

BIOLOGY

PAPER 1

(THEORY)

Maximum Marks: 70

Time Allotted: Three Hours

Reading Time: Additional Fifteen Minutes

Instructions to Candidates

1. You are allowed **an additional fifteen minutes** for **only** reading the question paper.
2. You must **NOT** start writing during reading time.
3. This question paper has **13 printed pages**.
4. It has **eighteen questions** in all. Answer **all** questions.
5. There are **four** sections in the paper: **A, B, C** and **D**. **Internal choices** have been provided in **two questions**, each in **Sections B, C** and **D**.
6. **Section A** consists of **one question** consisting of eighteen subparts. Each subpart carries **one mark**.
7. While answering **Multiple Choice Questions** in **Section A**, you are required to **write only one option** as the answer.
8. **Section B** consists of **seven questions** each carrying **two marks**.
9. **Section C** consists of **seven questions** each carrying **three marks**.
10. **Section D** consists of **three questions** each carrying **five marks**.
11. **Diagrams should be drawn** wherever necessary using a **pencil** only.
12. The intended marks for questions are given in brackets [].

Instruction to Supervising Examiner

Kindly read **aloud** the Instructions given above to all the candidates present in the examination hall.

Note: The Specimen Question Paper in the subject provides a realistic format of the Board Examination Question Paper and should be used as a practice tool. The questions for the Board Examination can be set from any part of the syllabus, though the format of the Board Examination Question Paper will remain the same as that of the Specimen Question Paper. The weightage allocated to various topics, as given in the syllabus, will be strictly adhered to.

SECTION A – 20 MARKS

Question 1

- (i) Stuti ate a cake containing nuts and immediately developed swelling of the lips and difficulty in breathing. Identify the chemical responsible for Stuti's condition. [1]
(Recall)

- (a) Insulin
- (b) Histamine
- (c) Interferon
- (d) Adrenaline

- (ii) A survey was conducted to study the age structure of a human population. [1]
The data obtained is shown below:

Age Group	Number of Individuals
Adults	60,000
Children	35,000
Old	50,000

Based on the above data, identify the **MOST** appropriate shape of the age pyramid for this population. (Evaluate)

- (a) Pyramidal
 - (b) Triangular
 - (c) Urn-shaped
 - (d) Bell-shaped
- (iii) In a single-stranded segment of a DNA molecule, the base ratio (A+T):(G+C) is found to be 0.3:1. What will be the ratio (A + G):(T + C) for the entire double-stranded DNA molecule? [1]
(Apply)
- (a) 1:1
 - (b) 3:10
 - (c) 10:3
 - (d) 13:3

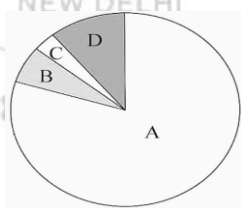
- (iv) Identify the vectors used for cloning genes into eukaryotic organisms. **(Recall)** [1]
- (P) BAC
 - (Q) Bacteriophages
 - (R) Ti plasmid
 - (S) Disarmed retroviruses
- (a) Only (P) and (Q)
- (b) Only (P) and (R)
- (c) Only (Q) and (S)
- (d) Only (R) and (S)
- (v) In an ecosystem, interspecific interaction of population is explained through certain signs. (+) sign is assigned for beneficial interaction, (-) sign is assigned for harmful interaction, and (0) is assigned for neutral interaction. [1]
- Which of the following represents amensalism? **(Understand)**
- (a) Species A (-), Species B (0)
 - (b) Species A (+), Species B (+)
 - (c) Species A (-), Species B (-)
 - (d) Species A (+), Species B (0)
- (vi) Given below are two statements marked Assertion and Reason. Read both the statements carefully and choose the correct option. [1]
- Assertion:** Excess dose of cocaine produces a sense of euphoria, increased energy and hallucinations.
- Reason:** Cocaine interferes with the transport of dopamine leading to abnormalities in the brain. **(Analyse)**
- (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.
 - (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
 - (c) Assertion is true and Reason is false.
 - (d) Both Assertion and Reason are false.

- (vii) Given below are two statements marked Assertion and Reason. Read both the statements carefully and choose the correct option. [1]

Assertion: In a majority of flowering plants, the embryo sac development is called monosporic.

