

Gangadhar Meher University, SAMBALPUR, ODISHA

UNDERGRADUATE PROGRAMME IN ZOOLOGY
(Courses effective from Academic Year 2017-18)



SYLLABUS OF COURSES OFFERED IN
Core Courses, Generic Elective, Ability Enhancement Compulsory Courses & Skill
Enhancement Course

DEPARTMENT OF ZOOLOGY

Gangadhar Meher University
SAMBALPUR, ODISHA - 768004

REGULATIONS OF GENERAL ACADEMIC AND EXAMINATION MATTERS FOR BA/B.Sc./B.COM/BBA/BSc.IST EXAMINATIONS

(THREE YEAR DEGREE COURSE) UNDER CHOICE BASED CREDIT SYSTEM AND
SEMESTER SYSTEM

(Effective for the students admitted to First year of Degree course during 2015-16 and afterwards)

CHAPTER-I

(REGULATIONS OF GENERAL ACADEMIC MATTERS)

1. APPLICATION & COMMENCEMENT:

- (i) These regulations shall come into force with effect from the academic session 2015-16.

2. CHOICE-BASED CREDIT SYSTEM (CBCS):

CBCS is a flexible system of learning that permits students to

1. Learn at their own pace.
2. Choose electives from a wide range of elective courses offered by the University Departments.
3. Adopt an inter-disciplinary approach in learning and
4. Make best use of the expertise of available faculty.

3. SEMESTER:

Depending upon its duration, each academic year will be divided into two semesters of 6 months duration. Semesters will be known as either odd semester or even semester. The semester from July to December will be Semesters I, III, V and similarly the Semester from January to June will be Semesters II, IV & VI. A semester shall have minimum of 90 instructional days excluding examination days / Sundays / holidays etc.

4. COURSE:

A Course is a set of instructions pertaining to a pre-determined contents (syllabus), delivery mechanism and learning objectives. Every course offered will have three components associated with the teaching-learning process of the course, namely:

- (i) Lecture – symbolized as L;
- (ii) Tutorial – symbolized as T; and
- (iii) Practical – symbolized as P.

In G.M. University, UG programmes have a minimum of 21 courses.

5. CREDIT:

Each course is rated in terms of credits or credit hours. Credit is a kind of weightage given to the contact hours to teach the prescribed syllabus, which is in a modular form. Normally one credit is allocated to 10 contact hours.

Mechanics of credit calculation:

As per G.M. University standard, 1 credit = 10 hours of lectures / contact hours. The contact hours will include all the modes of teaching like lectures / tutorials / laboratory work / field work or other forms. In determining the number of hours of instruction required for a course involving laboratory / field work, 2 hours of laboratory / field work is generally considered equivalent to 1 hour of lecture. In these regulations one credit means one hour of teaching works or two hours of practical works per week.

6. GRADE LETTER:

The Grade letter is an index to indicate the performance of a student in a particular course / paper. It is the transformation of actual marks secured by a student in a course / paper. The Grade letters are O, A+, A, B+, B, C, P, F. There is a range of marks for each grade letter.

7. GRADE POINT:

Grade point is an integer indicating the numerical equivalent of the letter grade / the weightage allotted to each grade letter depending on range of marks awarded in a course / paper.

8. CREDIT POINT (P):

Credit point is the value obtained by multiplying in grade point (G) by the credit (C): $P = G \times C$.

9. SEMESTER GRADE POINT AVERAGE (SGPA):

SGPA is the value obtained by dividing the sum of credit points (P) earned by a student in various courses taken in a semester by the total number of credits earned by the student in that semester. SGPA shall be rounded off to two decimal places.

10. CUMULATIVE GRADE POINT AVERAGE (CGPA):

CGPA is the value obtained by dividing the sum of credit points in all the courses earned by a student for the entire programme, by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicates the comprehensive academic performance of a student in a programme.

An overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his / her CGPA.

11. COURSE STRUCTURE:

- (a) **COURSE:** A course is a component / a paper of a programme. A course may be designed to involve lectures / tutorials / laboratory work / seminar / project work / practical training / report writing / viva voce etc. or a combination of these, to meet effectively the teaching and learning needs and the credits may be assigned suitably.

(b) **TYPES OF COURSES:**

- (i) Core Courses (14x6=84 credits)

Core courses comprise a set of at least fourteen papers that are identified as compulsory for the students registered for the UG degree in a particular subject. Core courses shall be spread over all the semesters.

- (ii) Ability Enhancement Compulsory Course (04 credits)

The Ability Enhancement Course (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement; i. Environmental Science and ii. English / MIL Communication. These are mandatory for all disciplines.

- (iii) Skill Enhancement Course (SEC) (04 credits)

SEC courses are value-based and / or skill-based and are aimed at providing hands-on-training, competencies, skills, etc. These courses may be chosen from a pool of courses designed to provide value-based and / or skill-based knowledge.

(iv) Elective Courses: 48 credits (24+24)

Elective Course: A course that can be chosen from a number of options other than the core and compulsory courses is known as elective course. An elective may be “Generic Elective” focusing on those courses which add generic proficiency to the student. An elective may be “Discipline Centric” or may be chosen from the main discipline / subject of study called Discipline Specific Elective. Such elective may also include project work / dissertation. It is considered as a special course involving the application of knowledge in solving / analyzing / exploring a real life situation / difficult problem.

The Three year Degree course leading to the Bachelors Degree in Arts/Science/Commerce/BBA/BSc.IST shall be spread over a period of six semesters in three academic years with the following course structure.

Semester	Core Course (6 credits per paper)	Ability Enhancement Compulsory Course (2 credits per paper)	Skill Enhancement Course (2 credits per paper)	Discipline Specific Elective (6 credits per paper)	Generic Elective (6 credits per paper)
I (350 Marks)	CC-I CC-II	AECC-I	-	-	GE-I
II (350 Marks)	CC-III CC-IV	AECC-II	-	-	GE-II
III (450 Marks)	CC-V CC-VI CC-VII	-	SEC-I	-	GE-III
IV (450 Marks)	CC-VIII CC-IX CC-X	-	SEC-II	-	GE-IV
V (400 Marks)	CC-XI CC-XII	-	-	DSE-I DSE-II	-
VI (400 Marks)	CC-XIII CC-XIV	-	-	DSE-III DSE-IV	-

CHAPTER – II

(REGULATION ON EXAMINATION MATTERS)

1. The Examinations

1.1.(a) A candidate for the Bachelor's Degree in Arts/Science/Commerce/BBA/BSc.IST shall be required to pass each of the following examinations.

- | | |
|--------------------|------------------|
| (i) Semester-I | (ii) Semester-II |
| (iii) Semester-III | (iv) Semester-IV |
| (v) Semester-V | (vi) Semester-VI |

Each of the semester examination includes one Mid-Term and one End Term examination.

1.1.(b) Each student has to register himself / herself within schedule date to be eligible to appear the examination. Unless a student registers himself / herself by filling up examination forms and pays the requisite fees for Semester-I, he/she will not be eligible to sit for semester-II examination. Similarly, he/she will not be eligible to take the subsequent semesters unless he/she registers for the previous semester.

1.1.(c) A student has to clear all semester examinations within a maximum period of 05 years.

1.2 Examination Calendar

The broad format of the examination calendar for UG classes shall be as follows:

- | | |
|--|-------------------------|
| (a) Mid term examination of odd semesters | ... September |
| (b) End Term examination of odd semesters | ... November – December |
| (c) Mid term examination of even Semesters | ... February |
| (d) End Term examination of even semesters | ... March – April |

The detail programme of end term examination shall be notified one month before the commencement of examinations.

1.3. Mid Term examination

In each semester there shall be one Mid Term examination of one hour / 60 minutes duration irrespective of marks in each paper having theory component. Out of the total marks of a paper, 20% of marks are earmarked for midterm examination.

1.4 End Term Examination

At the end of each semester, there shall be one examination of each paper called End Term examination. It shall cover 80% of the total marks of a paper. A student fulfilling the following conditions is eligible to appear the End Term examination.

- i. A student shall pay the prescribed examination fees and fill up the prescribed form meant for the examination as per the notification issued by Examination Section (General). No form fill up is allowed before seven days of the commencement of the End-Term examination.
- ii. The minimum number of lectures, practicals, seminars, which a student shall be required to attend before being eligible to take any Semester Examination shall not be less than 75% of the total number of lectures, practicals, seminars taken separately during the semester period.
- iii. Provided that in exceptional cases the authority may condone the shortage of attendance to the extent of 15%.
- iv. Provided further that the authority may condone the shortage of attendance to the extent of 10% over and above 15% in respect of students who represented the college or the state in any National / State Level: Camp, NCC, games or sports during the semester period under reference subject to prior approval and subsequent production of authenticated certificate of participation.

