precocious, delayed or absent puberty; Amenorrhea, Fertility disorders – Sexual dysfunction; Infertility; Spontaneous pregnancy loss, Pregnancy disorders – Pre-eclampsia,

IUGR, Labour abnormalities, Endocrine disorders – Hyperprolactinemia, Autoimmune disorders, Genetic disorders (mutations and syndromes), Breast, Reproductive pathology

4.2 Endocrine disruptors- alcohol, retinoic acid, DES, Bisphenol A, Atrazine. Transgenerational inheritance of developmental disorders.

4.3 Cancer as a disease of development: Cancers and biomarkers – Testicular; Prostate; Ovarian; Endometrial; Cervical; Context-dependent tumors, Defects in cell communication, Defects in paracrine pathways. Cancer stem cell hypothesis and epithelial to mesenchymal transition. Developmental therapies for cancer. (Chapter 24, Scot F. Gilbert, 11th Ed.)

5. Advanced signaling in Development 8 hour

5.1 Wnt/β-catenin signaling- Wnt ligands and biogenesis, Wnt receptors: Frizzled and LRP5/6, Wnt antagonists and agonists, Wnt/β-catenin signaling in diseases and potential therapeutics (https://dx.doi.org/10.1016%2Fj.devcel.2009.06.016).

5.2 TGF-β superfamily: Smad signaling and non-Smad signaling, Ligands and receptors of TGF-β, Generating Gradients of TGF-β Superfamily Ligand Activity, Modulation of TGF-β Superfamily. (https://doi.org/10.1016/j.devcel.2009.02.012)

5.3 FGF signaling in general embryonic development, FGF signaling in cranial suture development, Aberrant FGF signaling during development- Achondroplasia, Hypochondroplasia, Thanatophoric dysplasia, Craniosynostosis, Pfeiffer syndrome, Apert syndrome (Brief account). (https://doi.org/10.1016/j.gendis.2014.09.005)

6. Evolutionary embryology 3 Hours

6.1 Embryonic homology, Evo-Devo concept, Mechanisms of evolutionary changes- Hetetropy, Heterochrony, Heterometry, Heterotypy; Developmental constraints of evolution, Selectable epigenetic variation, Genetic assimilation in the laboratory and natural environments. (Refer Scot F. Gilbert Chapter 26 11th Ed).

7. Early development of Mammals (Scot F. Gilbert 11th Ed., Chapter 12) **8 hours**

7.1 Cleavage, Compaction- Trophoblast and ICM formation, Implantation, Mammalian gastrulation, Axis patterning, Hox code hypothesis in anterior-posterior patterning, Twins.

7.2 Placental macrophages: Hofbauer Cells, Placental macrophages in maternal-fetal tolerance, Placental macrophages in placenta construction, Placental macrophages as a barrier to infection, Placental macrophages as a mediator in parturition and other signaling/hormone. (https://doi.org/10.1007/978-3-319-54090-0_3, https://doi.org/10.3389/fimmu.2018.02628)

References

Advanced Developmental Biology

Essential Developmental Biology, 4th Edition, Jonathan M. W. Slack, Leslie Dale, Wiley-Blackwell (ISBN: 978-1-119-51284-4)

1. Gilbert SF. Developmental Biology. 11th edition. Sunderland (MA): Sinauer Associates; 2016:https://www.ncbi.nlm.nih.gov/books/NBK9983/https://doi.org/10.1007/978-3-319-54090-0_3.
2. Reyes, L. and T. G. Golos (2018). "Hofbauer Cells: Their Role in Healthy and Complicated Pregnancy." Frontiers in Immunology 9(2628).https://doi.org/10.3389/fimmu.2018.02628

3. Wu, M. Y. and C. S. Hill (2009). " TGF-β Superfamily Signaling in Embryonic Development and Homeostasis." Developmental Cell 16(3): 329-343. (https://doi.org/10.1016/j.devcel.2009.02.012)
4. Teven, C. M., E. M. Farina, et al. (2014). "Fibroblast growth factor (FGF) signaling in development and skeletal diseases." Genes & Diseases 1(2): 199-213. (https://doi.org/10.1016/j.gendis.2014.09.005)
5. MacDonald, B. T., K. Tamai, et al. (2009). " Wnt/β-Catenin Signaling: Components, Mechanisms, and Diseases." Developmental Cell 17(1): 9-26. (https://dx.doi.org/10.1016%2Fj.devcel.2009.06.016).
6. Gaj, T., S. J. Sirk, et al. (2016). "Genome-Editing Technologies: Principles and Applications." Cold Spring Harbor Perspectives in Biology 8(12). (https://dx.doi.org/10.1101%2Fcshperspect.a023754)
7. Thorn, K. (2016). "A quick guide to light microscopy in cell biology." Molecular Biology of the Cell 27(2): 219-222. (https://doi.org/10.1091/mbc.e15-02-0088).