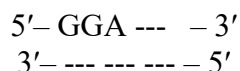
Reason: Embryo sac develops from one of the two megaspores formed by meiosis of megaspore mother cell. (Analyse)

- (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.
- (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion.
- (c) Assertion is true and Reason is false.
- (d) Both Assertion and Reason are false.
- (viii) A patient was found to have a mass of pancreatic cells in the liver producing large amounts of amylase. Further medical tests revealed a tumor in the pancreas. What type of tumour had developed in the pancreas? (Understand) [1]
- (ix) A research scholar isolated a novel restriction enzyme from *Bacillus anthracis* strain ZT4. It was the third restriction enzyme to be extracted from this specific strain. Derive the scientific name for this enzyme by applying the standard rules of biological nomenclature. (Understand) [1]
- (x) Why do leguminous crops fertilise the soil but cereals do not? (Understand) [1]
- (xi) The pie chart given below represents the extent of global biodiversity of invertebrates. [1]



- Which specific phylum of invertebrates does 'B' represent? (Recall)
- (xii) Construct an ecological pyramid of biomass for the following food chain: [1]
Grass → Deer → Fleas (Understand)
- (xiii) Observe the relation between the first two words and complete the analogy. [1]
Sigma factor: Initiation :: _____ : Termination (Understand)

- (xiv) A retroviral RNA undergoes reverse transcription to produce a double-stranded DNA molecule containing a six-nucleotide-long palindromic sequence. A partial segment of this double-stranded DNA is shown below: [1]



Obtain the six nucleotide long palindromic DNA sequence on the 3' – 5' strand of DNA. (Create)

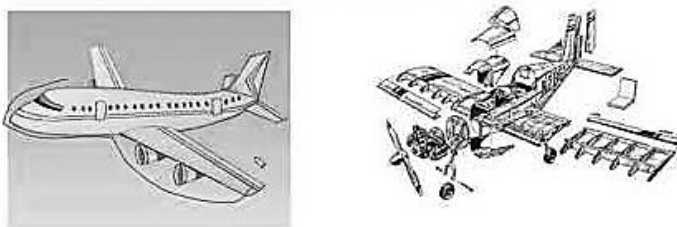
- (xv) A rural area has a population density of 150 individuals per sq. km. If the area is 250 sq. km, what will be the total population of the rural area? (Apply) [1]
- (xvi) Answer the following:
- (a) Expand the abbreviation KVIC. (Recall) [1]
- (b) Alexander Fleming had discovered an antibiotic which was later successfully purified by a team of scientists and used to save countless lives. Name the scientists who purified it and established it as a lifesaving drug. (Recall) [1]
- (xvii) State the underlying principle of ELISA test. (Recall) [1]
- (xviii) Give a reason for each of the following statements:
- (a) Our government has imposed strict conditions and regulations on Medical Termination of Pregnancy. (Recall) [1]
- (b) In the biolistic method of gene transfer, microparticles are preferred to be made of gold rather than copper. (Analyse) [1]

SECTION B – 14 MARKS

Question 2

[2]

The image shown below represents an ecological hypothesis proposed by Paul Ehrlich. Study it carefully and answer the following question.



Identify and explain this ecological hypothesis.

(Understand)

Question 3**[2]**

An alien gene was ligated by a research scholar at Sal I site of pBR322 plasmid. It affected a selectable marker.

- (i) Name the selectable marker which was affected. **(Recall)**
- (ii) State the underlying principle due to which the selectable marker was affected. **(Recall)**

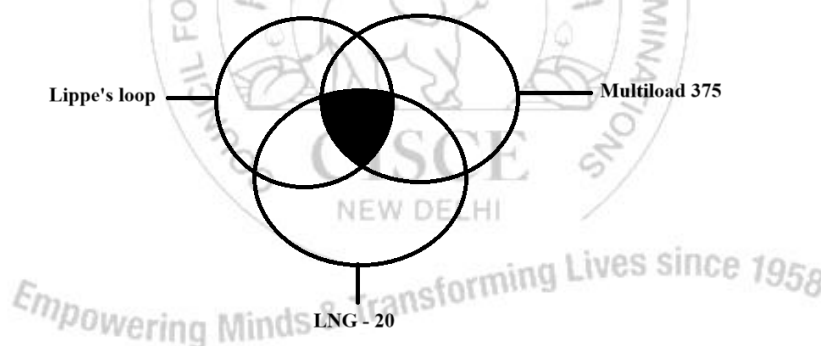
Question 4**[2]**

A scientist retrieved an embryo from the uterus of a human female just after implantation for the purpose of cloning.

