# BIOLOGY (863)

## CLASS XII

*There will be two papers in the subject:*

***Paper I:*** *Theory: 3 hours ... 70 marks*

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***Paper II****: Practical: 3 hours ... 15 marks*

*Project Work ... 10 marks*

*Practical File ... 5 marks*

### PAPER I- THEORY: 70 Marks

| S. No. | UNIT | TOTAL WEIGHTAGE |
|---|---|---|
| 1. | Reproduction | 16 Marks |
| 2. | Genetics and Evolution | 15 Marks |
| 3. | Biology and Human Welfare | 14 Marks |
| 4. | Biotechnology and its Applications | 10 Marks |
| 5. | Ecology and Environment | 15 Marks |
| **TOTAL** | | **70 Marks** |

## PAPER I –THEORY – 70 Marks

**All structures (internal and external) are required to be taught along with diagrams.**

### 1. Reproduction

(i) Sexual reproduction in flowering plants

Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; outbreeding devices; pollen-pistil interaction; artificial hybridisation, double fertilization; post fertilization events - development of endosperm and embryo, development of seed and formation of fruit; special modes - apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation.

*Pre-fertilisation structures and events.*

*Structure of microsporangium, T.S. of anther microsporogenesis, structure and development of pollen grain, viability of pollen grain, economic importance of pollen grain. Pistil – structure of megasporangium (L.S. of anatropous ovule), megasporogenesis, structure and development of female gametophyte.*

*Types of pollination (autogamy, chasmogamy, cleistogamy, geitonogamy, xenogamy), adaptations in flowers pollinated by wind, water and insects. Advantages of self and cross-pollination. Contrivances for prevention of self-pollination. Pollen-pistil interaction in terms of incompatibility/compatibility, events leading to fertilisation, artificial hybridisation: procedure (emasculation and bagging), and its significance in plant breeding); definition of triple fusion and double fertilization, significance of double fertilisation, changes in the ovary and ovule for seed and fruit formation; apomixis, polyembryony, parthenocarpy to be explained briefly. Fruits to be classified into true and false, structure (L.S) of a typical fruit (mango and coconut); Internal structure of dicot (bean) and monocot (maize) seeds; definition, differences and examples of albuminous and non-albuminous seeds. Significance of seed and fruit formation. Significance of dispersal of seeds.*

*Post-fertilisation events - embryo formation (monocot and dicot); types of endosperm (cellular, nuclear and helobial); definition of perisperm.*

(ii) Human Reproduction

Male and female reproductive systems; microscopic anatomy of testis and ovary; gametogenesis - spermatogenesis and oogenesis; menstrual cycle; fertilisation, embryo development upto blastocyst formation, implantation; pregnancy and placenta formation (elementary idea); parturition (elementary idea); lactation (elementary idea).

*Organs of male and female reproductive system and their functions; internal structure of testis and ovary to be taught with the help of diagrams; gametogenesis-spermatogenesis (including spermiogenesis and spermiation) oogenesis; hormonal control of gametogenesis, structure of sperm and mature ovum, menstrual cycle - different phases and hormone action, differences between oestrous and menstrual cycle, menarche and menopause, physico-chemical events during fertilisation, implantation, embryonic development up to blastocyst formation, important features of human embryonic development (formation of heart, limbs, digits, appearance of hair on head, eyelashes, separation of eye lids, external genital organs and first movement of foetus with reference to time period) placenta and its functions (structure and the types of placenta not required). Parturition; lactation – hormonal control and importance.*

(iii) Reproductive Health

Need for reproductive health and prevention of Sexually Transmitted Diseases (STDs); birth control - need and methods, contraception and medical termination of pregnancy (MTP); amniocentesis; infertility and assisted reproductive technologies (elementary idea for general awareness).

