



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM

B.Sc Human Genetics

Single Major

From 2023-24 (Syllabus-Curriculum)

Course Structure

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Introduction to Classical Biology	3+2	4
	I	2	Introduction to Applied Biology	3+2	4



SEMESTER-I

COURSE 1: INTRODUCTION TO CLASSICAL BIOLOGY

Theory

Credits: 4

5 hrs/week

Learning objectives

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

Learning Outcomes

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

Unit 1: Introduction to systematics, taxonomy and ecology.

- 1.1. Systematics – Definition and concept, Taxonomy – Definition and hierarchy.
- 1.2. Nomenclature – ICBN and ICZN, Binomial and trinomial nomenclature.
- 1.3. Ecology – Concept of ecosystem, Biodiversity and conservation.
- 1.4. Pollution and climate change.

Unit 2: Essentials of Botany.

- 2.1. The classification of plant kingdom.
- 2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones).
- 2.3. Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos.
- 2.4 Mushroom cultivation, floriculture and landscaping.

Unit 3: Essentials of Zoology

- 3.1. The classification of Kingdom Animalia and Chordata.
- 3.2 Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders
- 3.3 Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis)
- 34 Economic Zoology – Sericulture, Apiculture, Aquaculture



Unit 4: Cell biology, Genetics and Evolution

- 4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle.
- 4.2. Chromosomes and heredity – Structure of chromosomes, concept of gene.
- 4.3. Central Dogma of Molecular Biology.
- 4.4. Origin of life

Unit 5: Essentials of chemistry

- 5.1. Definition and scope of chemistry, applications of chemistry in daily life.
- 5.2. Branches of chemistry
- 5.3. Chemical bonds – ionic, covalent, noncovalent – Vander Waals, hydrophobic, hydrogen bonds.
- 5.4. Green chemistry

References

1. Sharma O.P., 1993. Plant taxonomy. 2nd Edition. McGraw Hill publishers.
2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4th edition. S. Chand publishers, New Delhi, India.
3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.
4. Rastogi, S.C., 2019. Essentials of animal physiology. 4th Edition. New Age International Publishers.
5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.
6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.
7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5th Edition. Pearson publishers.
9. Subrata Sen Gupta, 2014. Organic chemistry. 1st Edition. Oxford publishers.



ACTIVITIES:

1. Make a display chart of life cycle of nonflowering plants.
2. Make a display chart of life cycle of flowering plants.
3. Study of stomata
4. Activity to prove that chlorophyll is essential for photosynthesis
5. Study of pollen grains.
6. Observation of pollen germination.
7. Ikebana.
8. Differentiate between edible and poisonous mushrooms.
9. Visit a nearby mushroom cultivation unit and know the economics of mushroom cultivation.
10. Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell
11. Visit to Zoology Lab and observe different types of preservation of specimens
12. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow
13. Visit to Zoo / Sericulture / Apiculture / Aquaculture unit
14. List out different hormonal, genetic and physiological disorders from the society



SEMESTER-I

COURSE 2: INTRODUCTION TO APPLIED BIOLOGY

Theory

Credits: 4

5 hrs/week

Learning objectives

The student will be able to learn the foundations and principles of microbiology, immunology, biochemistry, biotechnology, analytical tools, quantitative methods, and bioinformatics.

Learning Outcomes

1. Learn the history, ultrastructure, diversity and importance of microorganisms.
2. Understand the structure and functions of macromolecules.
3. Knowledge on biotechnology principles and its applications in food and medicine.
4. Outline the techniques, tools and their uses in diagnosis and therapy.
5. Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

Unit 1: Essentials of Microbiology and Immunology

- 1.1. History and Major Milestones of Microbiology; Contributions of Edward Jenner, Louis Pasteur, Robert Koch and Joseph Lister.
- 1.2. Groups of Microorganisms – Structure and characteristics of Bacteria, Fungi, Archaea and Virus.
- 1.3. Applications of microorganisms in – Food, Agriculture, Environment, and Industry.
- 1.4. Immune system – Immunity, types of immunity, cells and organs of immune system.

Unit 2: Essentials of Biochemistry

- 2.1. Biomolecules I – Carbohydrates, Lipids.
- 2.2. Biomolecules II – Amino acids & Proteins.
- 2.3. Biomolecules III – Nucleic acids -DNA and RNA.
- 2.4. Basics of Metabolism – Anabolism and catabolism.