- (i) Identify the specific stage of the embryonic development at which the scientist retrieved it. **(Recall)**
- (ii) Which part of the embryo referred to in subpart (i) is most suitable for cloning? **(Understand)**

Question 5**[2]**

Study the following Venn diagram and answer the questions that follow.

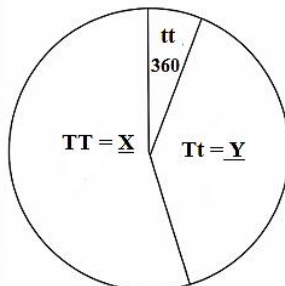
(Analyse)

- (i) Which contraceptive method occupies the shaded region in the given Venn diagram?
- (ii) How does Multiload – 375 function as a contraceptive agent?

Question 6**[2]**

- (i) The given pie chart shows the distribution of genotypes in a population of 9000 pea plants.

The population is in Hardy-Weinberg equilibrium. It is known that 360 plants are homozygous recessive (tt).



Using this information, calculate the following:

- (a) Frequency of the dominant allele (T) **(Apply)**
(b) Number of heterozygous pea plants **(Apply)**

OR

- (ii) A gene normally transcribes an mRNA of 603 nucleotides, including the stop codon, which encodes a functional protein. However, during DNA replication the 150th nucleotide was deleted.
- (a) Predict how many amino acids will remain unchanged before the mutation site. **(Apply)**
(b) Explain how the mutation is likely to affect the resulting protein. **(Analyse)**

Question 7**[2]**

A married couple was unable to conceive for five years. Diagnostic tests showed that the wife had normal ovulatory cycles and healthy Fallopian tubes, but the husband had a low sperm count.

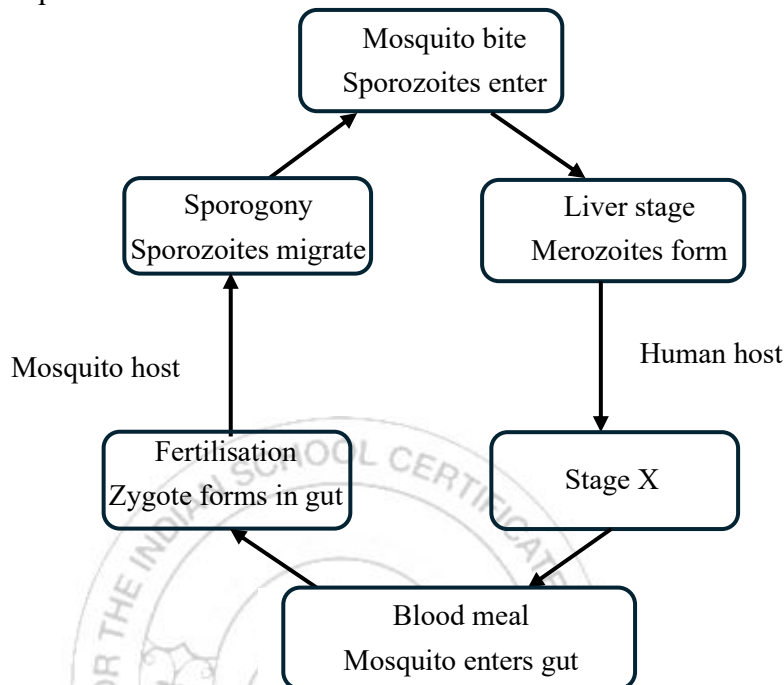
- (i) Suggest an assisted reproductive technique which can help the couple conceive. **(Understand)**
(ii) State *one* specific abnormality, other than low sperm count, in the husband's sperm that would necessitate the suggested technique over standard IVF procedure. **(Understand)**

Question 8**[2]**

- (i) Cattle excreta is an important source for producing domestic fuel.
- (a) Name the largest component of this domestic fuel. **(Recall)**
(b) Write the biological name of the microbe responsible for production of this domestic fuel. **(Recall)**

OR

- (ii) The flowchart provided below represents the life cycle of *Plasmodium*, alternating between its human host and the female *Anopheles* mosquito. Study the flowchart and answer the questions that follow.



- (a) Identify Stage 'X'. (Recall)
- (b) Name the toxin directly responsible for the recurring chills and fever experienced by a patient suffering from malaria. (Recall)

SECTION C – 21 MARKS

Question 9

- (i) Draw a neat, labelled diagram of the Graafian follicle.