*Definition of reproductive health, programs of reproductive health (family planning, RCH),*

*population explosion - role of government in controlling the population, contraceptives methods and their methods of action (natural- periodic abstinence, withdrawal or coitus interruptus, lactational amenorrhea; artificial – barriers, IUDs, oral pills, spermicidal agents, implants and surgical methods, definition of medical termination of pregnancy (MTP) and reasons for it; causes of infertility. Amniocentesis and its role in detecting genetic defects. Assisted reproductive technologies: IVF, IUT, ZIFT, ICSI, GIFT, AI, IUI. - definition and application only. Causes, symptoms and methods of prevention of sexually transmitted diseases (genital warts, genital herpes, hepatitis- B, AIDS gonorrhoea, syphilis, chlamydiasis, trichomoniasis).*

**2. Genetics and Evolution**

(i) Principles of inheritance and variation

Heredity and variation: Mendelian inheritance; deviations from Mendelism - incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups, pleiotropy; elementary idea of polygenic inheritance; chromosomal theory of inheritance; sex determination; linkage and crossing over; mutation; sex linked inheritance; Mendelian disorders in humans; chromosomal disorders in humans.

*Explanation of the terms heredity and variation; Mendel's Principles of inheritance; reasons for Mendel's success; Biological importance of Mendelism; definition of homologous chromosomes, autosomes and sex chromosomes; alleles – dominant and recessive; phenotype; genotype; homozygous; heterozygous, monohybrid and dihybrid crosses; back cross and test cross, definitions to be taught with simple examples using Punnett square. Incomplete dominance with examples from plants (snapdragon - Antirrhinum).- Co-dominance and multiple allelism – (pattern of inheritance of ABO blood group in humans), polygenic inheritance with an example of inheritance of skin colour in humans (students should be taught examples from human genetics through pedigree charts. They should be able to create a pedigree chart and interpret the patterns of inheritance by analysis of pedigree chart). Pleiotropy with reference to the example of Phenylketonuria (PKU) in human beings and starch synthesis in pea seeds. Chromosomal theory of inheritance; sex determination in humans, birds, honey bees and grasshopper, sex-linked inheritance - with reference to Drosophila (colour of body-yellow and brown; and colour of eyes-red and white), and man (haemophilia and colour blindness), definition and significance of linkage and crossing over. Mutation: spontaneous, induced, gene (point – transition, transversion and frame-shift); human genetic disorders: phenylketonuria, thalassaemia, colour blindness, sickle cell anaemia; chromosomal disorders: Down's syndrome, Klinefelter's syndrome, Turner's syndrome.*

(ii) Molecular basis of Inheritance

Search for genetic material; structure of DNA and RNA; DNA packaging; DNA replication; central dogma; transcription, genetic code, translation; regulation of gene expression - lac operon; human genome project; DNA fingerprinting.

*Structure of eukaryotic chromosomes with reference to nucleosome; properties of ideal genetic material such as ability to replicate, chemical stability, mutability and inheritability. Search for DNA as genetic material - Griffith's experiment, Hershey and Chase's experiment, Avery, McLeod and McCarty's experiment; double helical model of DNA (contributions of Miescher, Watson and Crick, Wilkins, Franklin and Chargaff); Differences between DNA and RNA; types of RNA (tRNA, mRNA and rRNA, snRNA, hnRNA); central dogma; reverse transcription (basic idea only), replication of DNA (role of enzymes, namely DNA polymerase and ligase), Meselson and Stahl's experiment, and Taylor's experiment. transcription, post-transcriptional processing in eukaryotes (splicing, capping and tailing). Intron, exon, cistron, recon, muton, monocistronic and polycistronic transcription unit (definitions only). Discovery and essential features of genetic code. Definition of codon. Protein synthesis - translation*

*in prokaryotes. Gene expression; lac operon in E. coli.*

*Human Genome Project: goal; methodologies [Expressed Sequence Tags (EST), Sequence Annotation], salient features and applications. DNA finger printing – technique, application and ethical issues to be discussed briefly.*

(iii) Evolution

Origin of life; biological evolution and evidences for biological evolution (palaeontology, comparative anatomy, embryology and molecular evidences); Darwin's contribution, modern synthetic theory of evolution; mechanism of evolution - variation and natural selection with examples, types of natural selection; gene flow and genetic drift; Hardy - Weinberg's principle; adaptive radiation; human evolution.