1.5.(a) Mode of Examination

The duration of examination shall be as follows:

Examination	Total marks	Duration
Theory paper	40 Marks	2 hours
	60/80 Marks	3 hours
Practical papers / Project Papers	25 Marks	3 hours
	50/100 marks	6 hours

1.5.(b) Mode of question papers

- (i) All examinations except Viva-voce and Project work shall be conducted by means of written paper (Printed, written / typed in English). The papers in Modern Indian Languages shall be set and answered in the respective languages as mentioned in the syllabus.
- (ii) Questions for a paper shall be set covering the total course of that paper either unit wise giving options from each unit unless specified otherwise in the syllabus.

1.5 (c) Results of examinations

The candidates shall have to appear and secure minimum pass grade in all the paper of a semester examination to be declared as pass. The following 10 – point grading system and corresponding letter grades be implemented in awarding grades and CGPA under CBCS system.

1.6 Award of Grade

The grade awarded to the student in any particular course / paper shall be based on his / her performance in all the tests conducted in a semester for that course / paper. The percentage of marks secured by the students in a particular course / paper shall be converted to a grade and grade point for that course / paper in the manner specified in the following table after conversion in to 100 marks.

% of Marks	Grade	Grade Letter	Grade Point
> = 90 – 100	Outstanding	O	10.0
> = 80 – < 90	Excellent	A+	9.0
> = 70 – < 80	Very good	A	8.0
> = 60 – < 70	Good	B+	7.0
> = 50 – < 60	Above average	B	6.0
> = 40 – < 50	Average	C	5.0
> = 30 – < 40	Pass	P	4.0
< 30	Fail	F	0.0
	Absent	S	0.0
	Malpractice	M	0.0

N.B.: Grade 'P' (30% of marks) shall be the pass grade for Theory and Grade 'C' (40% of marks) shall be the pass grade for Practical / Project work / Dissertation.

1.7 Result

1.7(a) In order to pass a course / paper, a candidate has to secure a minimum of Grade Point 4.0 in that course / paper with Grade 'P' (30% of marks) in Theory and Grade 'C' (40% of marks) in Practical / Project work / Dissertation failing which the candidate will be marked 'F' in that course / paper with the Grade Point of 0.0 (below 30 marks) irrespective of the marks secured in that course / paper.

A candidate obtaining Grade 'F' shall be considered as fail and will be required to reappear the course(s) / paper(s) as back paper. The back paper examination shall be held with the normal end semester examination and the students with backlogs shall clear their backlog course(s) / paper(s) along with regular students of lower semesters in the subsequent year within a period of 05 years from the date of admission and with the current syllabus after two consecutive chances.

1.7(b) In order to clear a semester examination, a candidate is required to pass each credit course / paper of that semester and must secure a minimum Semester Grade Point Average (SGPA) of 4.0. The semester result shall be indicated as detail below:-

A. P (Passed or Cleared) indicating that:

- The candidate has cleared every registered course / paper of odd/even semester of the academic year with a minimum Grade Point (GP) of 4.0 in each paper / component of a paper.

He / She has secured SGPA / CGPA of 4.0 or more.

B. NC (Not Cleared) indicating that:

The candidate is eligible for promotion with backlogs to next higher semester if he / she has registered for all the subjects of any semester.

C. 'X' (Not eligible for promotion) indicating that:

The candidate is not eligible for promotion to next higher level, when as he / she has not registered / filled up the form for the different subjects of a semester.

Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

- i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

$$SGPA (S_i) = \frac{\sum(C_i \times G_i)}{\sum C_i}$$

Where C_i is the number of credits of i th course and G_i is the grade point scored by the student in the i th course.

- ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

Where S_i is the SGPA of the i st. semester and C_i the total number of credits in that semester.

- iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration of Computation of SGPA and CGPA and Format for Transcripts

- i. Computation of SGPA and CGPA

Illustration for SGPA

Course	Credit	Grade letter	Grade point	Credit point
Course 1	3	A	8	3X8=24
Course 2	4	B+	7	4X7=28
Course 3	3	B	6	3X6=18
Course 4	3	O	10	3X10=30
Course 5	3	C	5	3X5=15
Course 6	4	B	6	4X6 =24
	20			139

Thus, SGPA = 139/20=6.95

Illustration for CGPA					
Semester-I	Semester-II	Semester-III	Semester-IV	Semester-V	Semester-VI
Credit-20 SGPA:6.9	Credit-22 SGPA:7.8	Credit-25 SGPA:5.6	Credit-26 SGPA:6.0	Credit-26 SGPA:6.3	Credit-25 SGPA:8.0
Thus, CGPA= $\frac{20 \times 6.9 + 22 \times 7.8 + 25 \times 5.6 + 26 \times 6.0 + 26 \times 6.3 + 25 \times 8.0}{144}$					=6.73

1.7(c) In Order To Pass A Programme, A Candidate Must Secure A Minimum Cgpa Of 4.5. A Candidate Securing Cgpa Of Less Than 4.5 Shall Be Declared As Fail.

In Order To Retain Honours, A Student Has To Secured 'C' Grade And Above In Cgpa After Completion Of 6th Semester.

In Order To Obtain Distinction, a student has to secure a minimum of 'B' Grade and above CGPA after completion of 6th Semester in first chance i.e. without any back or improvement.

The conversion of CGPA to percentage of marks = (CGPA – 0.5) x 10.

The conversion of CGPA into Grade Letter and classification of Honour shall be made on the basis of percentage of marks in the manner specified in the following table.

CGPA / OGPA	Grade Letter	Grade	% of Marks after conversion	Classification of Honours
> = 9.5	O	Outstanding	> = 90	First Class Honours
> = 8.5 - < 9.5	A+	Excellent	> = 80 - < 90	
> = 7.5 - < 8.5	A	Very good	> = 70 - < 80	
> = 6.5 - < 7.5	B+	Good	> = 60 - < 70	
> = 5.5 - < 6.5	B	Above average	> = 50 - < 60	Second Class Honours
> = 5.0 - < 5.5	C	Average	> = 45 - < 50	Pass without Honours
> = 4.5 - < 5.0	P	Pass	> = 40 - < 45	
Below 4.5	F	Fail	< 40	Fail

1.8 Promotion to the next semester

A student shall be promoted to the next higher semester when he/she has appeared and passed in all the courses of the previous semester examinations. However, a student failing to appear / pass semester examination in few or all papers due to some reasons may be admitted to the next semester, provided that such a student shall produce sufficient proof in favour of his/her reason for not being able to appear / pass in some or all papers of the semester examination and has taken readmission in the year. Such students shall be considered as absent /

failed candidate and will be required to appear the repeat / back paper examination in the next year.

1.9 Repeat / Back Paper Examination

A student who remains absent or failed to secure 30% of marks / SGPA of 4.0 in aggregate has to take the repeat examination. He/she shall repeat all the theory and practical papers of that semester within a period of 5 years from the date of first registration. However, a student who secures more than 30% of marks / SGPA of 4.0 in aggregate but failed in one / some papers, he/she has to take the Back paper examination in the failed papers only. If the student is unable to clear the back papers in the next two consecutive chances, he/she has to appear the repeat examination of all papers in the third and subsequent chances as per the current syllabus and the marks secured in the previous examinations shall stand cancelled.

During back paper examinations, the higher marks of the papers shall be retained at the time of computation of result. The student passing in all papers in terms of grade point but failing in grade point average, then he / she has to appear the back paper examinations in those papers in which he / she has secured less than the required average grade point to pass. Such students shall have to apply to the Head of the Department in plain paper before one week of the form fill up and also filling the form in due date of the ensuing semester examination by depositing the fees as prescribed by the university. The repeat / back paper examination shall be held with the normal end semester examination.

A student appearing in repeat / back paper examination shall not be awarded distinction even if he/she subsequently fulfils the conditions of distinction and will not be included in the merit list. The final result of the candidate will be determined after taking all the subject wise marks and hard case rule into consideration. Candidates taking repeat / improvement examinations shall not be considered for the merit list and it shall be reflected in the provisional certificate- cum mark sheet but not in the final Degree certificate.