Unit 3: Essentials of Biotechnology

- 3.1. History, scope, and significance of biotechnology. Applications of biotechnology in Plant, Animal, Industrial and Pharmaceutical sciences.
- 3.2. Environmental Biotechnology – Bioremediation and Biofuels, Bio fertilizers and Bio pesticides.
- 3.3. Genetic engineering – Gene manipulation using restriction enzymes and cloning vectors; Physical, chemical, and biological methods of gene transfer.
- 3.4. Transgenic plants – Stress tolerant plants (biotic stress – BT cotton, abiotic stress – salt tolerance). Transgenic animals – Animal and disease models.



Unit 4: Analytical Tools and techniques in biology – Applications

- 4.1. Applications in forensics – PCR and DNA fingerprinting
- 4.2. Immunological techniques – Immunoblotting and ELISA.
- 4.3. Monoclonal antibodies – Applications in diagnosis and therapy.
- 4.4. Eugenics and Gene therapy

Unit 5: Biostatistics and Bioinformatics

- 5.1. Data collection and sampling. Measures of central tendency – Mean, Median, Mode.
- 5.2. Measures of dispersion – range, standard deviation and variance. Probability and tests of significance.
- 5.3. Introduction, Genomics, Proteomics, types of Biological data, biological databases- NCBI, EBI, Gen Bank; Protein 3D structures, Sequence alignment
- 5.4. Accessing Nucleic Acid and Protein databases, NCBI Genome Workbench

REFERENCES

1. Gerard J., Tortora, Berdell R. Funke, Christine L. Case., 2016. Microbiology: An Introduction. 11th Edition. Pearson publications, London, England.
2. Micale, J. Pelczar Jr., E.C.S. Chan., Noel R. Kraig., 2002. Pelczar Microbiology. 5th Edition. McGraw Education, New York, USA.
3. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.
4. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
5. R.C. Dubey, 2014. Advanced Biotechnology. S. Chand Publishers, New Delhi, India.
6. Colin Ratledge, Bjorn, Kristiansen, 2008. Basic Biotechnology. 3rd Edition. Cambridge Publishers.
7. U. Sathyanarayana, 2005. Biotechnology. 1st Edition. Books and Allied Publishers pvt. ltd., Kolkata.
8. Upadhyay, Upadhyay and Nath. 2016. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.
9. Arthur M. Lesk. Introduction to Bioinformatics. 5th Edition. Oxford publishers.
10. AP Kulkarni, 2020. Basics of Biostatistics. 2nd Edition. CBS publishers.

ACTIVITIES

1. Identification of given organism as harmful or beneficial.
2. Observation of microorganisms from house dust under microscope.
3. Finding microorganism from pond water.

4. Visit to a microbiology industry or biotech company.
5. Visit to a waste water treatment plant.
6. Retrieving a DNA or protein sequence of a gene'
7. Performing a BLAST analysis for DNA and protein.
8. Problems on biostatistics.
9. Field trip and awareness programs on environmental pollution by different types of wastes and hazardous materials.
10. Demonstration on basic biotechnology lab equipment.
11. Preparation of 3D models of genetic engineering techniques.
12. Preparation of 3D models of transgenic plants and animals.

[**NOTE:** In the colleges where there is availability of faculty for microbiology and biotechnology, those chapters need to be handled by microbiology and biotechnology faculty. In other colleges, the above topics shall be dealt by Botany and Zoology faculty]

Course – I & II Model Paper (70 Marks)

SECTION A (Multiple Choice Questions)

30 x 1 = 30 M

30 Multiple Choice Questions (Each Unit 6 Questions)

SECTION B (Fill in the blanks)

10 x 1 = 10 M

10 Fill in the Blanks (Each Unit 2 Questions)

SECTION C (Very short answer questions)

10 x 1 = 10 M

10 Very short answer questions (Each Unit 2 Questions)

SECTION D (Matching) (From 5 Units)

2 x 5 = 10 M

1 A

B

C

D

E

2 A

B

C

D

E

SECTION E (True or False)

10 x 1 = 10 M

10 True or False (Each Unit 2 Questions)



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

Programme: B.Sc. Honours in Human Genetics (Major)

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
	II	3	Principles of Genetics	3	3
			Principles of Genetics Practical Course	2	1
		4	Human Genetics and Cytogenetics	3	3
			Human Genetics and Cytogenetics Practical Course	2	1



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

SEMESTER-II

COURSE 3: PRINCIPLES OF GENETICS

Theory

Credits: 3

3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:

1. Historical overview and laws of Inheritance
2. Understand Mendel's principles and deviations
3. Gene interactions and their outcome through gene mapping
4. Understand the mitochondrial inheritance in different organisms
5. Understand the variance and heritability of traits

