Syllabus and Examination Pattern for Genetic Counselling Entrance Examination (GCEE)

The syllabus for the Genetic Counselling Entrance Examination (GCEE) is designed to accommodate applicants from diverse educational backgrounds. It is based on the CSIR-UGC NET Life Sciences syllabus, enabling candidates to use its study materials and practice questions for preparation.

- Mode of examination is online proctored
- The questions will be set at the corresponding degree level.
- The questions will be of multiple choice type.
- Answer 100 out of 125 questions with duration of 150 minutes.
- Each correct answer carries 1 marks.
- There is no negative mark for wrong answers.

Important note:
If an applicant is found to be involved in malpractice, they will be disqualified from the selection process, and the application fee will not be refunded. However, they may appeal to the admission committee, whose decision will be final.

Question types and assessment.
To ensure a thorough evaluation of your suitability for the programme, the entrance exam is designed based on Bloom's taxonomy. It includes six levels of increasing difficulty and focuses on your ability to understand, apply, and analyse biological concepts, rather than just memorisation. The exam will include three types of questions.

Type 1: Remembering and Understanding (30% questions). These questions test your ability to recall biological facts and explain basic life processes.

Sample Questions

1. Which organelle is primarily responsible for ATP production in a eukaryotic cell?
   A) Ribosome
   B) Mitochondria

C) Golgi Apparatus

D) Lysosome

Ans: B

2. What is a primary difference between mitosis and meiosis?

   A) Mitosis produces four daughter cells

   B) Meiosis occurs only in somatic cells

   C) Mitosis results in genetically identical daughter cells

   D) Meiosis maintains the same chromosome count as the parent

Ans: C

Type 2: Applying and Analysing (50% questions)

These questions require you to apply biological principles to new scenarios or identify patterns in experimental data.

Sample questions

1. If two heterozygous (Tt) pea plants are crossed, what is the expected genotypic ratio (TT:Tt:tt) of the offspring?

   A) 1:2:1

   B) 3:1

   C) 1:1:1:1

   D) 2:2

   Ans: A

2. An enzyme is placed in an environment where the temperature is gradually increased. If the reaction rate suddenly drops to zero, what has most likely occurred?

   A) The activation energy decreased

   B) The substrate concentration increased

   C) The enzyme's active site was denatured

   D) The enzyme reached its optimal temperature

   Ans: C

Section 3: Evaluating & Creating (20% questions)

The highest levels of the exam ask you to justify scientific conclusions or propose a hypothetical experimental design

Sample questions

1. A biologist observes that an island bird population is declining due to an invasive predator. Which conservation strategy provides the most sustainable long-term solution?
   A) Culling the native bird population to reduce competition
   B) Introducing a second predator to hunt the invasive species
   C) Creating a predator-free fenced sanctuary on the island
   D) Providing extra food sources for the native birds
   Ans: C

2. You are designing an experiment to test the effect of light wavelength on photosynthesis. Which setup would best serve as the independent variable?
   A) Measuring the volume of oxygen produced
   B) Keeping the temperature constant at 25°C
   C) Exposing identical plants to red, blue, and green light filters
   D) Using the same species of aquatic plant for all trials
   Ans: C

Syllabus for the GCEE

The syllabus is divided into eight sections, all given equal importance in the exam. To ensure a fair and complete evaluation, the exam is based on the following principles:

- **Broad scientific scope:** The exam does not focus only on genetics. It assesses your overall understanding of general science, logical reasoning, and evidence-based thinking.
- **Equal weightage:** All sections are equally important. No single topic, including genetics, will dominate the paper, allowing candidates from different biology backgrounds to perform well. You can focus more on the sections you are comfortable with.
- **Aptitude over specialisation:** The exam values your ability to understand, apply, and analyse scientific information rather than memorising specialised facts.

Section 1: Molecules and their interaction relevant to Biology

- Structure of atoms, molecules and chemical bonds.
- Composition, structure and function of biomolecules, carbohydrates, lipids, proteins, nucleic acids and vitamins).
- Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
- Primary, secondary, tertiary and quaternary structure; domains; motif and folds of proteins
- Stability of protein and nucleic acid structures.
- Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

Section 2: Cellular Organization

- Membrane structure and function: Structure of model membrane, lipid bilayer, membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, and electrical properties of membranes.
- Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, vacuoles,, structure and function of cytoskeleton and its role in motility.
- Organization of genes and chromosomes: structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.
- Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.
- Computational methods: Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis, and presentation.

Unit 3: Fundamental Processes

- DNA replication, repair, and recombination: enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanisms.

- RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.
- Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.
- Control of gene expression at transcription and translation level in eukaryotes: eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

Section 4: Cell Communication and Cell Signaling

- Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways.
- Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
- Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.
- Innate and adaptive immune system: Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, inflammation, hypersensitivity and autoimmunity, immune response. congenital and acquired immunodeficiencies.

Section 5: Developmental Biology

- Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenic in analysis of development.
- Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals;
- Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis - vulva formation in Caenorhabditis elegans; eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Section 6: Human Physiology

- Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood groups, haemoglobin, immunity, haemostasis.
- Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG, its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.
- Respiratory system: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
- Nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.
- Sense organs: Vision, hearing and tactile response.
- Excretory system: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.
- Thermoregulation: Comfort zone, body temperature, physical, chemical, neural regulation, acclimatization.

- Stress and adaptation.
- Digestive system: Digestion, absorption, energy balance, BMR.
- Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation.

Section 7: Inheritance Biology

- Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance.
- Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests.
- Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- Extra chromosomal inheritance: Inheritance of mitochondrial and maternal inheritance.
- Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
- Quantitative genetics: Polygenic inheritance, heritability and its measurements
- Mutation: Types, causes and detection, mutant types - lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
- Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. K. Recombination: Homologous and non-homologous recombination, including transposition, site-specific recombination.
- The Mechanisms: Population genetics-populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

Section 8: Methods in Biology

- Molecular biology and recombinant DNA methods: Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric

focusing gels; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques.

- Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, floweytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.
- Statistical Methods: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance; X2 test;; basic introduction to Muetrovariate statistics, etc.
- Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.