*Origin of life - abiogenesis and biogenesis, effect of oxygen on origin of life to show that reducing atmosphere is essential for abiotic synthesis. Important views on the origin of life (panspermia, spontaneous generation), modern concept of origin of life, Oparin Haldane theory (definition of protobionts, coacervates); Miller and Urey experiment. Evidences of evolution: morphological evidences, definition and differences between homologous and analogous organs (two examples each from plants and animals), convergent evolution and divergent evolution, vestigial organs; Embryological evidences – theory of recapitulation, definition and differences between ontogeny and phylogeny. Palaeontological evidence – definition of fossils and radioactive carbon-dating. Geological time scale (with reference to dominant flora and fauna) Biogeographical evidence – definition of biogeography, molecular (genetic) evidences -for example genome similarity, universal genetic code; Darwin's finches and marsupials (adaptive radiation).*

*Darwinism: salient features of Darwinism, contribution of Malthus. Examples of natural selection – Long neck of giraffe, industrial melanism, resistance of mosquitoes to DDT and resistance of bacteria to antibiotics, Lederberg's replica plating experiment, criticism of Darwinism. Neo-Darwinism (Modern Synthetic Theory); gene migration or gene flow, genetic drift (Founder's effect, bottle-neck effect), mutation, genetic recombination and natural selection, Hugo de Vries theory of mutation - role of mutation in evolution; Hardy Weinberg's principle, factors affecting Hardy Weinberg equilibrium (numericals on Hardy Weinberg equilibrium), Variation - causes of variation (mutation and recombination), types of natural selection (directional, disruptive and stabilizing). Evolution of man - three features (for example cranial capacity, height, posture, dentition, social behaviour, etc.) of each of the ancestors Dryopithecus, Ramapithecus, Australopithecus, Homo habilis, Homo erectus, Homo neanderthalensis, Cro-magnon man leading to man of today (Homo sapiens sapiens).*

## 3. Biology and Human Welfare

(i) Human Health and Diseases

Pathogens; parasites causing human diseases (viruses, bacteria, protozoans, helminths, and fungi);Basic concepts of immunology - vaccines; cancer, HIV and AIDS; Adolescence - drug and alcohol abuse.

*Communicable diseases; modes of transmission, causative agents, symptoms and prevention; viral diseases (common cold, chikungunya and dengue), bacterial diseases (typhoid- diagnosed by Widal test, pneumonia, diphtheria and plague), protozoal diseases (amoebiasis, and malaria, graphic outline of life cycle of Plasmodium), helmintic diseases (ascariasis, and filariasis); fungal (ringworms); cancer - types of tumour (benign, malignant), causes, diagnosis and treatment (surgery, immunotherapy, and radiotherapy), characteristics of cancer cells (loss of contact inhibition and metastasis); allergies and allergens – definition and general symptoms of allergies.*

*Immunity (definition and types – innate immunity - role of physical barriers,*

*physiological barriers, cellular barriers, and cytokine barriers; and acquired, active and passive, humoral and cell-mediated), Interferons – definition, source and function; structure of a typical antibody molecule, types of antibodies - IgG, IgA, IgM, IgD and IgE (function and occurrence, e,g. in serum, saliva, colostrum); vaccination and immunisation; autoimmunity, primary and secondary lymphoid organs and tissues, brief idea of AIDS – causative agent (HIV), modes of transmission, diagnosis (ELISA), symptoms, replication of retrovirus in the infected human cell (including diagram) and prevention.*

*Alcoholism and smoking - effects on health.*

*Drugs: effects and sources of opioids, cannabinoids, cocaine and barbiturates.*

*Reasons for addiction; prevention and control of alcohol and drug abuse.*

(ii) Microbes in Human Welfare

In household food processing, industrial production, sewage treatment, energy generation and microbes as biocontrol agents and biofertilisers. Antibiotics.