1.10 Improvement Examination

After the publication of final result the student getting 2nd Class (Honours) or Pass without Honours may be allowed to improve his/her performance in the next two year immediately from the year of publication of result. He/she shall be allowed to improve in Honours paper only. However he / she has to fill up the form of all the Honours papers of odd semester (I/III/V) and even semester (II/IV/VI). In such case, the highest mark secured in each paper shall be considered for computation of the mark.

1.11 Discipline in the examination

1.11(a) The students are allowed to enter the examination hall half an hour before the commencement of examination. A student arriving in the examination hall / room fifteen minutes after the commencement of the examination shall not be ordinarily allowed to sit for the examination. No examinee shall be allowed to go out of the examination hall within one hour of the commencement of examination.

1.11(b) The students are allowed to enter the examination hall only with a valid admit

card and Identity card. Mobile phones and any other electronic gadgets are strictly prohibited in the examination hall. The possession of such things in the examination hall shall be treated as malpractice.

- 1.11(c)** The possession of unauthorized materials and using it / copying from the scripts of other students / from any other source, sharing his/her answer scripts with other, creating disturbance or acting in a manner, so as to create inconvenience for the other students / invigilators inside the examination hall shall be treated as adoption of unfair means or malpractice.

In case of adoption of unfair means by an examinee in the examination hall / outside, the invigilator shall immediately report to the Centre Superintendent in writing along with the incriminating material recovered from the examinee signed by both the examinee and invigilator. The Centre Superintendent shall refer the matter to the Controller of Examinations for necessary disciplinary action as per the rules and regulations of the University.

1.12 Issue of Grade sheet, Provisional Certificate, Award of Degree & Gold Medals.

After the publication of the result of Semester examination, the Controller of Examinations shall issue the grade sheet of each semester as per the prescribed format (Appendix-I) and provisional certificate cum grade sheet after the final semester examination as per the prescribed format (Appendix-II) to the candidates against a prescribed fee collected at the time admission / filling of form. A degree certificate under the official seal of the university and signed by Vice-Chancellor as per the prescribed format (Appendix-III) shall be issued / given to the successful students of a particular course at the convocation or in-absentia on submission of application and fee as prescribed.

For award of gold medals, the University shall form a committee. The best graduate shall be decided from amongst the toppers of each Honours. In case of equality of CGPA, the SGPA of last semester examination shall be considered. The students who have failed / remained absent / improved their marks by repetition or improvement shall not be eligible for University rank or gold medal.

By order of Syndicate

**Registrar
G.M. University, Sambalpur**

**SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.Sc. ZOOLOGY
HONOURS**

SEMESTER		CORE COURSE(14)	ABILITY ENHANCEMENT COMPULSORY COURSE (2)	SKILL ENHANCEMENT COURSE (SEC) (2)	DISCIPLIN E SPECIFIC ELECTIVE DCE (4)	GENERIC ELECTIVE: (GE) (4)
I	CC1	Diversity and Evolution of Non-Chordata (Protista to Pseudocoelomates)	AECC-I Environmental Studies			GEI Perspectives in Ecology
	CCII	Perspectives in Ecology				
II	CCIII	Diversity and Evolution Of Non-Chordata (Coelomate Non- Chordates)	AECC-II English Communication/ Odia/ Hindi			GE-II Cell Biology
	CCIV	Physiology: Life Sustaining Systems				
III	CCV	Diversity and Distribution of Chordata		SEC -I Communicative English and English writing skill		GE-III Biotechnology: Microbes to Animal
	CCVI	Physiology – Controlling And Coordinating System				
	CCVII	Comparative Anatomy of Vertebrates				
IV	CCVIII	Biochemistry of Metabolic Processes		SEC -II Public Health and Hygiene		GE-IV Food, Nutrition and Health
	CCIX	Cell Biology				
	CCX	Principles of Genetics				
V	CCXI	Developmental Biology			DSE-I Microbiology	
	CCXII	Molecular Biology			DSE-II Biostatistics	
VI	CCXIII	Immunology			DSE -III Biotechnology	
	CC XIV	Evolutionary Biology			DSE-IV Dissertation/ Project Work	

Semester	Course Name	Course Offered	Title of Paper	Credits	Marks
I 4 Papers 350 marks 20 Credits	AECC	Ability Enhancement Compulsory Course-I	Environmental Studies	2	50 (10+40)
	Generic Elective	Generic Elective -1	Perspectives in Ecology	4	75 (15+60)
		Generic Elective -1 Practical	Practical	2	25
	Core Course	Core Course-I	Diversity and Evolution of Non- Chordata (Protista to Pseudocoelomates)	4	75 (15+60)
		Core Course-I Practical	Practical	2	25
		Core Course-II	Perspectives in Ecology	4	75 (15+60)
		Core Course-II Practical	Practical	2	25
II 4 Papers 350 marks 20 Credits	AECC	Ability Enhancement Compulsory Course II	English Communication / Odia / Hindi	2	50 (10+40)
	Generic Elective	Generic Elective -II	Cell Biology	4	75 (15+60)
		Generic Elective -II Practical	Practical	2	25
	Core Course	Core Course-III	Diversity and Evolution of Non-Chordata (Coelomate Non- Chordates)	4	75 (15+60)
		Practical Core Course-III	Practical	2	25
		Core Course-IV	Physiology: Life Sustaining Systems	4	75 (15+60)
		Core Course-IV Practical	Practical	2	25
III 5 paper 450 Marks 26 Credits	SEC	Skill Enhancement Course -I	Communicative English	2	50 (10+40)
	Generic Elective	Generic Elective - III	Biotechnology: Microbes to Animal	4	75 (15+60)
		Generic Elective -III Practical	Practical	2	25
	Core Course	Core Course-V	Diversity and Distribution of Chordata	4	75 (15+60)
		Core Course-V Practical	Practical	2	25
		Core Course-VI	Physiology –Controlling and Coordinating System	4	75 (15+60)
		Core Course-VI Practical	Practical	2	25
Core Course-VII		Comparative Anatomy of Vertebrates	4	75 (15+60)	
Core Course-VII Practical	Practical	2	25		
IV 5 Papers 450 Marks 26 Credits	SEC	Skill Enhancement Course -II	Public Health and Hygiene	2	50 (10+40)
	Generic Elective	Generic Elective - IV	Food, Nutrition and Health	4	75 (15+60)
		Generic Elective -IV Practical	Practical	2	25
	Core Course	Core Course-VIII	Biochemistry of Metabolic Processes	4	75 (15+60)
		Course-VIII Practical	Practical	2	25
		Core Course-IX	Cell Biology	4	75 (15+60)
		Core Course-IX Practical	Practical	2	25
Core Course-X		Principles of Genetics	4	75 (15+60)	
Course-X Practical	Practical	2	25		

Semester	Course Name	Course Offered	Title of Paper	Credits	Marks
V 4 Paper 400 marks 24 credits	DSE	Discipline Specific Elective I	Microbiology	4	75 (15+60)
		Discipline Specific Elective -1	Practical	2	25
		Discipline Specific Elective -II	Biostatistics	4	75 (15+60)
		Discipline Specific Elective- II	Practical	2	25
	Core Course	Core Course-XI	Developmental Biology	4	75 (15+60)
		Core Course-XI Practical	Practical	2	25
		Core Course-XII	Molecular Biology	4	75 (15+60)
		Core Course-XII Practical	Practical	2	25
VI 4 Paper 400 marks 24 credits	DSE	Discipline Specific Elective -III	Biotechnology	4	75 (15+60)
		Discipline Specific Elective - III	Practical	2	25
		Discipline Specific Elective- IV	Dissertation/ Project Work	6	100
	Core Course	Core Course-XIII	Immunology	4	75 (15+60)
		Core Course-XIII Practical	Practical	2	25
		Core Course-XIV	Evolutionary Biology	4	75 (15+60)
		Core Course-XIV Practical	Practical	2	25
				Total: 140	2400

SEMESTER- I

Ability Enhancement Compulsory Course (AECC I) Environment Studies

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)

(Unit wise question pattern, answer one question from each unit)

Unit I : Introduction to environmental studies

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Ecosystems: Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems:

- a) Forest ecosystem
- b) Grassland ecosystem
- c) Desert ecosystem
- d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit II: Natural Resources: Renewable and Non-renewable Resources

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources: Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit III: Biodiversity and Conservation

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management : Control measures of urban and industrial waste.
- Pollution case studies.

Unit V: Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.

- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquake, cyclones and landslides.
- Environmental movements : Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
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4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
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7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.
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11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzuhl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India. Tripathi 1992*.
14. Sengupta, R. 2003. *Ecology and economics: An approach to sustainable development*. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voices from the Tropics*. John Wiley & Sons.
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18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
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20. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

Zoology GE I: Perspectives in Ecology

(Credits: Theory-04, Practicals-02)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Introduction to Ecology

Relevance of studying ecology, History of ecology, Autecology and synecology, levels of organization, Laws of limiting factors, detailed study of temperature and light as physical factors.