References

Advanced Physiology

1. Arthur C.Guyton & John E. Hall (2006): Textbook of Medical Physiology, Saunders Elsevier.
2. William F.Ganong (1999): Review of Medical Physiology, Lange Medical Publications.
3. JainA.K.
(2009):TextBookofPhysiology(Vol.I&II),AvichalPublishingCompany,NewDelhi.
4. Kunt-Schmidt-Nielsen.(1994).Animal Physiology, Adaptation and Environment.Cambridge UniversityPress.
5. Pat Willmer, Graham Stone and Ian Johnston (2005) Environmental Physiology of Animals 2nd Ed. Blackwell., UK.
6. Gerard J Tortora, Bryan H Derrickson, 2009, Principles of Anatomy and Physiology, (10th edition) HarperCollins College Publishers.
7. Bijilani R L (2004) Understsnding Medical Physiology (third edition) Jaypee brothers medical publishers , Nwedelhi.
8. Sembulingam K & Prema Sembulingam (2012) Essentials of Medical Physiology (sixth Edition) Jaypee brothers medical publishers , Nwedelhi.
9. Hochachka, P.W. and Somero, G. N. (2002) Biochemical Adaptation: Mechanism and Process in Physiological Evolution, Oxford University Press., Oxford. New York. 15
10. Campbell et al. (1984): Clinical Physiology, 5th Edn. Blackwall Scientific Publications,Oxford.

FOURTH SEMESTER PRACTICALS

ZOL4L04 -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.

ZOL4L04 – 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.

ZOL4L04 - MICROTECHNIQUE 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-CummingsPublishing Company.USA.

ZOL4L05 - CELLULAR PHYSIOLOGY

1. Study and identification of stained sections of different mammalian tissues and organs: Muscles, nerves, Kidney, Skin, Testis, Ovary, Thyroid gland, Pancreas, Spleen, & Lymph gland.
2. Erythrocyte Osmotic fragility determination.
3. Effect of pesticides (any xenobiotic toxin) on fishes.
    (a) Cellular and Biochemical responses to toxicants (Change in blood cell counts, catalase/ any other antioxidant enzymes).
    OR
    (b) Other physiological and behavioral responses to the toxicant
4. Influence of temperature and pH on the ciliary activity in fresh water mussel/ Mytilus using silver foil. Plot graph
5. Mosso's ergography to obtain a graphic record of flexion of a finger, hand, or arm. 6. Isolation of chick embryo fibroblast cells/ bone marrow stromal cells and *In vitro* cell culture of fibroblast cells using suitable sterile media
7. Estimation of the Confluency of a Monolayer Cell Culture (Imaging) and Trypsinization of cells
8. Preparing Cells from Culture for Counting on a Hemacytometer- live/dead assay using membrane exclusionary dye Trypan blue stain.
9. Cell migration and proliferation assays using Fibroblast cells (Imaging and MTT assays)
10. *In vitro* scratch wound assay using Fibroblast cells (Imaging)

References

1. Guyton. A. Rext Book of Medical Physiology, Elsevier Publication
2. Ganong, W.F.Reviews of Medical Physiology Lange Publication
3. Khurana I, Text Book of Physiology
4. Berne V Principal of Physiology Elsevier Mosby Publication
5. A. K. Jain Text Book of Physiology
6. B. K. Jain Practical Physiology
7. C. L. Ghai Practical Physiology
8. Neurophysiology Kandel
9. Human Physiology from cells to system auralee Sherwood
10. Human Physiology Best and Tylo
11. Alberts et al. Molecular Biology of the Cell, 6th ed, 2014, Garland Publishing. (Optional.
12. Highly recommended for those who consider graduate study in the field of cell biology and developmental biology)
13. Applications of Mechanobiology
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6135919