*Use of microbes in: (i) Household products: Lactobacillus (curd), Saccharomyces (bread), Propionibacterium (Swiss cheese); (ii) Industrial products: beverages (with and without distillation), antibiotics (Penicillin – discovery and use); sources (microbes) and uses of organic acids, alcohols and enzymes (lipase, pectinase, protease, streptokinase) in industry, sources (microbes) and applications of Cyclosporin-A, Statins. (iii) Sewage treatment – primary and secondary treatment; (iv) Production of biogas (methanogens, biogas plant, composition of biogas and process of production); (v)Biocontrol agents (ladybird, dragonfly, Bacillus thuringiensis Trichoderma, Nucleopolyhedrovirus (Baculovirus), and (vi) Microbes as biofertilisers (Rhizobium, Azospirillum, Azotobacter, Glomus, Mycorrhiza, Cyanobacteria), IPM, harmful effects of chemical pesticides.*

## 4. Biotechnology and its Applications

(i) Biotechnology - Principles and processes

Genetic Engineering (recombinant DNA technology).

*Definition and principles of biotechnology; isolation of genomic (chromosomal) DNA (from bacteria/plant cell/animal cell, by cell lysis), isolation of gene of interest (by electrophoresis), steps of formation of recombinant DNA, discovery, nomenclature, features and role of restriction enzymes (EcoRI, HindII) and role of ligase; cloning vectors (features of a good cloning vector, examples of cloning vectors like pBR322, Agrobacterium, retroviruses, bacterial artificial chromosome (BAC), yeast artificial chromosome (YAC)), methods of transfer of rDNA into a competent host, e.g. by direct-method (temperature shock), microinjection, gene gun, methods of selection of recombinants (antibiotic resistance, insertional inactivation/blue-white selection), cloning of recombinants, i.e., gene amplification (by in vivo or in vitro method - using PCR technique), bioreactor (basic features and uses of stirred tank and sparged tank bioreactors), downstream processing.*

(ii) Biotechnology and its applications

Applications of biotechnology in health and agriculture: human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, biopiracy and biopatents.

*In agriculture: Micropropagation and somatic hybridisation techniques for production of GM crops tolerant to abiotic stresses (cold, drought, salt, heat); pest-resistant crops (Bt-crops, RNAi with reference to Meloidogyne incognita); crops with enhanced nutritional value (golden rice).*

*In medicine: insulin, vaccine production, definition of stem cells and application of stem cell technology; gene therapy - with reference to treatment of SCID, molecular diagnosis by PCR, ELISA (the details of the technique of ELISA are not required), and use of DNA/RNA probes.*

*Transgenic animals for bioactive products like alpha-1-antitrypsin for emphysema, alpha-lactalbumin; vaccine safety testing, chemical safety testing; study of diseases.*

*Role of GEAC, definition and two examples of biopiracy (for example Basmati rice and turmeric), biopatent; ethical issues.*

## 5. Ecology and Environment

(i) Organisms and Populations

Population; population interactions - population attributes - growth, birth rate and death rate, age distribution.

*Definition of population; population attributes: sex ratio, types of age distribution pyramids for human population; definition of population density, natality, mortality, emigration, immigration, carrying capacity. Ways to measure population density. Calculation of natality and mortality.*

*Population growth: factors affecting population growth and population growth models: exponential growth and logistic growth models along with equations, graph and examples of the same; life history variations: definition of reproductive fitness and examples.*

*Population interactions – definition of mutualism, competition (interspecific, interference, competitive release and Gause's Principle of Competitive Exclusion), predation (adaptations in organisms to avoid predation), parasitism (ecto-, endo-, and brood parasites), commensalism, amensalism.*

(ii) Ecosystem

Ecosystems: patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, energy.

*Definition and types of ecosystems; structure of ecosystem (brief idea about biotic and abiotic components).*

*Structure and function of pond ecosystem; ecosystem functions: (i) Productivity – gross primary productivity (GPP), net primary productivity (NPP) and secondary productivity (ii) Decomposition (fragmentation, leaching, catabolism, humification and mineralization), factors affecting rate of decomposition (iii) Energy flow. Various types of food chains – grazing and detritus, food webs, trophic levels, ecological pyramids – energy, number and biomass.*

*Definition of PAR, 10% Law, standing crop and standing state.*

(iii) Biodiversity and its Conservation

Concept of biodiversity; patterns of biodiversity; importance of biodiversity; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, biosphere reserves, national parks, sanctuaries and Ramsar sites