Unit II: Population

Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equation and patterns, r and K strategies, Population regulation - density-dependent and independent factors; Population interactions,

Unit III: Community

Community characteristics: Dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example; Theories pertaining to climax community

Unit IV: Ecosystem

Types of ecosystem with one example in detail, Food chain, Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies. Nutrient and biogeochemical cycle with one example of Nitrogen cycle

Unit V: Biodiversity Conservation

Types of biodiversity, its significance, loss of biodiversity, Conservation strategies, Application of ecology in wild life conservation

Suggested Readings

- Colinvaux, P. A. (1993). *Ecology*. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). *Ecology*. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). *Fundamentals of Ecology*. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology Harper and Row publisher

GE I: PRACTICALS

Credits – 2 , Full Marks – 25,

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂.
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

Zoology CCI:

Diversity and Evolution of Non-Chordata (Protista to Pseudocoelomates)

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Kingdom Protista

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Plasmodium vivax*, *Trypanosoma gambiense* and *Entamoeba histolytica*; Locomotion and Reproduction in Protista

Unit II: Evolution of Parazoa and Metazoa

Phylum Porifera: General characteristics and classification up to classes; Canal system in sponges, skeleton and reproduction in Porifera

Unit III: Phylum Cnidaria

General characteristics and classification up to classes; Metagenesis in *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs

Phylum Ctenophora: General characteristics and evolutionary significance

Unit IV: Phylum Platyhelminthes:

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Fasciola hepatica*, *Schistosoma haematobium* and *Taenia solium*, Parasitic adaptations in platyhelminthes

Unit V: Phylum Nematelminthes

General characteristics and classification up to classes; Life cycle, pathogenicity and prophylaxis of *Ascaris lumbricoides* and *Wuchereria bancrofti* Parasitic adaptations in Nematelminthes

Note: Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition”

SUGGESTED READINGS

1. Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home

CC I: PRACTICAL
Credits – 2 , Full Marks – 25,

Kingdom Protista

1. Study of *Paramecium* W.M., Binary fission and Conjugation in *Paramecium*
2. Life stages of *Plasmodium vivax*, *Trypanosma gambiense* and *Entamoeba histolytica* (Slides/Micro-photographs)
3. Examination of pond water for protists
- 4.

Phylum Porifera

5. Study of *Sycon* (including T.S. and L.S.), *Hyalonema*, and *Euplectella*
6. Temporary mounts of spicules, gemmules and spongin fibres

Phylum Cnidaria

7. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, Ephyra larva, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium* (including T.S. and L.S.)

Phylum Ctenophora

8. Any one specimen/slide

Phylum Platyhelminthes

9. Study of adult *Schistosoma haematobium*, *Taenia solium* and their life stages (Slides/micro-photographs)

Phylum Nemathelminthes

10. Study of adult *Ascaris lumbricoides*, *Wuchereria bancrofti* and their life stages (Slides/micro-photographs)

Note: Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition,”

Zoology CC II: Perspectives in Ecology

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Introduction to Ecology

Relevance of studying ecology, History of ecology, Autecology and synecology, levels of organization, Laws of limiting factors, detailed study of temperature and light as physical factors.

Unit II: Population

Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equation and patterns, r and K strategies, Population regulation - density-dependent and independent factors; Population interactions, Predation, functional and numerical responses

Unit III: Community

Community characteristics: Dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example; Theories pertaining to climax community

Unit IV: Ecosystem

Types of ecosystem with one example in detail, Food chain, Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies. Nutrient and biogeochemical cycle with one example of Nitrogen cycle

Unit V: Biodiversity Conservation

Types of biodiversity, its significance, loss of biodiversity, Conservation strategies, Application of ecology in wild life conservation

Suggested Readings

- Colinvaux, P. A. (1993). *Ecology*. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). *Ecology*. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). *Fundamentals of Ecology*. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology Harper and Row publisher

CC II: PRACTICALS

Credits – 2 , Full Marks – 25,

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂.
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

SEMESTER II
Ability Enhancement Compulsory Course (AECC II) ENGLISH
Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

This course aims at enhancing the English language proficiency of undergraduate students in humanity, science and commerce streams to prepare them for the academic, social and professional expectations during and after the course. The course will help develop academic and social English competencies in speaking, listening, pronunciation, reading and writing, grammar and usage, vocabulary, syntax, and rhetorical patterns. Students, at the end of the course, should be able to use English appropriately and effectively for further studies or for work where English is used as the language of communication.

Unit I: Reading Comprehension

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas, and information
- Read “between the lines” to understand underlying meanings
- Connect information to what they already know

Book Prescribed

Vistas and Visions: An Anthology of Prose and Poetry. Texts to be studied

PROSE

- Playing the English Gentleman (M.K. Gandhi)
- The Need for Excellence (N.R. Narayana Murthy)
- The Last Leaf (O. Henry)

POETRY

- One Day I Wrote Her Name (Edmund Spenser)
- Miracles (Walt Whitman)
- The Felling of the Banyan Tree (DilipChitre)

Unit II: Writing

1. Expanding an Idea
2. Writing a Memo
3. Report Writing
4. Writing a Business Letter
5. Letters to the Editor
6. CV & Resume Writing
7. Covering Letter
8. Writing Formal Email
9. Elements of Story Writing
10. Note Making

Unit III: Language functions in listening and conversation

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually
(Practice to be given using speaking activities from the prescribed textbooks)

Grammar and Usage

1. Simple and Compound Sentences
2. Complex Sentences
3. Noun Clause
4. Adjective Clause
5. Adverb Clause
6. The Conditionals in English
7. Words and their features
8. Phrasal Verbs
9. Collocation
10. Using Modals
11. Use of Passives
12. Use of Prepositions
13. Subject-verb Agreement
14. Sentence as a system
15. Common Errors in English Usage

Examination pattern

Each reading and writing question will invite a 200 word response.

Language function questions set in context will carry 01 mark per response. There will be 15 bit questions.

Midterm test 10 marks

End Term Total 40 marks

Unit I- Reading: 05 questions (03x 05 qns= 15 marks)

Unit II- Writing: 03 questions (05 x 03 qns= 15 marks)

Unit III- Grammar & usage: 10 qns (01x 10 qns = 10 marks)

Grammar questions must be set in contexts; not as isolated sentences as used for practice in the prescribed textbook.

All grammar and writing activities in the textbook

‘Vistas and Visions: An Anthology of Prose and Poetry’ (Ed.) Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. (Orient Black Swan Publisher)

Ability Enhancement Compulsory Course (AECC -II) ODIA
Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)
(Unit wise question pattern, answer one question from each unit)

ପ୍ରଥମ ଏକକ : କବିତା : ଭକ୍ତି - ଗଙ୍ଗାଧର ମେହେର

ଗ୍ରାମପଥ - ବିନୋଦ ଚନ୍ଦ୍ର ନାୟକ

ଦ୍ୱିତୀୟ ଏକକ : ଗଳ୍ପ : ମାଗୁଣିର ଶଗଡ଼ - ଗୋଦାବରୀଶ ମହାପାତ୍ର

ଗୋପପୁର - ରାମଚନ୍ଦ୍ର ବେହେରା

ତୃତୀୟ ଏକକ : ପ୍ରବନ୍ଧ : ଜଳଭୂମି - କୃଷ୍ଣଚନ୍ଦ୍ର ପାଣିଗ୍ରାହୀ

ଆଧୁନିକ - ହରେକୃଷ୍ଣ ମହତାବ

ଚତୁର୍ଥ ଏକକ : ପ୍ରବନ୍ଧ ରଚନା, ପତ୍ରଲିଖନ, ସମ୍ବାଦଲିଖନ

ପଞ୍ଚମ ଏକକ : ବ୍ୟାକରଣ – ଭ୍ରମ ସଂଶୋଧନ, ବିପରିତାର୍ଥବୋଧକ ଶବ୍ଦ, ସମୋଚ୍ଚାରିତ ଭିନ୍ନାର୍ଥବୋଧକ ଶବ୍ଦ

ଆନ୍ତଃପରୀକ୍ଷା ପାଇଁ ୧୦ ମାର୍କ ପ୍ରଶ୍ନ ପଡ଼ିବ । (୧ x ୧୦ = ୧୦)