14. Grodzinsky, A. *Fields, Forces and Flows in Biological Systems*. Garland Science, 2011. ISBN: 9780815342120. [Preview with Google Books]
15. Boal, D. *Mechanics of the Cell*. Cambridge University Press, 2001. ISBN: 9780815342120.
16. Lodish, H., D. Baltimore, et al. *Molecular Cell Biology*. W. H. Freeman & Company, 2012. ISBN: 9781464109812.
17. Dill, K., S. Bromberg. *Molecular Driving Forces: Statistical Thermodynamics in Chemistry & Biology*. Garland Science, 2003. [Preview with Google Books] ·
18. Howard, J. *Mechanics of Motor Proteins and the Cytoskeleton*. Sinauer Associates, 2001. ISBN: 9780878933334.
19. Phillips, R., J. Kondev, et al. *Physical Biology of the Cell*. Garland Science, 2008. ISBN: 9780815341635.
20. Jackson, M. B. *Molecular and Cellular Biophysics*. Cambridge University Press, 2006. ISBN: 9780521624701. [Preview with Google Books]
21. Cellular Physiology- A Practical manual, S. Rajashekara, D.V. Purushothama

ZOL4L06 - ADVANCED PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY

PART A - ADVANCED PHYSIOLOGY

1. Recording of human blood pressure
2. Analysis of blood lipid profiles – Total cholesterol, Triglycerides, HDL, LDL
3. Urine examination procedures for the following – Sugar, Creatinine, Protein
4. Demonstrate the oxygen consumption in fish (normal & stressed)
5. Demonstration of Osmotic haemolysis
6. Effect of temperature on Operculum movement of fish
7. Effect of osmotic stress on rate of respiration.
8. Identification of hemocytes in insects
9. Hemolymph protein profile of any insect using PAGE (demonstration only)
10. Estimation of Hb level in the blood of fish / vertebrate
11. Record the vital capacity using a spirometer.

References

1. Gary F. Merrill M.D (2015). Our Marvelous Bodies: An Introduction to the Physiology of Human Health. Rutgers University Press; 1st edition
2. Oser B. L.(1965). Hawk‟s Physiological chemistry, McGraw Hill Book Company
3. Hill R.W., Wyse G.A. (1989), Animal Physiology 2nd edition. Harper Collins Publishers
4. Schmidt-Nielsen, K. (1997), Animal Physiology, adaptation and environment, Cambridge UniversityPress.

5. Dounersberger, Anne.B.Lesak, Anne,C and Timmons, Maichael,J.(1992).A laboratory Text Book OfAnatomy and Physiology. 5th ed. D.C.Heath & Co.

PART B: ADVANCED DEVELOPMENTAL BIOLOGY

(Any twelve experiments)

1. Construction of fate map for Chick
2. Study on the different stages of embryonic development in fish
3. Understanding the tree of life and developmental relatedness
4. Evaluation of different types of placenta in mammals (bat, rat, bird, goat, pig, human any four)
5. Observation of the permanent slides of any three developmental stages of invertebrates (echinoderm, Platyhelminthes, nematodes etc).
6. Observation of the permanent slides (any four) of gonads, developmental stages (egg, blastula, gastrula, neurula), tadpole internal gill stage, external gill stage of amphibians
7. Study of any seven invertebrate and two vertebrate larval stages (Slides)
8. Culturing *Drosophila melanogaster*, observation of Egg, embryogenesis, larval and pupal development
9. Dissection of Imaginal Discs of *Drosophila melanogaster*
10. Study on the morphology, motility and counting of sperms (Rat/Fish/ Guinea pig)
11. Study on the developmental stages (18, 24, 33, 48 and 72 hours) of Chick embryo
12. Study on the influence of temperature on the heart rate of in 72 hour chick embryo
13. Chick Embryo Chorioallantoic Membrane in the Study of Angiogenesis
14. Influence of teratogens on the fish/ amphibian development
15. Description on the development of model organisms- Nematodes, Sea urchin, Zebra fish, Mouse
16. Regeneration in amphibian tadpole/ Planaria
17. Study of individual meiotic stages in the testis of grasshopper (or any organism) and observation of prepared slides of individual stages

References

1. Developmental Biology: A Guide for Experimental Study. 2000. Mary S. Tyler. Sinauer Associates Inc. 978-0878938438
2. Biocraft scientific (Slide source). http://biocraftscientific.com/micro-prepared-slides-2/
3. Biocraft scientific (Specimens and embryos). http://biocraftscientific.com/zoology-plastic-mount-in-jar/

STUDY TOUR

A study tour of not less than 10 days duration (need not to be at a stretch) to sanctuaries, National Parks, Zoos, Research Institutes and other places of ecological importance. The field report with the dated signature of the teacher concerned and duly certified should submit at the time of examination. Slides should be submitted at the time of examination during IV semester.