*Definition of biodiversity, few examples of each type of biodiversity - species, ecosystem and genetic. Global biodiversity and proportionate number of species of major taxa of plants, invertebrates and vertebrates; patterns of biodiversity (latitudinal gradients, species-area relationship – graph and equation), "rivet popper hypothesis", importance of species diversity to the ecosystem (narrowly utilitarian, broadly utilitarian, ethical terms).*

*Examples of some recently extinct organisms (dodo, quagga, Steller's Sea cow, thylacine and the three sub-species of tiger – Bali, Caspian and Javan), causes of loss of biodiversity (habitat loss and fragmentation, over-exploitation, alien species invasion, co-extinction).*

*Biodiversity conservation: In-situ methods - protected areas: biosphere reserves, national parks, wildlife sanctuaries, sacred groves; ex-situ methods - captive breeding, zoo, botanical gardens, cryopreservation, wild life safari, seed banks, tissue culture. Definitions and examples of each of the above. Hotspots, Ramsar sites and Red Data Book.*

*The place, year and main agenda of historic conventions on biological diversity (the Earth Summit and the World Summit).*

**Note:** Topics having numerical problems to be taught with illustrative examples.

## PAPER II
## PRACTICAL WORK – 15 Marks

**(1) Taxonomy**: Study floral characteristics through dissection of flowers, drawing floral formula and diagrams of following families:

(i) Malvaceae: type – China rose / Hollyhock.

(ii) Leguminosae: subfamily – Papilionaceae – type – Sweet pea/ Pea/ Bean/ *Sesbania*/ *Clitoria* (single flower).

(iii) Solanaceae: type – *Petunia* / *Datura* / Brinjal Flower / *Solanum nigrum*.

(iv) Liliaceae: type – Onion or Amaryllidaceae – type – Lily/Spider lily/ Tiger lily/ Tube rose/ *Gladiolus*.

(v) Cruciferae: type – mustard, candytuft (*Iberis* sp)

(vi) Compositae (Asteraceae): type sunflower, *Chrysanthemum*, *Cosmos*, *Dahlia*, Marigold.

(vii) Gramineae (Poaceae): type – wheat, corn, rice

*Floral characteristics should be explained by dissection of flowers. Students should be taught how to cut vertical section of the flower and draw accurately labelled diagrams. The technique of drawing floral diagrams with the* ***mother axis in the right position is necessary.*** *Floral formula should be correctly written. Identification of the correct family giving reasons, technique of cutting T.S. and L.S of ovary should be explained and accordingly correct labelled-diagram should be drawn.*

*Students should know the examples of plants (belonging to each family) which are of economic importance. The examples of common names of plants must be supported with correct scientific names as well.*

***NOTE: In the examination, candidates will be tested on <u>any one</u> of the above families.***

**(2) Simple biochemical and physiological experiments**

(i) Study of arrangement/distribution of stomata in dicot and monocot leaves.

(i) Study of soils from ***two different sites***.

*Collect soil samples from two different areas and make a comparative study of their texture, moisture content, humus content, water holding capacity and pH.*

***Guidelines for collection of soil samples:***

- *Texture - loamy, sandy and clayey soil.*
- *Moisture content – Soil samples are to be collected from a dry place and a wet place. Alternatively, samples of soil can be dried to different degrees in oven/by keeping in sun.*
- *Humus Content – Collect one sample from roadside/barren land and one sample from garden/cultivated field.*
- *Water holding capacity – Pour given amount of water in known weight of soil sample and record the volume of water retained by the soil sample.*
- *pH – Add distilled water to the soil sample and test with pH paper.*

*Students should be taught to set up and demonstrate the experiments with correct diagram of the setup, record their observations methodically and give conclusions. This will give a clear idea of the physiological processes. Questions can be asked based on the above physiological processes studied.*

(ii) To study the effect of enzyme action at three different temperatures and pH on starch solution.

*Effect of enzyme (amylase/ diastase) action at three different temperatures (low- below 10°C, optimum - 37°C and high – above 70°C) and pH (acidic, neutral and basic) on starch solution.*

(iii) To isolate DNA from available plant material.