ବିଶ୍ୱବିଦ୍ୟାଳୟସ୍ତରୀୟ ମୁଖ୍ୟ ପରୀକ୍ଷାରେ ନିମ୍ନମତେ ପ୍ରଶ୍ନ ପଡ଼ିବ:

ପ୍ରଥମ ଏକକରୁ ଚତୁର୍ଥ ଏକକ ପର୍ଯ୍ୟନ୍ତ ପ୍ରତ୍ୟେକ ଏକକରୁ ୨ଟି ଲେଖାଏଁ ପ୍ରଶ୍ନ ପଡ଼ିବ। ବିଦ୍ୟାର୍ଥୀ ପ୍ରତ୍ୟେକ

ଏକକରୁ ଗୋଟିଏ ଲେଖାଏଁ ପ୍ରଶ୍ନ ର ଉତ୍ତର ଦେବେ । (୪ x ୮ = ୩୨)

ପଞ୍ଚମ ଏକକରୁ ୧୫ ଟି ଅତି ସଂକ୍ଷିପ୍ତ ପ୍ରଶ୍ନ ପଡ଼ିବ । ବିଦ୍ୟାର୍ଥୀ ନିର୍ଦ୍ଦେଶ ଅନୁଯାୟୀ ୮ ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବେ ।

(୮x୧=୮)

ଗ୍ରନ୍ଥ ସୂଚୀ

୧. କବିତାଶ୍ରୀ - ସଂ. - କୃଷ୍ଣଚରଣ ବେହେରା

୨. ଗଳ୍ପ ଦିଗନ୍ତ - ସଂ. - ସୁରେନ୍ଦ୍ର ନାଥ ଦାସ

୩. ଭାଷଣ କଳା ଓ ଅନ୍ୟାନ୍ୟ ପ୍ରସଙ୍ଗ - ଡ. କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ

୪. ପ୍ରବନ୍ଧ ଗୌରବ - ସଂ.- ପ୍ର. କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ

୫. ସାରସ୍ୱତ ପ୍ରବନ୍ଧ ପତ୍ରମାଳା -

୬. ବିଶ୍ୱବିଦ୍ୟାଳୟ ପ୍ରବନ୍ଧମାଳା - ପ୍ର. କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ

୭. ସର୍ବସାର ବ୍ୟାକରଣ - ଶ୍ରୀଧର ଦାସ ଓ ନାରାୟଣ ମହାପାତ୍ର

୮. ସାରସ୍ୱତ ବ୍ୟାବହାରିକ ବ୍ୟାକରଣ - ଡ. କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ ଓ ସାଥୀ

Ability Enhancement Compulsory Course (AECC - I): HINDI

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)

(Unit wise question pattern, answer one question from each unit)

हिन्दी भाषा, व्याकरण एवं रचना

Unit I: हिन्दी के विविध रूप

- (क) राजभाषा, संचारभाषा (श्रव्या माध्यम - दृश्य) (8)
- (ख) सरकारी पत्र लेखन (व्यावहारिक पक्ष) नमूना (8)

Unit II: अपठित गद्यांश (8)

Unit III: अशुद्धि लेखन

- (क) शब्द शुद्धिकरण (4)
- (ख) वाक्य शुद्धिकरण (4)

Unit IV: शब्द ज्ञान

- (क) पर्याय वाची (4)
- (ख) अनेक शब्द के लिए एक शब्द (4)

Unit V: प्रशासनिक शब्दावली

- (क) अंग्रेजी से हिन्दी (4)
- (ख) हिन्दी से अंग्रेजी (4)

Unit I: यूनिट एक (क) विभाग से एक प्रश्न एवं (ख) विभाग से एक प्रश्न पूछे जाएंगे ।

एक का उत्तर लिखना होगा । (8)

Unit II: एक अपठित गद्यांश दिया जाएगा । जिनमें से चार प्रश्न पूछे जाएंगे । चारों प्रश्नों का उत्तर

देना अनिवार्य होगा । (8)

Unit III: (क) छः शब्द शुद्धिकरण के लिए दिये जाएंगे । चार का उत्तर लिखना होगा । (4)

(ख) छः वाक्य शुद्धिकरण के लिए दिये जाएंगे । चार का उत्तर लिखना होगा । (4)

Unit IV: (क) छः पर्यायवाची शब्द दिये जाएंगे , जिनमें से चार शब्दों का पर्यायवाची लिखना होगा । (4)

(ख) छः अनेक शब्दों के लिए एक शब्द दिये जाएंगे , जिनमें से चार का उत्तर लिखना होगा । (4)

Unit V: (क) छः अंग्रेजी शब्द दिये जाएंगे , जिनमें से चार का हिन्दी रूप लिखना होगा । (4)

(ख) छः हिन्दी शब्द दिये जाएंगे , जिनमें से चार का अंग्रेजी प्रतिरूप लिखना होगा । (4)

Zoology GE II: CELL BIOLOGY

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Overview of Cells

Cell Concept, Cell Theory, Prokaryotic and Eukaryotic cells, Structure of Plasma Membrane, Various models of plasma membrane structure, Modification of Plasma membrane, Transport across membranes (Osmosis, Diffusion, Active Transport)

Unit II: Endomembrane System

Structure and Function of Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Mechanism of vesicular transport

Unit III: Cytoskeleton, Mitochondria and Ribosomes

Structure and functions of microtubules and microfilaments, Structure and function of mitochondria, Mitochondrial Respiratory Chain, Oxidative Phosphorylation, Structure and function of Ribosomes.

Unit IV: Nucleus and Chromosomes

Structure and function of nucleus and Nucleolus. Fine structure and composition of Eukaryotic Chromosome. Giant Chromosomes- Lampbrush and Polytene Chromosome.

Unit V: Cell Cycle and Cell Division

Cell cycle, Regulation of cell cycle, Cell Division- Mitosis and Meiosis

Suggested Readings

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

GE II: PRACTICAL

Credits – 2 , Full Marks – 25,

1. Gram's staining technique for visualization of prokaryotic cells
2. Study various stages of mitosis from permanent slides
3. Study various stages of meiosis from permanent slides.
4. Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides)
5. Cytochemical demonstration (Preparation of permanent slides) i DNA by Feulgen reaction ii Mucopolysaccharides by PAS reaction iii Proteins by Mercurbromophenol blue iv DNA and RNA by MGP

ZOOLOGY CC III:

Diversity and Evolution of Non-Chordata (Coelomate Non- Chordates)

(Credits: Theory-4, Practicals-2) Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Phylum Annelida

General characteristics and classification up to classes; Evolution of Coelom, Metamerism; Excretion in Annelida

Unit II: Phylum Arthropoda

General characteristics and classification up to classes; Vision in Arthropoda; Respiration in Arthropoda; Moulting in insects, Metamorphosis in Insects; Social life in insects (bees and termites)

Unit III: Phylum Onychophora: General characteristics and evolutionary significance; Apiculture, Sericulture & Lac culture

Unit IV: Phylum Mollusca

General characteristics and classification up to classes; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves; Evolutionary significance of trochophore larva

Unit V: Phylum Echinodermata

General characteristics and classification up to classes; Water-vascular system in Asterozoa; Larval forms in Echinodermata; Evolutionary significance (Affinities with Chordates)

Note: Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition, Holt Saunders International Edition.

Suggested Readings

1. Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition
2. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

CC III: PRACTICAL

Credits – 2 , Full Marks – 25,

Phylum Annelida

1. Study of *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*, *Pheretima*, *Hirudinaria*
2. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
3. T.S. through crop of leech

Phylum Arthropoda

4. Study of *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, honeybee, silk moth, wasp

Phylum Onychophora

5. Any one specimen/slide

Phylum Mollusca

6. Study of *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Mytilus*, *Loligo*, *Sepia*, *Octopus* and *Nautilus*

Phylum Echinodermata

7. Study of Echinoderm larvae
8. Study of *Pentaceros/Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Echinocardium*, *Cucumaria* and *Antedon*

Zoology CC IV: Physiology: Life Sustaining Systems
(Credits: Theory-4, Practicals-2), Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I. Digestive System

Structural organization, histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Role of gastrointestinal hormones on the secretion and control of enzymes of Gastrointestinal tract

Unit II. Respiratory System

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen in the blood oxygen- hemoglobin and myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood; buffering action of blood and haemoglobin Control of respiration

Unit III. Excretory System

Structure of kidney and its histological details, Renal blood supply; Mechanism urine formation and its regulation ,Regulation of acid-base balance

Unit IV. Blood

Components of blood and their functions; Structure and functions of haemoglobin; Haemopoiesis; Haemostasis and Coagulation of blood; Disorders of blood

Unit V. Heart

An outline structure of heart; Coronary circulation; structure of conducting and working myocardial fibers. Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart, nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram.