(Recall)

OR

- (ii) Draw a neat, labelled diagram of the L.S. of an anatropous ovule.

(Recall)

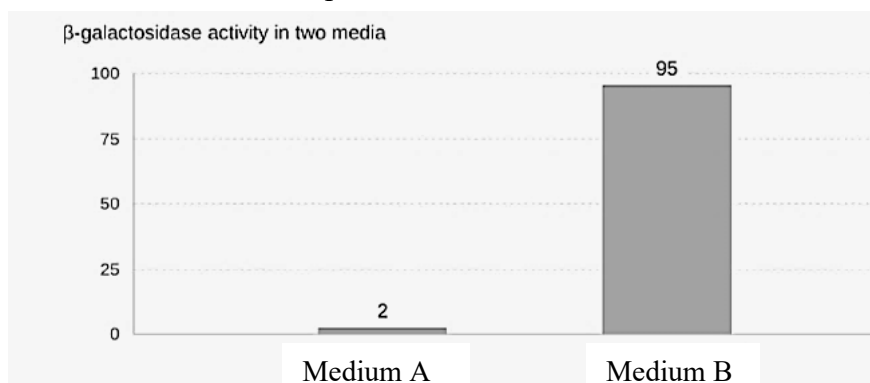
Question 10

- (i) A biotechnologist successfully inserts a gene for drought tolerance into isolated somatic cells of a wheat plant. She now needs to regenerate thousands of genetically identical, pathogen-free complete plants from these modified cells.

- (a) Which technique should the biotechnologist use to develop these genetically modified cells of wheat into a complete plant? (Understand)
- (b) Explain *two* major steps involved in this technique. (Understand)

OR

- (ii) The bar graph given below shows the growth of *E. coli* in two different media (Medium – A and Medium – B), along with the corresponding β -galactosidase activity and the state of the lac operon in each case.



Based on the above graph, answer the following questions:

- (a) Why is the operon switched OFF in one medium? **(Understand)**
- (b) The lac operon is described as an example of negative regulation of gene expression. Explain the statement with reference to the role of the operator site. **(Understand)**

Question 11

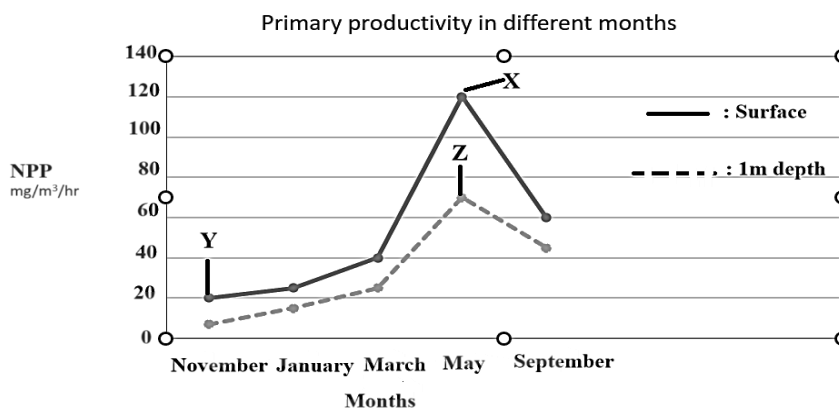
[3]

- (i) pBR322 was used in the making of genetically engineered insulin. What was the possible role played by this plasmid? **(Analyse)**
- (ii) Can this plasmid be used for gene transfer in plants? Substantiate your opinion with a reason. **(Evaluate)**

Question 12

[3]

The following graph shows seasonal variations in Net Primary Productivity at the level of the surface and 1m depth in a marshy area of India during a study.



- (i) Account for the difference in primary productivity at points 'X' and 'Y'. **(Analyse)**

- (ii) The GPP of a terrestrial ecosystem is $2700 \text{ kg/m}^2/\text{yr}$ and $3/10^{\text{th}}$ of its energy is used for respiration. Calculate the amount of energy available as NPP. **(Apply)**

Question 13

[3]

Describe *three* types of natural selection, illustrating each with a suitable graph.

(Recall)

Question 14

[3]

During an experiment, Sneha was given the following base sequence of mRNA of *E. coli* and asked to derive an amino acid sequence from it.

