PART - I (BIO-BOTANY)

SECTION – 1

1. (c)
2. (b)
3. (a)
4. (d)
5. (b)
6. (c)
7. (c)
8. (d)

SECTION – 2

9. A cell or organism produced by the fusion of the cytoplasm of one species with the nucleus of another species.

Key points:

- The term comes from "cytoplasm + hybrid."
- Only the cytoplasm (and its organelles like mitochondria or chloroplasts) comes from one parent, while the nucleus comes from the other.
- Purpose: To combine desirable cytoplasmic traits (like disease resistance or stress tolerance) with the nuclear traits of another plant.

Example: A plant created by fusing the cytoplasm of Raphanus with the nucleus of Brassica to make a Rhaphanobrassica cybrid.

10. Four uses of Seedballs:

(i) Afforestation and Reforestation – Used to plant trees in degraded or barren lands.
(ii) Soil Conservation – Help in reducing soil erosion by quickly covering bare soil with vegetation.
(iii) Restoration of Ecosystems – Useful in restoring grasslands, forests, and wastelands.
(iv) Easy and Cost-effective Sowing – Seeds are protected inside the ball, improving germination and survival rates.

11. The Clean Development Mechanism (CDM) is a part of the Kyoto Protocol under the UNFCCC. Its main objectives are:

(i) Reduce Greenhouse Gas (GHG) Emissions – Promote projects in developing countries that help cut carbon dioxide and other greenhouse gases.
(ii) Sustainable Development – Encourage projects that support economic growth, environmental protection, and social benefits in developing countries.
(iii)Technology Transfer – Facilitate the transfer of clean and eco-friendly technologies from developed to developing nations.
(iv) Cost-effective Emission Reduction – Allow developed countries to meet their emission reduction targets economically by investing in projects abroad.
(v) Promote Renewable Energy – Support the development and use of renewable energy sources and energy-efficient technologies.

12. Organic Farming can be defined as:-

A method of farming that relies on natural inputs and processes, avoiding synthetic chemicals like fertilizers, pesticides, and genetically modified organisms, to produce food in an environmentally sustainable way.

Key points:

- Uses compost, green manure, biofertilizers, and biological pest control.
- Maintains soil fertility and ecosystem health.
- Focuses on sustainable agriculture rather than just high yield.

Example: Using cow dung compost instead of chemical fertilizers and Neem-based pesticides instead of synthetic ones.

13. Nilavembu is a medicinal plant commonly used in traditional medicine. Here are the details:

- Botanical Name: Andrographis paniculata
- Family: Acanthaceae
- One Use: It is used as an antipyretic and to treat malaria.

If you want, I can also give a short table of important medicinal plants with their botanical names, families, and uses—very handy for exams. Do you want me to do that?

14. The enzymes involved in genetic engineering are essential for manipulating DNA. The main ones are:

(i) Restriction Enzymes (Restriction Endonucleases)
- Cut DNA at specific sequences.
- Example: EcoRI, BamHI.

(ii) DNA Ligase
- Joins DNA fragments together (like sealing recombinant DNA).

(iii) DNA Polymerase
- Synthesizes new DNA strands during DNA replication or PCR.
- Example: Taq DNA polymerase.

(iv) Reverse Transcriptase
- Converts RNA into complementary DNA (cDNA).

(v) Topoisomerase (optional but important)
- Relieves supercoiling in DNA during replication or cloning.

(vi) RNA Polymerase (for transcription studies)
- Synthesizes RNA from a DNA template.

Summary Table (for exams):-

Enzyme	**Function**
Restriction enzyme	Cuts DNA at specific sites
DNA ligase	Joins DNA fragments
DNA polymerase	Synthesizes new DNA strands
Reverse transcriptase	Converts RNA → DNA
Topoisomerase	Relieves DNA supercoiling
RNA polymerase	Synthesizes RNA from DNA template

SECTION – 3

15. n 4 o'clock plant (Mirabilis jalapa), the cross

Pale green leaved plant (Male) × Dark green leaved plant (Female)

illustrates cytoplasmic (maternal) inheritance.