Suggested Readings

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition.Lippincott W. & Wilkins.

CC IV: PRACTICAL – 25 marks

1. Enumeration of red blood cells using haemocytometer
2. Estimation of haemoglobin using Sahli's haemoglobinometer
3. Preparation of haemin and haemochromogen crystals
5. Recording of blood pressure using a sphygmomanometer
6. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

SEMESTER- III

English SEC I: Communicative English & English Writing skill

Credits – 2, Full marks 50 (Mid Term 10 + End Term 40)

(Unit wise question pattern, answer one question from each unit)

Unit I: Introduction to the essentials of Business Communication: Theory and practice

Communication: Definition, Process, Purpose, Communication Network, Types of Communication, Barriers to communication

Unit II: Mechanics of Writing

Stages of writing, Preparing Notes, Style and Tone, linguistic unity, coherence and cohesion, How to Compose Business Messages, Citing references, and using bibliographical

Unit III: Writing a project report

Report planning, Types of Reports, Developing an Outline, Sections of the Report

Unit IV: Writing minutes of meetings, Circular, Notices, Memos, Agenda

Unit V: E-correspondence: E-mails, Business Letter Format, Styles, Types of Letter

Suggested Readings:

1. Scot, O.; Contemporary *Business Communication*. Biztantra, New Delhi.
2. Lesikar, R.V. & Flatley, M.E.; *Basic Business Communication Skills for Empowering the Internet Generation*, Tata McGraw Hill Publishing Company Ltd. New Delhi.
3. Ludlow, R. & Panton, F.; *The Essence of Effective Communications*, Prentice Hall of India Pvt. Ltd., New Delhi.
4. R. C. Bhatia, *Business Communication*, Ane Books Pvt Ltd, New Delhi

Zoology GE III: Biotechnology: Microbes to Animal

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Introduction

Concept and scope of Biotechnology, Restriction and modifying enzymes, Cloning vectors and Expression vectors, and Expression vectors, Transformation techniques.

Unit II: Techniques in Gene Manipulation

Identification of recombinants, Construction and screening of DNA libraries; Molecular analysis of DNA, RNA and proteins (i.e. Southern, Northern and western blotting), DNA sequencing (Sanger's method and automation), Polymerase chain Reaction, Microarrays, DNA fingerprinting, RAPD.

Unit III: Microbes in Biotechnology

Growth kinetics of microbes, Applications of microbes in industry (Concept of primary and secondary metabolites, Fermentation / Bioreactors, Downstream processing), Bioremediation and biosensing.

Unit IV: Transgenic Animal

Production of transgenic animal: Retroviral method, DNA Microinjection method, embryonic stem cell method, nuclear transplantation; Application of transgenic animal; knockout mice; Transgenic livestock; transgenic fish.

Unit V: Biotechnology and Human Welfare

Animal cell technology; Concept of expressing cloned genes in mammalian cells, recombinant in health (recombinant vaccines, Gene therapy; vitro, in-vivo. Ethical issues concerning: Transgenesis, Biosafety and intellectual Property Rights.

GE III: PRACTICAL

Credits – 2 , Full Marks – 25,

- (i) Isolation of genomic DNA from E.coli and analyze it using agarose gel electrophoresis
- (ii) Isolation of plasmid DNA (pUC 18/19 and analyze it using agarose gel electrophoresis.
- (iii) Transformation of E. coli (pUC 18/19) and calculation of transformation efficiency.
- (iv) Restriction digestion of lambda (λ) DNA using ECORI and Hind III.
- (v) DNA ligation (lambda DNA ECORI / Hind III Digested).
- (vi) Construction of restriction digestion maps from data provided.
- (vii) Study of Southern blot hybridization of PCR; Analysis of DNA fingerprinting (DRY Lab)
- (viii) **Project on animal Cell Culture**

Zoology CC V: Diversity and Distribution of Chordata

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Outline classification of Chordates

Unit I: Protochordata

General characters of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata

Unit II: Origin of Chordates

Dipleurula concept and the Echinoderm theory of origin of chordates

Introduction to Vertebrata: Advanced features of vertebrates over Protochordata

Agnatha: General characters and classification of cyclostomes up to class, Petromyzon, Affinities of Cyclostomata

Unit III: Pisces

General characters of Chondrichthyes and Osteichthyes and classification up to order; Migration, Osmoregulation and Parental care in fishes

Unit IV: Amphibia

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characters and classification up to order; Parental care in Amphibians

Reptilia

General characters and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes

Unit V: Aves

General characters and classification up to order; Principles and aerodynamics of flight, Flight adaptations; *Archaeopteryx*-- a connecting link; Migration in birds

Mammals

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

Zoogeography

Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, Distribution of vertebrates in different realms

Suggested Readings:

1. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life*, VIII Edition, Pearson International.
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub. Co.
4. Hall B.K. and Hallgrímsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

ZOOLOGY CC V: PRACTICAL

Credits – 2 , Full Marks – 25,

2. Protochordata

Balanoglossus, *Herdmania*, *Branchiostoma*, Colonial Urochordata Sections of *Balanoglossus* through proboscis and branchiogenital regions Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions Permanent slide of *Herdmania* spicules

3. Agnatha

Petromyzon

4. Fishes

Sphyrna, *Pristis*, *Torpedo*, *Chimaera*, *Notopterus*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Tetrodon/Diodon*, *Anabas*, Flat fish

5. Amphibia

Ichthyophis/Ureotyphlus, *Necturus*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*

6. Reptiles

Chelone, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Draco*, *Ophiosaurus*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus*

Key for Identification of poisonous and non-poisonous snakes

7. Aves

Study of six common birds from different orders, Types of beaks and claws

8. Mammalia

Sorex, Bat (Insectivorous and Frugivorous), *Funambulus*, *Loris*, *Herpestes*, *Hemiechenis*

Zoology CC VI: Physiology – Controlling and Coordinating System

(CREDITS: THEORY-4, PRACTICALS-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I. Tissues and Glands

Structure, location, function and classification of Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue and glands

Bone and cartilage

Structure and types of bones and cartilages, Ossification, bone growth, resorption

Unit II: Nervous System

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapses, Synaptic transmission and, Neuromuscular junction; Reflex action and its types -reflex arc; Physiology of hearing and vision

Unit III: Muscle

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor Unit, summation and tetanus

Unit IV: Reproductive System

Histology of male and female reproductive systems, Puberty, Physiology of male and female reproduction; Methods of contraception (depicted through flow chart)

Unit V: Endocrine System

Functional Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenals; hormones secreted by them and their mechanism of action, Classification of hormones; Regulation of their secretion; Mode of hormone action; Signal transduction pathways utilized by steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system, Placental hormones.

Suggested Books

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders. 5 DeFiore Atlas of Human histology
6. Physiology Vantor

ZOOLOGY CC VI: PRACTICALS

Credits – 2, Full Marks – 25,

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
3. Examination of sections of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid

Zoology CC VII: Comparative Anatomy of Vertebrates

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Integumentary System

Structure, functions and derivatives of integument

Skeletal System

Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches

Unit II: Digestive System

Alimentary canal and associated glands

Respiratory System

Skin, gills, lungs and air sacs; Accessory respiratory organs

Unit III: Circulatory System

General plan of circulation, evolution of heart and aortic arches

Unit IV: Urinogenital System

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

Unit V: Nervous System

Comparative account of brain; Autonomic nervous system, Spinal cord, Cranial nerves in mammals

Sense Organs

Classification of receptors: Brief account of visual receptors, chemo-receptors and mechanoreceptors

SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Weichert C.K and William Presch (1970). *Elements of Chordate Anatomy*, Tata McGraw Hills
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.

CC VII: PRACTICAL **Credits – 2 , Full Marks – 25,**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs.
2. Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit
3. Carapace and plastron of turtle /tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal.

SEMESTER- IV

Zoology SEC II: Courses Public Health and Hygiene

Full Marks: 50 (Midterm – 10+ End term – 40), Credits 2

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Scope of Public health and Hygiene – nutrition and health – classification of foods – Nutritional deficiencies - Vitamin deficiencies.

Unit II: Environment and Health hazards – Environmental degradation – Pollution and associated health hazards.

Unit III: Communicable diseases and their control measures such as Measles, Polio, Chikungunya, Rabies, Plauge, Leprosy and AIDS.

