

Programs	Institute
M.Sc. Genome Engineering M.Sc. Bio Molecular Physics M.Sc. Medical Biotechnology M.Sc. Molecular Biology & Human Genetics M.Sc. Systems Biology M.Sc. Tissue Engineering M.Sc. by Research in Life Sciences	Manipal School of Life Sciences (MSLS), Manipal

### MET 2024 Details

- Test Duration: **120** minutes
- Total Questions: **120** questions
  - Botany & Zoology (30 Qs), Biology & Biotechnology (60 Qs), Chemistry (10 Qs) & Biochemistry (20 Qs)
- Max Marks: **480**
- Marking Scheme: + 4 for every correct answer, -1 for every wrong answer, 0 for every unattempted question
- No. of Attempts: **1**
- Schedule & Mode: Refer <https://www.manipal.edu/met> for updates

### GENERAL BIOLOGY

**Contribution of scientists to society:** Introduction to biological concepts, Biographies and contributions of scientists: Charaka, Sushruta, Charles Darwin, John Gregor Mendel, Louis Pasteur, A.I. Oparin, J.B.S. Haldane, J. C. Bose, Hermann Joseph Mueller, J.D. Watson, Francis Harry Compton Crick, Har Gobind Khorana, Francois Jacob and Jacques Monod, Marshall W Nirenberg and Frederick Sanger, Barbara McClintock, Venkatraman Ramakrishnan and others.

**Introduction to Biology:** Definition of Biology and its main branches - Botany and Zoology. Scope of Biology. Branches of Biology. Classical branches - morphology, cytology, histology, anatomy, physiology, developmental biology, biosystematics, genetics, ecology, organic evolution and palaeontology. Interdisciplinary branches - biophysics, biochemistry and biostatistics. Applied branches and career prospects - agriculture, entomology, silviculture, pathology, apiculture, microbiology and bioinformatics. Role of biology in dispelling myths and disbeliefs, **Origin of Life and Organic Evolution:** Origin of life: Introduction. Concept of abiogenesis and biogenesis (experimental evidences not required). A.I. Oparin's Theory of chemical evolution of life (views of Haldane and Sidney Fox). Stanley Miller's experiment in support of chemical evolution. Divergent and convergent evolution. Evolution of man. Organic evolution: Introduction. Darwin's Theory (DDT resistance in mosquitoes and industrial melanism in Peppered moth, to illustrate natural selection). Brief account of Mutation Theory. Neo-Darwinism - Introduction, Darwinian concept vs Neo Darwinian concept (gene pool and gene frequency). Hardy - Weinberg Law and sources of variations as evolutionary force - sexual reproduction, genetic drift, gene flow, mutation and isolation (reproductive and geographic). **Cell Biology:** Cell structure: Structure and functions of cell components - cell wall, plasma membrane (fluid mosaic model), endoplasmic reticulum, plastids (brief), mitochondria (brief), Golgi complex, Ribosomes, Lysosomes, Centrosome, vacuole and nucleus - nuclear envelope (nuclear pores and nuclear lamina) nucleoplasm, nucleolus and chromatin, a brief account of ergastic substances (reserve food, secretory and excretory substances with examples). Differences between plant cell and animal cell, Cytoskeleton, cilia, flagella, centriole, **Chromosomes:** Discovery, shape, size and number of chromosomes, Autosomes and allosomes; Karyotype and idiogram. Chemical composition and function. General structure - Concept of centromere (primary constriction), secondary constriction, satellite, kinetochore, telomere. Types of chromosomes based on the position of centromere. Ultrastructural organization of the eukaryotic chromosome - nucleosome model. Numerical aspects of chromosomes: Concepts of aneuploidy (monosomy and trisomy) and euploidy (haploidy, diploidy and polyploidy), **Cell Reproduction:** Cell division and types. Concept of cell cycle. Mitotic division and significance. Meiotic division and its significance. Cancer - meaning of cancer, benign and malignant tumours, characters of cancer cells, types of cancer (Carcinoma, Sarcoma, Lymphoma and Leukemia), causes of cancer (physical, chemical and biological carcinogens with examples). Concept of cell senescence and apoptosis. **Gene:** The gene, the genetic code and its characteristics, genetic control of protein synthesis (transcription and translation) and *Lac* operon. Concept of gene (prokaryotic and eukaryotic). **Genetics:** Mendelian genetics: Mendel and his work. Definitions of the following terms: Allele, Phenotype, Genotype, Homozygous and Heterozygous. Principles of inheritance, dominance, law of segregation (purity of gametes) and law of independent assortment. Monohybrid cross, Dihybrid cross and Test cross, **Deviations from Mendelian laws:** Incomplete dominance: Example - Flower