Explanation: -
- In Mirabilis jalapa, leaf colour is controlled by chloroplast genes, not by nuclear genes.
- Chloroplasts are present in the cytoplasm of the egg (female parent) and are absent or negligible in pollen (male parent).
- Therefore, the offspring always resembles the female parent, irrespective of the male parent.

Result of the given cross:
- Since the female parent has dark green leaves, all progeny will have dark green leaves.
- The male parent's pale green trait is not inherited.

Conclusion: -

This inheritance pattern is called cytoplasmic inheritance, also known as maternal inheritance, because the trait is transmitted only through the female parent.

16. p^{BR322} plasmid is a widely used cloning vector in genetic engineering.

Definition: -

pBR322 is a small, circular, double-stranded DNA plasmid found in *Escherichia coli*, developed by Bolivar and Rodriguez (1977).

Important features of pBR322:
- Origin of replication (ori): Allows independent replication inside the host cell.
- Selectable marker genes:
- amp^R → resistance to ampicillin
- tet^R → resistance to tetracycline
- Unique restriction enzyme sites: Present within the antibiotic resistance genes, useful for insertion of foreign DNA.
- Small size (~4.36 kb): Easy to manipulate and transfer.

Use: -

pBR322 is used as a cloning vector to insert, replicate, and select foreign DNA fragments in bacteria.

17. Greenhouse Effect: -

The greenhouse effect is the natural process by which certain gases present in the Earth's atmosphere trap heat and keep the planet warm enough to support life.

- Solar radiation from the Sun reaches the Earth.
- Some of this energy is reflected back into space.
- Greenhouse gases (like CO_2, CH_4, etc.) absorb and re-emit the outgoing infrared radiation.
- This trapped heat warms the atmosphere and the Earth's surface.

Excessive increase in greenhouse gases due to human activities leads to global warming.

Relative Contributions of Greenhouse Gases: -

CO_2 ——————————————————— 60%
CH_4 ——————————————— 20%
CFCs ——————————————— 14%
N_2O ——— 6%

Explanation: -

- Carbon dioxide (CO_2): Major contributor due to burning of fossil fuels and deforestation.
- Methane (CH_4): Released from paddy fields, cattle, and landfills.
- CFCs: Released from refrigerators, air conditioners, and aerosols.
- Nitrous oxide (N_2O): Emitted from fertilizers and industrial processes.

Conclusion: -

The greenhouse effect is essential for life, but its enhancement causes climate change and global warming.

18. Cryo-preservation

Cryo- preservation is a technique used to preserve living cells, tissues, embryos, or organs at very low temperatures, usually at $-196°C$ in liquid nitrogen. At this temperature, all metabolic and biological activities almost completely stop, allowing the material to be stored for a very long time without damage.

Before freezing, special chemicals called cryo-protectants (such as glycerol or DMSO) are added to prevent the formation of ice crystals, which can damage cells. The preserved material can later be thawed carefully and revived, retaining its original structure and function.

Cryo-preservation is widely used in medicine and biology, such as in:

Preservation of sperms, eggs, embryos, and blood cells
Storage of stem cells
Conservation of endangered plant and animal species
Research in genetics and biotechnology

Thus, cryo-preservation plays an important role in reproductive technology, biodiversity conservation, and medical research.

19. Differences between Habitat and Niche

Habitat	Niche
(1). Habitat is the physical place where an organism lives.	(1). Niche is the functional role or position of an organism in an ecosystem.
(2). It describes the address of an organism.	(2). It describes the profession of an organism.
(3). Many species can share the same habitat.	(3). No two species can occupy the same niche for a long time (competitive exclusion principle).

SECTION – 4

20. (a)(i) Chalazogamy
(ii)Mesogamy

OR

(b) The diagrammatic representation of the position of genes and related distances between the adjacent genes is called genetic mapping. It is directly proportional to the frequency of recombination between them. It is also

called a linkage map.

Uses of genetic mapping: -

- It is used to determine gene order, identify the locus of a gene and calculate the distances between genes.
- They are useful in predicting the results of dihybrid and trihybrid crosses.
- It allows the geneticists to understand the overall genetic complexity of the organism.