*Isolation of DNA from spinach leaves, green pea seeds, pulp of banana and papaya.*

*Take half a ripe and peeled banana into a beaker and add 50 ml of extraction fluid (1.5gm table salt +10 ml liquid detergent +90 ml distilled water). Place the beaker in a water bath set at 60 °C for 15 minutes. Stir gently with a glass rod. Filter 5ml of cooled content into a clean test tube and add 5ml of cold 90% ethanol. DNA molecules separate out and appear as white fibres.*

**(3) Slide preparation**

(i) Germination of pollen grain in a nutrient medium.

(ii) T.S. of ovary of any locally available flower, to show marginal / axile placentation.

(iii) T.S. of a hydrophyte stem.

(iv) T.S. of a xerophytic leaf (*Nerium).*

(v) L.S. of monocot and dicot seed (soaked seeds of maize/wheat, pea/ bean.)

*The technique of staining and mounting neatly should be explained. Students should also know how to make labelled outline diagrams. They should also be taught to identify the mount under low/ high power of microscope.* ***Two*** *identifying features of the above need to be mentioned.*

**(4) Spotting: (three minutes to be given for each spot which includes identification, drawing a labelled diagram and writing at least two identifying characteristics).**

**NOTE: Spotting must be done on a separate answer sheet during examination, which should be handed over to the Examiner immediately after spotting.**

(i) Identify and comment on the following:

(a) T.S. of ovary of mammal (chart/slide).

(b) T.S. of testis of mammal (chart/slide).

(c) Germinating pollen grain (slide/chart).

(d) T.S. of ovary to show the type of placentation (marginal, axile, basal (LS), parietal).

(e) T.S. of blastula / blastocyst of a mammal (chart/ slide).

(f) Whole mount of *Plasmodium* sporozoite (slide /chart).

(g) Whole mount of *Entamoeba histolytica* trophozoite (slide/chart).

(h) Preserved specimen/ chart/ model of *Ascaris.*

(ii) Comment upon ecological adaptations of plants and animals.

*Models/ virtual images/ charts of one plant and one animal found in xeric and aquatic habitats. Examples: Hydrilla, cactus, fish and camel.*

(iii) Flowers adapted to pollination by different agencies – insect, water and wind.

*Students should be able to identify the type of pollination of the given flower, draw the diagram of the flower and* ***give two reasons*** *for the type of pollination. Example: Hibiscus and grass.*

*Students should be taught how to identify, draw, label and give significantly visible characteristics as observed, of each spot, in a given time of three minutes. 'T.S.', 'model', 'whole mount', 'chart', 'image' of the specimen should be mentioned as a part of identification.*

## PROJECT WORK AND PRACTICAL FILE – 15 Marks

**Project Work – 10 Marks**

The project work is to be assessed by a Visiting Examiner appointed locally and approved by CISCE.

The candidate is to creatively execute **one** project/assignment on an aspect of biology. Preference is to be given to handwritten original investigatory projects, no plagiarism allowed. Candidates are required to submit a **hard copy** of their computer-generated projects duly signed by the Internal Examiner (and the Head of the Institution) for physical verification and assessment. Teachers may assign or students may choose any **one** project of their choice. Students can choose any other project besides the ones indicated in the list. Following is **only a suggestive** list of topics:

(i) Genetic disorders
(ii) Gene therapy
(iii) Human Genome Project
(iv) DNA fingerprinting
(v) Bio-piracy
(vi) Cancer.
(vii) AIDS/Hepatitis.
(viii) Drug addiction and community.
(ix) Role of micro-organisms in industry.
(x) Human population.
(xi) Mendelian Inheritance
(xii) Environmental resistance.
(xiii) Traditional and modern methods: Study of a few traditional methods of pest deterrence vis-

a-vis modern methods of pest control - viability of traditional methods in today's scenario and limitations and dangers of modern methods.

(xiv) Role of agrochemicals in increasing food production.

**Suggested Evaluation Criteria for Project Work:**

Format of the Project:

| |
|---|
| – Content |
| – Introduction |
| – Presentation (graphs, tables, charts, newspaper cuttings, diagrams, photographs, statistical analysis if relevant) |
| – Conclusion/ Summary |
| – Bibliography |

**Practical File – 5 Marks**

The Visiting Examiner is required to assess students on the basis of the Biology Practical file maintained by them during the academic year.