colour in *Mirabilis jalapa*. Pleiotropy, Polygenic inheritance, chromosomal theory of inheritance, Sex determination, Linkage and crossing over, Pedigree, **Epigenetics**: Definition, mechanisms, **Multiple allelism**: Example - ABO blood groups and their inheritance in man: Blood typing; Rh factor with a note on erythroblastosis foetalis. Sex linked inheritance in man: Example - Inheritance of colour-blindness, hypertrichosis in man, Phenylketonuria, **Genetic disorders in man**: Chromosomal disorders - Down's syndrome, Klinefelter's syndrome, Turner's syndrome and Cri-du-Chat syndrome. Gene disorders - Sickle cell anaemia, haemophilia, Thalassemia.

### ZOOLOGY

**Trends in animal body evolution** (germ layers, symmetry, body cavity, etc.), **Principles of animal classification, nomenclature and concept of species, General characteristics and classifications: Protozoa**: Type study: *Paramecium* (structure and reproduction), **Porifera**: Type study: *Leucosolenia*, types of spicules and cells, water canal systems, **Cnidaria**: Type study: *Obelia* (structure and life cycle), structure of nematocyst, **Platyhelminthes**: Type study: *Fasciola hepatica* (structure and life cycle), **Nematoda**: Type study: *Ascaris* (structure and life cycle), **Annelida**: Type study: *Nereis* (morphology), metamerism, **Arthropoda**: Type study: *Paneus* (morphology), life cycles of silk worm, **Mollusca**: Type study: *Lamellidens* (shell structure and internal anatomy), **Echinodermata**: Type study: Star fish (morphology), water vascular system, **Fishes**: Type study: *Scoliodon* (morphology), scale types, accessory respiratory organs in fishes, migration in fishes, **Amphibia**: Type study: *Rana tigrina* (morphology), digestive system, urogenital systems and respiratory system, Parental care in Amphibia, **Reptilia**: Amniotic egg, identification of poisonous and non-poisonous snakes, poison apparatus and mechanism of biting, Jacobson's and pit organs, snake venom and its importance, **Aves**: Type study: Ostrich (morphology), flight adaptations, flightless birds, **Mammalia**: Type study: Rat (morphology), dentition in mammals, adaptive radiations in mammals

### BOTANY

**Biodiversity of flora, taxonomy, importance and its conservation**: General characters and economic (food, medicine and industry) importance of Cyanobacteria, Fungi, Algae, Lichens, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. Principles of Plant taxonomy- Branches of taxonomy, principles of nomenclature and its significance, artificial, natural and phylogenetic systems. Rare, endangered and threatened plants, Conservation strategies -in situ and ex situ conservation, gene and DNA banks, and cryopreservation methods,

**Physiology: Plant-water relations**: Definition of Diffusion, Osmosis, Plasmolysis, Imbibition, Active & Passive absorption, Ascent of sap, Loss of water (Transpiration and Guttation) and Translocation of solutes.

**Photosynthesis**: Mechanism of photosynthesis - light reactions, electron transport, Dark reactions, photorespiration, C4 and CAM pathways.

**Respiration**: Definition and significance, EMP pathway (Glycolysis), Pentose Phosphate pathway, Krebs cycle and electron transport system, Anaerobic respiration, Fermentation, R.Q., factors affecting respiration,

**Plant Growth**: Definition of growth, phases of growth (cell division, enlargement and differentiation), factors affecting growth rate – External factors – light (photoperiodism) and temperature (vernalization); Internal factors – phytohormones – natural and synthetic. Secondary metabolites - biosynthesis and role.

**Plant Pathology**: Plant disease epidemiology, defence mechanism in plants, mode of infection, symptoms and control measures for the following pathogens: Virus – TMV, Bacteria - Citrus canker, Fungi – Tikka disease, Nematodes – Root knot disease.