21. (a) (i) Buying and using only eco-friendly products and recycle them.

(ii) Growing more trees.

(iii) Choosing sustained farm products (vegetables, fruits, and greens, etc.)

(iv) Reducing the use of natural resources.

(v) Recycling the waste and reduce the amount of waste you produce.

(vi) Reducing consumption of water and electricity.

(vii) Reducing or eliminating the use of household chemicals and pesticides.

(viii) Maintaining your cars and vehicles properly to reduce carbon emissions.

(ix) Creating awareness and educate about ecosystem protection among your friends and family members and ask them to find out the solution to minimize this problem.

OR

(b) (i) Somu is more likely to get new varieties because cultivating from a mixed population introduces genetic recombination, creating diverse offspring with novel trait combinations, potentially leading to new traits like disease resistance or better yield.

- Ramu, through self-fertilization, maintains existing traits but doesn't easily create new combinations, focusing on pure-breeding lines.

(ii) Ramu (Self-Fertilization)

Advantages: -

- Purity & Consistency: Maintains desired traits (like yield or color) in pure lines over generations.
- Predictable: Offspring are genetically similar to the parent, ensuring consistent quality.

Disadvantages: -

- Reduced Genetic Diversity: Lack of new gene combinations makes crops vulnerable to diseases or environmental changes.
- Continuous selfing can lead to weaker plants with reduced fitness.

Somu (Mixed Population/Cross-Pollination)

Advantages: -

- Genetic Diversity: Introduces new gene combinations, increasing adaptability and resilience.
- New Varieties: Higher chance of combining beneficial traits (hybrid vigor, disease resistance).

Disadvantages: -

Unpredictability: Offspring vary, and desirable traits might not appear consistently.

- Resource Allocation: May need more resources or attention as plants are less uniform.

PART - II (BIO-ZOOLOGY)

SECTION – 1

22. (a)

23. (c)

24. (c)

25. (d)

26. (c)

27. (d)

28. (d)

29. (d)

SECTION – 2

30. Ovulation: -

- It's the process where a mature egg (ovum) escapes from an ovarian follicle and travels into the fallopian tube, ready for potential fertilization by sperm.

Ovulation is the release of a mature egg from an ovary, a key event for fertility, typically happening around day 14 of a standard 28-day menstrual cycle, though timing varies, occurring roughly 14 days before the next period starts, and can be tracked using apps or tests for the most fertile days.

31. Cause of Down's Syndrome: -

Down's syndrome is caused by trisomy of chromosome 21, i.e., the presence of three copies of chromosome number 21 instead of two.

Reason: -

- It occurs due to non-disjunction of chromosome 21 during meiosis, leading to an extra chromosome in the gamete.
- After fertilization, the zygote contains 47 chromosomes (2n + 1) instead of the normal 46.

32. Operons: -

- An operon is a genetic unit in prokaryotes (like bacteria) containing multiple genes for a specific metabolic pathway or function, transcribed as a single mRNA molecule from one promoter.

Operons in E. coli: -

- E. coli has a complex operon structure, with estimates varying based on detection methods, but generally falling in the range of hundreds to over a thousand.
- Recent analyses suggest over 2,500 mRNA-encoding genes are grouped into about 2,569 operons, with roughly 788 being polycistronic (multiple genes on one transcript).
- Estimates from genomic analyses suggest around 630 to 700 operons, while other predictions point to around 1292 "directions" (gene groups in the same direction).

33.

Active Immunity	Passive Immunity
(1). Antibodies are produced by the body itself after infection or vaccination.	(1). Antibodies are received from another source (mother or serum).
(2). It is long-lasting due to the formation of memory cells.	(2). It is short-lived as memory cells are not formed.

34. Saccharomyces cerevisiae is the major producer of ethanol (C_2H_5OH). It is used for industrial, laboratory and fuel purposes. So ethanol is referred to as industrial alcohol.