II. Syllabus

UNIT-1 HISTORY OF GENETICS

1. Pre-mendelian Genetic concepts, Heredity, and environment, the concept of phenotype and genotype, pure lines and inbred lines
2. Biography of Mendel and his experiments on pea plants. Mendel laws
3. Deviations of Mendelism (Incomplete dominance and codominance; Multiple alleles, Lethalalleles, Pleiotropy, Penetrance, and Expressivity, Epistasis, and non-epistasis)

UNIT- 2 Sex Linked Inheritance and Sex Determination

1. Chromosome theory of Sex determination: XX- XY, XX-XO, ZZ-ZW, Genic balance theory of Bridges, Intersexes and Super sexes in Drosophila,
2. Sex differentiation in Drosophila and Man, Sex limited and Sex influenced inheritance
3. Sex determination in mammals- and role of human Y chromosome

UNIT-3 LINKAGE, CROSSING OVER, AND GENE MAPPING

1. Linkage - Definition, Linkage group- Drosophila and man; Types of linkage-complete linkage and incomplete linkage, Significance of linkage.
2. Crossing over - definition; recombination and recombination frequency, Mechanism of crossing over: Chiasma Interference and coincidence; Coupling and Repulsion hypothesis.
3. Gene Mapping – physical mapping and genetic mapping, mapping in eukaryotes and prokaryotes

UNIT – 4 EXTRACHROMOSOMAL INHERITANCE

1. Characteristic features of Cytoplasmic Inheritance; Inheritance of- Mitochondrial DNA, Chloroplast DNA, Kappa particles in Paramecium, Shell coiling in snail.
2. Infective heredity -Drosophila, petite mutations and mitochondrial inheritance in man
3. Epigenetics and genome imprinting in humans



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

UNIT -5 INHERITANCE OF QUANTITATIVE TRAITS

1. Continuous and Discontinuous variation
2. Polygenic Inheritance and Multifactorial Inheritance
3. Genetic Variance, Heritability (narrow sense and Broad sense)

III . Skills Outcome

On Successful Completion of this Course, Student shall be able to

1. Study the Mendel Laws and their Deviations
2. Study the Chromosomal Recombination's
3. Study the Genetic Disorders
4. Identification of the Blood Groups



SEMESTER-II

COURSE 3: PRINCIPLES OF GENETICS

Practical

Credits: 3

3 hrs/week

IV .

1. Mendel's laws through seed ratios & Drosophila mutants
2. Study of linkage, recombination, and chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
5. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism.
6. Tests for red-green Colour blindness, Widow's peak, Rolling of the tongue, Hitchhiker's thumb, and Attached ear lobe.
7. Incomplete dominance and gene interaction through seed ratios
8. Blood Typing: ABO groups & Rh factor.
9. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
10. Mitosis & Meiosis through temporary squash preparation.
11. Smear technique to demonstrate sex chromatin buccal epithelial cells

V. REFERENCES

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition

VI. Co-Curricular Activities

a) Suggested Co-Curricular Activities

1. Assignments
2. Seminars, Group Discussions on related topics
3. Preparation of mitosis and meiosis slides
4. Pedigree preparations based on community
5. Colour blindness study in a community
6. Blood group Studies



SEMESTER-II

COURSE 4: HUMAN GENETICS & CYTOGENETICS

Theory

Credits: 3

3 hrs/week

I. LEARNING OUTCOMES

Upon successful completion, each student will have the basic knowledge:

1. On Pedigree symbols
2. Understand the types of Inheritance patterns
3. On Twin Studies
4. On Mapping Techniques
5. Understand the chromosome and their anomalies

II. Syllabus

Unit 1 Basic Human Genetics – Monogenic Traits

1. History of Human Genetics. Pedigrees – family history, symbols, construction of a pedigree
2. Monogenic traits - autosomal inheritance, sex-linked inheritance, sex-limited and sex-influenced inheritance, mitochondrial inheritance
3. Complications in pedigree patterns – non-penetrance, expressivity, pleiotropy, genetic heterogeneity, uniparental disomy, male lethality, X inactivation, consanguinity

Unit 2 Basic Human Genetics – Complex traits

1. Twin Studies - monozygotic and dizygotic twins
2. Polygenic inheritance of continuous traits – normal growth charts, dysmorphology
3. Polygenic inheritance of discontinuous traits – threshold model, liability and recurrence risk

Unit 3 Genetic Mapping of Mendelian and Complex characters

1. Identifying recombinants and non-recombinants in pedigrees
2. Two-point mapping – LOD score analysis, multipoint mapping, homozygosity mapping
3. Genetic mapping of complex traits – difficulties in mapping, allele sharing methods, sib-pair analysis, allelic association, linkage disequilibrium mapping