**Plant Cell, Tissue and Organ Culture**: Culture of plant cell, tissue and organ culture, differentiation, dedifferentiation and redifferentiation, direct and indirect organogenesis, direct and indirect somatic embryogenesis, plantlet regeneration.

**Manipulation of plants**: Methods and application of Conventional breeding, plant tissue culture, genetic engineering, advantages and disadvantages. Genetically engineered crops in India and world, advantages and disadvantages..

### CHEMISTRY

**Periodic properties**: Atomic radius, covalent, ionic & van der Waal's radii, ionization energy, electron affinity and electronegativity – definition, trends in periodic table, **Acids and Bases**: Arrhenius, Bronsted-Lowry, Lux-Flood, Solvent system and Lewis concepts of acids and bases with examples. Conjugate acid-base pairs. Limitations of the theories. Hard and Soft Acids and Bases (HSAB): Classification of acids and bases as hard and soft-examples and comparison, Pearson's HSAB concept-acid base strengths and hardness and softness. Electronegativity and hardness and softness – explanation, **Bioinorganic chemistry**: Photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, **Thermodynamics**: Introduction, terminologies associated with thermodynamics, 1st law of thermodynamics, Heat capacity, relation between  $C_p$  and  $C_v$  (no derivation), Joule Thomson effect, 2nd law of thermodynamics, entropy and its significance. Gibbs free energy and Helmholtz free energy, their relationships. Thermodynamics of biological systems - importance of Gibbs

free energy, G, **Ionic Equilibria:** Common ion effect, solubility product and application in salting out soap and purification of common salt, Henderson's equation, buffer solutions, buffer action, buffer capacity, pH values of buffer mixtures, preparing buffers of desired pH, hydrolysis of salts, hydrolysis constants, relationship between  $K_h$ ,  $K_a$ ,  $K_b$  and  $K_w$  for various types of salts, degree of hydrolysis, **Chemical kinetics:** Law of mass action, Rate of reaction, Order and molecularity of reaction, I, II & III order reactions, Derivation of rate equations for I, II and  $n^{\text{th}}$  order reactions, determination of order (differential, half-life and isolation methods). Effect of temperature of reaction rates-Arrhenius equation, **Oils, Fats & Waxes:** Composition of oils, fats & waxes, analysis of fats and oils - Acid value, saponification value, iodine value, Polenske value, Reichert-Meisss value, acetyl value, manufacture of soap, cleaning action of soaps & detergents, **QSAR:** The basic concepts of structure activity relationships (SAR) and quantitative structure activity relationships (QSAR), QSAR parameters – Physicochemical parameters Lipophilicity – Electronic parameters, Steric parameters, effect of electronic and steric parameters on lipophilicity. Hansch analysis, significance of slopes and intercepts in Hansch analysis. 3D QSAR approach, **Stereochemistry of Organic Compounds:** Optical isomerism-elements of symmetry, chirality, enantiomers, optical activity, properties of enantiomers- chiral and achiral molecules with two stereogenic centres e.g., Lactic acid and Tartaric acid. Diastereomers-definition & examples, threo and erythro diastereomers, meso compounds-definition and examples, Resolution of enantiomers – mechanical, chemical and biochemical methods. Relative and absolute configuration, sequence rules, D&L, R&S systems of nomenclature. Geometrical isomerism, cis-trans, E-Z, syn-anti configurations, **Green Chemistry:** Definition and principles, planning a green synthesis in a chemical laboratory, Green Preparation-Aqueous phase reactions, solid state (solvent less) reactions, photochemical reactions, Phase transfer catalyst catalysed reactions, enzymatic transformations & reactions in ionic liquids. **Analytical Techniques:** Titrations, spectroscopy/spectrometry, chromatography, and gravimetry analysis for qualitative and quantitative determination of concentration of compounds and structural characterizations.