Unit4: Non-Communicable diseases and their preventive measures such as Hypertension, Coronary Heart diseases, Stroke, Diabetes, Obesity and Mental ill-health.

Unit V: Food Hygiene, Potable water sources and methods of purification, food and water borne infection

Reference:

1. Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
2. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.

Zoology GE IV: Food, Nutrition and Health

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Basic concept of food and nutrition Functions of food Components of food-nutrients (Macro and micronutrients): their biochemical role and dietary sources. Food groups and the concept of a balanced diet.

Unit II: food spoilage; Food adulteration Nutrition through the life cycle- Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, preschool and school children, adolescents and elderly.

Unit III: Nutritional Biochemistry Carbohydrates, Lipids, Proteins - Definition, Classification. Essential and Non-essential amino acids; Enzymes- Definition, Classification, Vitamins- Fat-soluble and Water-soluble vitamins;

Unit IV: Health Introduction to health- Definition and concept of health; Major nutritional deficiency diseases- Protein Energy Malnutrition, Vitamin A deficiency, Iron deficiency anaemia, Iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary/lifestyle modifications. Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS); Common ailments- cold, cough, fevers, diarrhoea, constipation- their causes and dietary treatment

Unit V: Food hygiene, Potable water- sources and methods of purification, Food and Water borne infections

Suggested Books

3. Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers
4. Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.
5. Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.
6. Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.
7. Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.
8. Wardlaw GM, Hampl JS. Perspectives in Nutrition; Seventh Ed; 2007; McGraw Hill.

GE IV: PRACTICALS – 25 marks

2. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
3. To determine absorbed oil content in fried foods
4. Estimation of lactose in milk
5. Ascorbic acid estimation in food by titrimetry
6. Estimation of calcium in foods by titrimetry
7. Preparation of temporary mounts of various stored grain pests
8. Project- Undertake computer aided diet analysis and nutrition counselling for different age groups. OR Identify nutrient rich sources of foods, their seasonal availability and price; study of nutrition labelling on selected foods.

Zoology CC VIII: Biochemistry of Metabolic Processes

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Biomolecules

Structures and properties of important mono-, di- and polysaccharides; fatty acids, triglycerides and steroids; and amino acids and proteins

Unit II: Carbohydrate Metabolism

Glycolysis, Citric acid cycle, pentose phosphate pathway, Gluconeogenesis, Shuttle systems (Malate-aspartate shuttle, Glycerol 3-phosphate shuttle), Glycogenolysis, Glycogenesis

Unit III: Lipid Metabolism

β -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis and its regulation

Protein Metabolism

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit IV: Oxidative Phosphorylation

Oxidative phosphorylation in mitochondria, Respiratory chain, ATP synthase, Inhibitors and Uncouplers

Unit V: Intermediary metabolism

Inter-relationship of carbohydrates, lipid and protein metabolism

Enzymes

Introduction, kinetics, mechanism of action, inhibition, allosteric enzymes

Suggested Readings

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry* XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.

CC VIII: PRACTICALS

Credits – 2 , Full Marks – 25,

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose)
2. Colour tests of functional groups in protein solutions.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH on the action of salivary amylase.
5. Effect of temperature on the action of salivary amylase.
6. Estimation of total protein in given solutions by Lowry's method.

Zoology CC IX: Cell Biology
(Credits: Theory-4, Practicals-2)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Overview of Cells: Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions
Plasma Membrane

various models of plasma membrane structure. Transport across membranes, Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata

Unit II: Endomembrane System

The Endoplasmic Reticulum, Golgi Apparatus, Mechanism of vesicular transport, Lysosomes, Polymorphism of lysosomes, Ribosome

Unit III: Mitochondria and Peroxisomes

Structure of mitochondria, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis, Semi-autonomous nature of mitochondria, endosymbiotic hypothesis, Peroxisomes

Cytoskeleton: Structure and functions of intermediate filament, microtubules and microfilaments

Unit IV: Nucleus

Ultra structure of nucleus, Nuclear Envelope - Structure of nuclear pore complex, Chromosomal DNA and its packaging, Structure and function of Nucleolus

Cell Cycle : Cell cycle, Regulation of cell cycle

Unit V: Cell Signaling Signaling molecules and their receptors

Apoptosis & Cancer

Extrinsic (Death Receptor) Pathway and Intrinsic (Mitochondrial) Pathway

Overview of tumor growth and development, Metastasis

SUGGESTED READINGS

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

CC IX: PRACTICAL
Credits – 2 , Full Marks – 25,

1. Gram's staining technique for visualization of prokaryotic cells
2. Study various stages of mitosis from permanent slides
3. Study various stages of meiosis from permanent slides.
4. Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides)
5. Cytochemical demonstration (Preparation of permanent slides) i DNA by Feulgen reaction
ii Mucopolysaccharides by PAS reaction
iii Proteins by Mercurobromophenol blue iv DNA and RNA by MGP

Zoology CC X: Principles of Genetics
(Credits: Theory-4, Practicals-2)
Full Marks: 75 (Midterm – 15+ End term – 60)
(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Mendelian Genetics and its Extension

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked inheritance.

Unit II: Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

Unit III: Mutations

Gene mutations, Chromosomal mutations: Deletion, duplication, inversion, translocation, aneuploidy and polyploidy; Induced versus spontaneous mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method, DNA repair mechanisms

Unit IV: Sex Determination

Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex-limited characters.

Unit V: Extra-chromosomal Inheritance

Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations and Maternal effects.

Quantitative Genetics: Polygenic inheritance

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.

CC X: PRACTICAL

Credits – 2 , Full Marks – 25,

2. To study the Mendelian laws and gene interactions and their verification by Chi- square analyses using seeds/beads/*Drosophila*.
3. Identification of various mutants of *Drosophila*.
4. To calculate allelic frequencies by Hardy-Weinberg Law.
5. Linkage maps based on data from *Drosophila* crosses.
6. Study of human karyotype (normal and abnormal).
7. Pedigree analysis of some human inherited traits.
8. Preparation of polytene chromosomes from *Chironomous/Drosophila* larva.
9. To study mutagenicity in *Salmonella/E. coli* by Ames test.

SEMESTER-V

Zoology DSE I: Microbiology

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

- Unit I:** History of Microbiology; Microbial World – Characterization, Classification and identification of microbes
- Unit II:** Prokaryotes – General morphology and classification of bacteria, their characters and economic importance; Gram-positive and Gram-negative Bacteria.
- Unit III:** Eukaryotes – General morphology of Protista and Fungi – classification and economic importance
Viruses – structure, genome, replication cycle
- Unit IV:** Epidemiology of infectious diseases with reference of Human Hosts – Bacterial [Tuberculosis], Viral [Hepatitis], Protozoan [Amoebiasis] and Fungal [any one]
- Unit V:** Microbe interactions-Immune Responses-Antibiotics and other chemotherapeutic agents Applied Microbiology in the fields of Food, Agriculture, Industry and Environment

DSE I: PRACTICAL

Credits – 2 , Full Marks – 25,

1. Cleaning of glasswares, sterilisation principle and methods - moist heat - dry heat and filtration methods.
2. Media preparation: Liquid media, solid media, Agar slants, Agar plates. Basal, enriched, selective media preparation - quality control of media, growth supporting properties, sterility check of media
3. Pure culture techniques: Streak plate, pour plate, decimal dilution
4. Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description. Demonstration of pigment production
5. Staining techniques: Smear preparation, simple staining, Gram's staining, Acid fast staining, Staining for metachromatic granules
6. Morphology of microorganisms
7. Antibiotic sensitivity testing: Disc diffusion test - Quality control with standard strains
8. Physiology characteristics: IMViC test, H₂S, Oxidase, catalase, urease test, Carbohydrate fermentation, Maintenance of pure culture, Paraffin method, Stab culture, maintenance of mold culture.

Zoology DSE II: Biostatistics

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Concept of sample and population, Frequency Distribution (Normal, Binomial & Poisson), Graphic representation of Data, measures of central tendency, mean, median, mode.

Unit II: Measures of Dispersion, Range, Quartile deviation, Standard deviation, Standard error of mean.

Unit III: Variance, coefficient of variance, ANOVA. One way classification of ANOVA, Two way classification of ANOVA, F-test. Probability, theorems of Probability.

Unit IV: Testing of Hypothesis, Null Hypothesis, test of single mean, test of difference of two means, test of significance based on students "t" test and χ^2 (Chi-square) test.