The practical file should cover all the practical exercises outlined in the syllabus. Each practical done during the year, needs to be recorded date wise by the student in the Practical file and the same must be checked, signed and dated by the teacher.

**SCIENTISTS AND THEIR CONTRIBUTIONS:**

1. Oparin: Coacervates, Conditions on primitive earth were favourable for chemical evolution
2. Stanley Miller & Harold Urey: Conducted experiment to validate Oparin's theory.
3. Ernst Haeckel: Proposed the recapitulation theory
4. Charles Darwin: Natural Selection
5. Hugo de Vries: Mutation
6. T. R. Malthus: Theory of Human Population Growth/ Essays on population
7. Alec Jeffreys: DNA finger printing
8. Temin and Baltimore: Reverse transcription.
9. Jacob, Monod and Lwoff: proposed Lac operon.
10. Watson and Crick: Structure of DNA
11. Nirenberg and Khorana: Genetic code
12. Benzer: Cistron, recon, muton
13. Gregor Mendel: Father of genetics
14. Sutton and Boveri: Chromosomal theory of inheritance
15. Hugo de Vries, Correns and Tschermack: Rediscovered Mendelism
16. T H Morgan: Linkage
17. P Maheshwari: Plant tissue culture
18. Henking: Discovered X-chromosome
19. F. Miescher: Isolated nucleic acid from pus cells, called Nuclein
20. Chargaff: Rule of equivalence in DNA structure
21. F. Griffith: Transformation in bacteria
22. Avery, MacLeod and McCarty: DNA is the genetic material
23. Hershey and Chase: DNA is the genetic material
24. Meselson and Stahl: Semi-conservative replication of DNA
25. G. Gamow: Triplet nature of codons
26. S Ochoa: Discovered polynucleotide phosphorylase
27. Wallace: Divided the Earth into biogeographical regions
28. M S Swaminathan: Green revolution in India
29. H Boyer: Discovered Restriction Enzyme
30. S Cohen: Developed the method to transfer plasmid DNA in host cells
31. R. Mishra: Father of Indian Ecology
32. E. Wilson: Coined the term Biodiversity
33. P Ehrlich: Rivet Popper Hypothesis
34. Sanger: DNA/Protein sequencing
35. Ernest Chain and Howard Florey – Use of Penicillin as a lifesaving antibiotic

**LIST OF ABBREVIATIONS TO BE STUDIED**

1. ADA- Adenosine Deaminase
2. CMI- Cell Mediated Immunity
3. DFC- Detritus Food Chain
4. EFB- European Federation of Biotechnology
5. EST- Expressed Sequence Tags
6. ET- Embryo Transfer
7. GFC- Grazing Food Chain
8. GMO- Genetically Modified Organism
9. GPP- Gross Primary Productivity
10. hnRNA - Heterogeneous Nuclear Ribo Nucleic Acid
11. IARI- Indian Agricultural Research Institute

12. IMR- Infant Mortality Rate
13. IRRI- International Rice Research Institute
14. ICSI - Intra Cytoplasmic Sperm Injection
15. IUCD/IUD – Intra uterine contraceptive device
16. IUCN- International Union for Conservation of Nature and Natural Resources
17. IUI- Intra Uterine Insemination
18. IUT- Intra Uterine Transfer
19. KVIC- Khadi and Village Industries Commission
20. LAB- Lactic Acid Bacteria
21. MALT- Mucosa Associated Lymphoid Tissue
22. MMR- Maternal Mortality Rate
23. NACO- National AIDS Control Organisation
24. NPP- Net Primary Productivity
25. PID- Pelvic Inflammatory Diseases
26. PKU- Phenyl ketonuria
27. RCH- Reproductive and Child Health Care Programmes
28. SCID – Severe Combined Immuno Deficiency
29. SNPs - Single Nucleotide Polymorphisms
30. snRNA- Small Nuclear Ribo Nucleic Acid
31. sRNA - Soluble Ribo Nucleic Acid
32. SSBP – Single Strand Binding Protein
33. UTR - Untranslated Region
34. VNTRs - Variable Number of Tandem Repeats