### **BIOCHEMISTRY**

**Biomolecules, Carbohydrates:** Definition. Classification - monosaccharides (ribose, deoxyribose, glucose, fructose and galactose), oligosaccharides (maltose, sucrose and lactose) and polysaccharides (starch, glycogen, cellulose, pectin, chitin and agar agar). Biological significance, **Proteins:** Definition. Classification - simple proteins (albumins, globulins, histones, actin, myosin and keratin), conjugate proteins - Chromoproteins (haemoglobin), glycoproteins (mucin of saliva), phosphoproteins (casein of milk) and lipoproteins (lipovitelline of egg yolk). Biological significance of amino acid and proteins, **Lipids:** Definition. Classification - Simple lipids - oils (vegetable oil and oil of animal origin), fats (butter) and waxes (beeswax), Compound lipids - phospholipids (lecithin and cephalin) and sphingolipids (cerebrosides), Related compounds - steroids (estrogen, progesterone and testosterone), sterols (cholesterol) and prostaglandins. Biological significance, **Nucleic acid:** Occurrence, basic chemical composition (nucleoside and nucleotide), type (DNA and RNA) and functions, **Enzymes:** Definition, properties, classification based on functions. Mode of action - induced fit theory of Koshland, **Metabolism of carbohydrates and lipids, Metabolism of amino acids (glycine, Sulphur-containing amino acids, tyrosine, tryptophan)**

### **BIOTECHNOLOGY**

**Introduction:** Scope of biotechnology, **Molecular Techniques and Genetic Engineering:** Introduction; Tools used in genetic engineering - Vectors (plasmids), Enzymes (REN and Ligase), Host cell (E.coli), PCR, Transformation, Nucleic Acid Hybridization, Microarrays, Microscopy & Imaging, Animal and Plant Tissue Culture, Bioreactors. **Recombinant DNA technology and its applications:** Insulin synthesis to be used as an example, **DNA fingerprinting, Gene therapy, Human genome project, Monoclonal antibodies, Improvement of crop plants:** Breeding techniques; Tissue culture technique - organ culture example: stem; transgenic plants example: Golden rice, **Improvement of animals:** Breeding techniques and stem cell culture, transgenic animals, example- Cattle. Hazards and safeguards of genetic engineering, **Ecology:** ecosystem- structure and function, biotic and abiotic factors, productivity, decomposition, energy flow, ecological pyramids, ecological succession, biogeochemical cycles( C, P, N),ecosystem services, Population interactions- mutualism, competition, predation and parasitism, **Biodiversity: Definition and Types:** Ecosystem or habitat diversity, Species diversity and Genetic diversity, **Biodiversity profiles of India and Karnataka:** Species diversity, Endemic species, Threatened species and Endangered species, **Benefits of biodiversity:** Economic - Traditional crop varieties and lesser known plants and animals of food value, medicinal plants harvested from wild habitat. Ecological / Social - For controlling soil - water regimes and hydrology, for efficient organic residue management and soil fertility management. Ethical - Cultural, Spiritual and Religious belief systems centered on the concepts of sacred species, sacred groves and sacred landscapes, **Biodiversity depletion:** Anthropocentric causes - urbanization, expansion of agriculture, deforestation, pollution, acidification of soil and water, mining activities, desertification and loss of soil fertility. **Concept of ecosystem sustainability:** Conservation of natural resources based on traditional ecological knowledge (TEK): Conservation of Water - rainwater harvesting and watershed management. Conservation of soil - Prevention of soil erosion and maintenance of soil fertility: methods of soil conservation. Conservation of forests - Afforestation and maintenance of

biosphere reserves. **Conservation of wild life:** Setting up of national parks, sanctuaries, bioserves and zoos, Habitat improvement, **Global issues:** Pollution – a brief account of air pollution, water pollution, solid wastes, radioactive waste and agricultural waste. Concept, causes, effects and control measures of the following: Global warming and greenhouse effect, Ozone layer depletion, Acid rain, Nuclear winter, **Man in Health and Diseases:** Concept of Homeostasis - The central Dogma in physiology: Definition. Meaning of internal environment. Factors to be kept constant to achieve homeostasis. An example to illustrate homeostasis - regulation of blood glucose level by liver and pancreas through negative feedback. A note on diabetes mellitus, **Body Defense and Immunity:** Introduction. Nonspecific body defenses: a) Surface barriers b) Cellular and bio-chemical defenses: phagocytosis, natural killer cells, interferons and inflammatory response. Specific body defenses (immunity): Antigen and antibody, role of B and T lymphocytes. Types of immunity: Active (infection and vaccination) and Passive (from mother and immune serum Y-globulins)

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♣ **Best of Luck** ♣

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