35. The most important application of human stem cells is regenerative medicine.

Explanation: -

Human stem cells have the unique ability to: -

- Self-renew (produce more stem cells)
- Differentiate into specialized cells

SECTION – 3

36. The let-down reflex, or milk ejection reflex, is the automatic process where breast milk is released from the milk glands and pushed into the ducts for the baby to feed, triggered by the baby's suckling stimulating nerves in the nipple, which causes the brain to release oxytocin. This hormone makes tiny muscles around the milk sacs contract, ejecting milk and widening ducts, and can also be triggered by the sight or sound of a baby, causing milk to flow.

37. Amniocentesis: -

Amniocentesis is a prenatal diagnostic technique used to detect genetic, chromosomal, and metabolic disorders in the developing fetus.

Procedure: -

- It is usually performed between the 14th and 16th week of pregnancy.
- A small amount of amniotic fluid surrounding the fetus is withdrawn using a sterile needle.
- The fluid contains fetal cells, which are cultured and examined.

Disorders detected: -

- Down's syndrome
- Thalassemia
- Sickle cell anemia
- Hemophilia
- Neural tube defects

Uses: -

- Helps in early diagnosis of genetic abnormalities.

- Assists doctors and parents in making medical decisions.

Misuse: -

- It has been misused for sex determination of the fetus, leading to female foeticide.
- Due to this, its misuse is legally banned in India.

38. Hormone of Thymus Gland

The thymus gland secretes the hormone thymosin.

Functions of Thymosin (any two) :-

(i) Stimulates maturation of T-lymphocytes (T-cells), which are essential for cell-mediated immunity.

(ii) Enhances immune response by helping the body recognize and fight pathogens.

39. A gene bank is a facility storing genetic material (seeds, pollen, tissues, DNA) of plants, animals, and microbes to conserve biodiversity, ensure food security, and support breeding/research, protecting species from extinction due to climate change or disease. These biorepositories preserve genetic diversity using methods like freezing or tissue culture, acting as crucial biological libraries for future generations to restore crops or endangered life forms.

Key Functions:

- Conservation: Safeguards genetic diversity of crops, livestock, and wild species.
- Food Security: Preserves traits (like drought resistance) for future food development.
- Research & Breeding: Provides genetic resources for developing new, resilient varieties.
- Species Revival: Offers material to potentially revive endangered or lost species.

Stored Materials:

- Seeds, pollen, tissues, cells, embryos, sperm, eggs, and DNA.

Importance:

- Acts as an insurance policy against extinction, disease, and climate impacts, crucial for agriculture and ecosystem health.

40. This pattern is called Criss-cross inheritance, commonly seen in X-linked genes.

Explanation: -

- The character present in the grandfather (male) is passed to his daughter (carrier) through his X-chromosome.
- The daughter then passes this character to her son (grandson).
- Thus, the trait appears in alternate generations and passes from male → female → male.

Flowchart of Inheritance (Criss-cross pattern):-

Grandfather (Affected)

↓ X-linked gene

Daughter (Carrier)

↓ X-linked gene

Grandson (Affected)

SECTION – 4

41. (a) The human genome project remains the world's largest collaborative project that includes the identification and mapping of all the genes of the human genome.

The methods of the human genome project are :-

-Expressed sequence tags wherein the genes were differentiated into those forming a neighbourhood of the genome and therefore the others which expressed RNAs.

-Sequence Annotation wherein the whole genome was first sequenced and therefore the functional tags were assigned later.

The process of the human genome projects are :–

-The entire gene set was isolated from a cell.

-It was then split into small fragments.

-This DNA structure was then amplified with the assistance of a vector which mostly was BAC (Bacterial artificial chromosomes) and YAC (Yeast artificial chromosomes).

-The smaller fragments were then sequenced using the DNA sequencers.

-On the idea of overlapping regions, the sequences were then arranged.

-All the knowledge of this genome sequence was then stored during a computer-based program.
-This way the whole genome was sequenced and stored as a genome database in computers. Genome mapping was a subsequent goal that was achieved with the assistance of the repetitive DNA sequences.