Unit 4 Human Chromosomes

- 1 History of human cytogenetics
2. Human karyotype – banding, the nomenclature of banding
3. Nomenclature of aberrant karyotypes



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

Unit 5 Chromosome anomalies

1. Common syndromes due to numerical chromosome changes
2. Common syndromes due to structural alterations (translocations, duplications, deletions, microdeletions, fragile sites)
3. Common chromosome abnormalities in cancer

III Skill Outcomes

On successful completion of practical course students shall be able to

1. Barr Body Analysis
2. Dermatoglyphics
3. Karyotyping
4. Chromosomal Abnormal Studies
5. Metaphase Chromosome Preparations of leucocyte culture



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

SEMESTER-II

COURSE 4: HUMAN GENETICS & CYTOGENETICS

Practical

Credits: 1

3 hrs/week

IV. Practical's Syllabus

1. Preparation of pedigree charts for blood group, tongue rolling, ear lobes and colour-blindness
2. Genetics of codominant genes – blood groups.
3. Barr Body analysis.
4. Dermatoglyphics
5. Polygenic inheritance – fingerprint ridge count
6. Preparation of metaphase chromosome spread using peripheral blood sample.
7. Preparation of metaphase plates and their staining and analysis
8. Human karyotyping – numerical on chromosome number.
9. Camera-lucida drawing of chromosomes.
10. Study of various abnormal karyotypes observed in humans.
11. G- banding of metaphase plates and their analysis
12. Sister Chromatid exchange analysis from peripheral blood

V. SUGGESTED READINGS:

1. Human Genetics: Concept and Application by Ricki Lewis 10th Edition
2. Vogel and Motulsky's Human Genetics: Problems and Approaches
3. The Principles of Clinical Cytogenetics by Steven L. Gersen, Martha B. Keagle 3rd edition.
4. Human Cytogenetics: Constitutional Analysis: a Practical Approach by Denise E. Rooney.

VI Co-curricular Activities

a) Suggested Co-curricular Activities

1. Assignments
2. Group Discussions and Seminar On Related Topics
3. Karyotype Preparation
4. Dermatoglyphics



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

Single Major
Model Question Paper
SEMESTER-II
Human Genetics

PRINCIPLES OF GENETICS

Time:3hrs

MAX MARKS: 70 M

Section A

- I. Answer any FIVE questions. All questions carry equal marks. 5X4 = 20
1. Incomplete dominance & codominance
 2. Epistasis
 3. Haemophilia
 4. Heterogametic female
 5. Kappa particles
 6. Crossing over
 7. Petite mutations
 8. Recombination

Section B

- II. Answer ALL Questions. All questions carry equal marks 5X10 = 50
9. (a) Explain law of independent assortment with suitable examples.
(or)
(b) Write an essay on pre Mendelian genetic concepts
10. (a) Explain the mechanism of sex-determination in Humans
(or)
(b) Write about sex-linked inheritance in humans.
11. (a) Write an essay on linkage
(or)
(b) Explain in detail about genetic mapping
12. (a) Write an essay on Infective heredity
(or)
(b). Explain in detail about epigenetics and genomic imprinting in humans
13. (a) Write about quantitative trait loci
(or)
(b) Explain in detail about multi factorial inheritance



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Human Genetics (w.e.f:2023-24A.B)

Single Major
Model Question Paper
SEMESTER-II
Human Genetics

HUMAN GENETICS & CYTOGENETICS

Time:3hrs

MAX MARKS: 70 M

Section A

Answer any FIVE questions. All questions carry equal marks. 5X4 = 20

1. Holandric inheritance
2. Pleiotropy
3. Concordance and Discordance
4. Polygenic inheritance
5. Sib pair analysis
6. Banding
7. Turner's syndrome
8. Robertsonian translocation

Section B

II. Answer ALL Questions. All Questions carry equal marks 5X10 = 50

9. (a) Write about the inheritance of monogenic characters
(or)
(b) Write an essay on pedigree
10. (a) Explain the role of twin studies in understanding complex traits
(or)
(b) Write about genetic susceptibility of multifactorial disorders
11. (a) Write an essay on two-point mapping.
(or)
(b) Explain in detail about genetic mapping of complex traits.
12. (a) Write an essay on nomenclature of abnormal chromosomes
(or)
(b). Explain the different events in the history of human genetics
13. (a) Write about autosomal chromosomal abnormalities.
(or)
(b) Explain in detail about chromosomal abnormalities of cancer.