Unit V: Correlation, types of correlation, measurement of correlation, Scatter diagram and Karl Pearson coefficient of correlation. Rank correlation Regression Analysis. Lines of Regression and Regression coefficient

DSE II: PRACTICAL

Credits – 2 , Full Marks – 25,

1. Construction of Frequency table from given data.
2. Presentation of data in various graphical forms.
3. Calculation of mean, median and mode from the given data.
4. Calculation of mean deviation, standard deviation and standard error of mean from the given data.
5. Solving the problems of χ^2 test, 't' test and 'F' test.
6. Finding out the correlation coefficient and Regression coefficient from the given data.

Zoology CC XI: Developmental Biology

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Introduction

History and basic concepts: Epigenesis, preformation, Mosaic and regulative development; Discovery of Embryonic induction and organizer concept, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division, Reliability of development: Redundancy and negative feed-back.

Unit II: Early Embryonic Development

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization: Changes in gametes, monospermy and polyspermy; Planes and patterns of cleavage; Early development of frog and chick up to gastrulation;

Unit III: Late Embryonic Development

Fate map, Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

Unit IV: Post Embryonic Development

Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and models

Unit V: Implications of Developmental Biology

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell culture, Amniocentesis.

Suggested Readings

1. Gilbert, S. F. (2010). *Developmental Biology*, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky B. I. and Fabian B. C. (1981). *An Introduction to Embryology*, V Edition, International Thompson Computer Press.
3. Kalthoff (2008). *Analysis of Biological Development*, II Edition, McGraw-Hill Publishers.

CC XI: PRACTICAL

Credits-021, Full Marks- 25 marks

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of developmental stages (above mentioned) by raising chick embryo in the laboratory.
4. Study of the developmental stages and life cycle of *Drosophila* from stock culture
5. Study of different types of placenta
6. Project report on *Drosophila* culture/chick embryo development

Zoology CC XII: Molecular Biology

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Nucleic Acids

Salient features of DNA double helix: Watson and Crick model of DNA, DNA denaturation and renaturation; DNA topology - linking number and DNA topo-isomerases, C₀t curves, Structure of RNA, tRNA and DNA and RNA associated proteins

Unit II: DNA Replication

DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Role of proteins and enzymes in replication, Licensing factors, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres

Unit III: Transcription

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors, regulation of transcription

Post Transcriptional Modifications and Processing of Eukaryotic RNA Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing.

Unit IV: Translation

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit V: Gene Regulation

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencers elements; Gene silencing, Genetic imprinting

Regulatory RNAs

Ribo-switches, RNA interference, miRNA, siRNA

Suggested Readings:

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett

CC XII: PRACTICAL
Credits – 2 , Full Marks – 25,

1. Study of DNA replication using Photographs or slides and special cases e.g. Polyteny using permanent slides of polytene chromosomes
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
3. Estimation of the growth kinetics of *E. coli* by turbidity method.
4. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
5. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A₂₆₀ measurement).
7. Quantitative estimation of RNA using Orcinol reaction.

SEMESTER VI

Zoology DSE III: BIOTECHNOLOGY

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Origin, Definition, Scope and Importance of Biotechnology. Basic idea on recombinant DNA technology, Restriction and modifying enzymes, Cloning and Expression vectors.

Unit II: Integration of DNA insert into the vectors and Transformation techniques (introduction of vector into suitable host), Selection of recombinant clones. Isolation of desired DNA, C-DNA synthesis. Construction of genomic library, PCR (Polymerase Chain Reaction)

Unit III: Molecular Analysis of DNA, RNA and Proteins (i.e. Southern, Northern and Western Blotting). DNA sequencing (Sanger's method and automation), DNA fingerprinting RAPD.

Unit IV: Gene transfer in plants using Agro bacterium and development of transgenic plants. Gene transfer in animals and production of transgenic animals. Bioremediation, Biosensing. Ethical issues concerning Transgenesis, hazards and Biosafety of Genetic Engineering.

Unit V: Hybridoma technique and development of monoclonal antibodies. Manufacture of biopharmaceutical products: Insulin, Interferon and growth hormones. Production of recombinant vaccines. Diagnosis and cure of diseases by Gene Therapy, Biotechnology in Forensic medicine and DNA fingerprinting.

DSE III: PRACTICAL

Credits – 2 , Full Marks – 25,

- (i) Isolation of genomic DNA from F. Coli using agarose gel electrophoresis.
- (ii) Isolation of Plasmid DNA using agarose gel electrophoresis.
- (iii) Construction of restriction digestion maps from data provided.
- (iv) Analysis of DNA fingerprinting.
- (v) Project on Cell culture.

Zoology DSE IV:

PROJECT WORK ON ECONOMIC ZOOLOGY

Credits – 06 Full Marks – 100

- (i) Bee-keeping and Bee Economy (Apiculture)
Visit to an Apiculture Institute and Honey processing Unit.
- (ii) Silk and Silk Production (Sericulture)
Visit to a Sericulture Institute and processing Unit.
- (iii) Aquaculture
Preparation and maintenance of fish aquarium. Project on Preservation and processing of harvested fish and fishery by-products.
- (iv) Dairy /Poultry Farming
Visit to any Dairy farm / Poultry farm for Dairy / Poultry farm management and business plan.

Submission of report on anyone fields visits mentioned above.

(To be evaluated by internal members)

Zoology CC XIII: Immunology

(CREDITS: THEORY-4, PRACTICALS-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: Overview of Immune System

Historical perspective of Immunology, Early theories of Immunology, Haematopoiesis, Cells and organs of the Immune system

Innate and Adaptive Immunity: Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions.

Unit II: Antigens: Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

Unit III: Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies, Hybridoma technology

Unit IV: Major Histocompatibility Complex

Structure and functions of endogenous and exogenous pathway of antigen presentation

Cytokines: Properties and functions, Cytokine-based therapies

Unit V: Complement System

Components and pathways of complement activation.

Hypersensitivity: Gell and Coombs' classification and Brief description of various types of hypersensitivities

Vaccines: Types of vaccines: Recombinant vaccines and DNA vaccines

Suggested Readings:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.
3. Abbas, K. Abul and Lichtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication.

CC XIII: PRACTICAL

Credits – 2 , Full Marks – 25,

1. Demonstration of lymphoid organs
2. Ouchterlony's double immuno-diffusion method
3. ABO blood group determination
4. Preparation of single cell suspension of splenocytes from chick spleen, cell counting and viability test
5. ELISA/ dot Elisa (using kit)
6. Principles, experimental set up and applications of immuno-electrophoresis, RIA, F

Zoology CC XIV: Evolutionary Biology

(Credits: Theory-4, Practicals-2)

Full Marks: 75 (Midterm – 15+ End term – 60)

(Unit Wise question pattern- Answer one question from each Unit)

Unit I: History of Life- Introduction to Evolutionary Theories

Historical Overview, Chemogeny, Biogeny, RNA World, Major Events in History of Life, Lamarckism, Darwinism, Neo-Darwinism

Evidences of Evolution

Fossils as direct evidences, Types of fossils, Incompleteness of fossil record, Dating of fossils, Molecular evidences (Globin gene families as an example), Molecular clock concept

Unit II: Processes of Evolutionary Change

Organic variations; Isolating Mechanisms; Natural selection (Examples; Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection, Artificial selection

Unit III: Principles of population genetics

Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency without selection – Genetic drift, Mutation pressures and Gene flow Shifts in gene frequencies with selection

Unit IV: Species Concept

Biological species concept (Advantages and Limitations); Sibling species, Polymorphic species, Polytypic species, Ring species; Modes of speciation (Allopatric, Sympatric)

Evolution above species level & Extinction

Macro-evolutionary Principles (example: Darwin's Finches); Convergence, Divergence, Parallelism

Background extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

Unit V: Origin and Evolution of Horse & Man

Phylogeny of Horse, Palaeontological evidences (from *Dryopithecus* to *Homo sapiens*); Note on molecular evidences; Note on cultural evolution

Suggested Readings

1. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
2. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
3. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
4. Pevsner, J. (2009). *Bioinformatics and Functional Genomics*. II Edition. Wiley-Blackwell.
5. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
6. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.
7. Minkoff, E. (1983). *Evolutionary Biology*. Addison-Wesley.

CC IX: PRACTICAL
Credits – 2 , Full Marks – 25,

2. Study of fossil evidences from plaster cast models and pictures
3. Study of homology and analogy from suitable specimens/ pictures
4. Demonstration of changing allele frequencies with and without selection
5. Construction of cladogram based on morphological characteristics
6. Construction of phylogenetic tree with bioinformatics tools (Clustal X and Phylip)
7. Interpretation of phylogenetic trees