OR

(b) Evolutionary Path of Man (Human Evolution)
The evolution of man describes the gradual development of modern humans (Homo sapiens) from primitive primate ancestors over millions of years.
Major Stages in Human Evolution: -
(i) Dryopithecus (≈ 15–20 million years ago)
- Ape-like ancestor
- Lived on trees
- Walked on all fours
(ii) Ramapithecus (≈ 14 million years ago)
- More man-like than apes
- Lived in open grasslands
- Used simple objects as tools
(iii) Australopithecus (≈ 3–4 million years ago)
- First bipedal hominid
- Small brain size
- Lived in Africa
(iv) Homo habilis (≈ 2 million years ago)
- "Handy man"
- First to use stone tools
- Larger brain than Australopithecus
(v) Homo erectus (≈ 1.5 million years ago)
- Walked fully upright
- Discovered use of fire
- Migrated out of Africa
(vi) Homo neanderthalensis (≈ 100,000 years ago)
- Well-developed brain
- Lived in caves
- Used animal skins and tools
(vii) Homo sapiens (≈ 50,000 years ago to present)
- Modern humans
- Highly developed brain
- Language, art, culture, and advanced tools

42. (a) (i) Population Density
Population density refers to the number of people living per unit area of land. It is usually expressed as persons per square kilometre (km^2).
It is calculated using the formula:

$$\text{Population Density} = \frac{\text{Total Population}}{\text{Total Land Area}}$$

Population density helps in understanding how crowded or sparsely populated a region is. Areas with high population density (like big cities) often have better facilities, job opportunities, and infrastructure but may face problems such as congestion, pollution, and shortage of resources. Areas with low population density (like deserts or mountainous regions) usually have fewer people due to harsh climate or lack of resources.
Population density is an important concept in geography and planning as it helps governments in resource distribution, urban planning, and development activities.
(ii) Natality and Mortality: -
Natality (Birth Rate): -
Natality refers to the rate at which new individuals are added to a population by reproduction during a specific period of time.
- It increases the population size.
- Expressed as number of births per unit population per unit time.
- Two types:
- Maximum (potential) natality – under ideal conditions.

- Ecological (realized) natality – under actual environmental conditions.

Mortality (Death Rate): -

Mortality refers to the rate at which individuals are removed from a population due to death during a specific period of time.

- It decreases the population size.
- Expressed as number of deaths per unit population per unit time.
- Types: -
- Minimum mortality – under ideal conditions.
- Ecological mortality – under natural environmental conditions.

Conclusion: -

Natality increases population size, while mortality reduces it; together, they play a key role in regulating population growth and population dynamics.

OR

(b) Agricultural chemicals, like fertilizers and pesticides, boost yields but significantly harm soil, water, air, and human health through pollution, nutrient loss, pest resistance, and potential chronic illnesses (cancers, organ damage) from residues and endocrine disruption, entering the food chain and disrupting ecosystems, creating a cycle of dependence and environmental damage.

Effects on the Environment: -

- Soil Degradation: Overuse kills beneficial microbes, alters pH, increases salinity, and depletes fertility, requiring more chemicals.
- Water Pollution: Runoff contaminates groundwater and surface water (rivers, lakes), leading to algal blooms and making water unfit for consumption.
- Air Pollution: Sprayed chemicals become airborne, degrading air quality and causing respiratory issues.
- Ecosystem Imbalance: Kills non-target organisms, disrupts food chains, and contributes to declining pollinators like bees.

Effects on Human Health: -

- Acute Poisoning: High-level exposure, especially in developing nations, causes immediate illness and death.
- Chronic Diseases: Long-term, low-dose exposure is linked to cancers (leukemia, lymphoma, breast), neurological damage, birth defects, infertility, and organ damage (liver, kidneys).
- Nutritional Decline: Crops grown with chemicals may lack essential nutrients like calcium, iron, and zinc.
- Hormonal Disruption: Pesticides can act as endocrine disruptors, interfering with hormones.
- "Cocktail Effect": The combined impact of multiple chemical exposures is poorly understood but potentially dangerous.

Effects on Agriculture: -

- Pest Resistance: Pests develop resistance, requiring stronger or more chemicals in a vicious cycle.
- Nutrient Imbalance: Can cause unnatural growth and reduce the nutritional quality of produce.