5' GUG GCU CAA 3'

- She successfully derived the amino acid sequence as valine, alanine and glycine.
 - Then, she was given the amino acid sequence of arginine, serine, proline and was asked to derive the base sequence of mRNA from it.
- (i) Sneha could not derive the mRNA sequence successfully. Provide a scientific reason to explain why she could not determine it. **(Understand)**
- (ii) Later, she observed that GCU codon changed to GCA and the amino acid was alanine in the fungal cell. Which feature of genetic code enabled it? **(Recall)**
- (iii) Based on the sequence provided above, deduce the anticodon sequence of the tRNA and write it in the $5' \rightarrow 3'$ orientation. **(Apply)**

Question 15

[3]

Two patients A and B were admitted to a hospital. Patient A suffered from Typhoid and Patient B from Chikungunya. Upon analysis of their blood samples, it was found that their lymphocytes produced certain immunological proteins, referred to as 'X' and 'Y' respectively.

The table below presents some features of proteins 'X' and 'Y'. Study it and answer the following questions:

Features	Protein X	Protein Y
Patient suffering from the disease	Typhoid	Chikungunya
Mode of action	Slow but long lasting	Rapid but temporary
Effective against cancer cells	No	Yes

- (i) Identify the proteins 'X' and 'Y'. **(Understand)**
- (ii) How does protein 'Y' develop an immunological response in the patient suffering from Chikungunya? **(Analyse)**

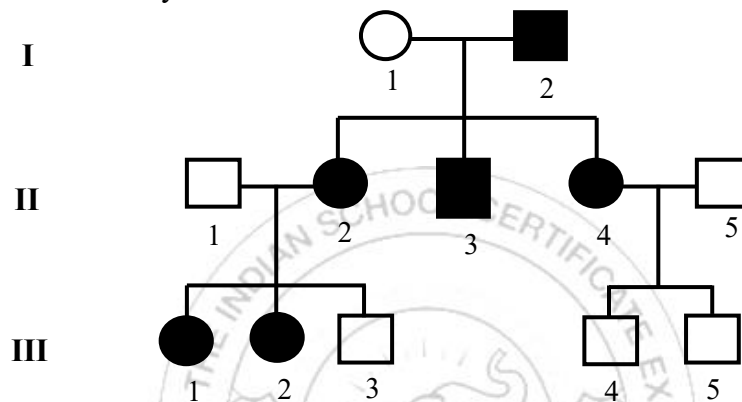
SECTION D – 15 MARKS

Question 16

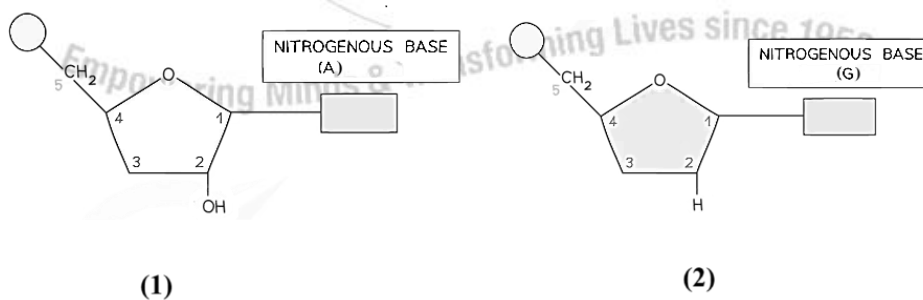
[5]

- (i) Marfan Syndrome is a human genetic disorder caused by a mutation in the FBN1 gene. This gene codes for fibrillin – 1, a protein that gives connective tissues strength and flexibility. People suffering from Marfan Syndrome show symptoms like dislocation of the eye lens, flat feet, unusually tall height and rupturing of aorta.

The following pedigree chart represents the pattern of inheritance of Marfan Syndrome in a family.



- (a) Identify the type of inheritance from the given pedigree chart. **(Understand)**
- (b) If the parents of a child are heterozygous for this particular trait, calculate the probability of the child being unaffected using a Punnett square. **(Apply)**
- (ii) Prisha is provided with two nucleotides as shown below. Which of these nucleotides should she choose to make an ideal genetic material? Give a reason. **(Analyse)**



Question 17

[5]

- (i) (a) Differentiate between the following based on the parameter specified below: **(Analyse)**
- (1) Leydig cells and Sertoli cells based on Location in testis
 - (2) Corpus luteum and Placenta based on Endocrine function

- (b) What would happen if the zona pellucida disappears prematurely at the morula stage of human embryonic development? **(Evaluate)**
- (c) Name and state the function of the middle wall of the human uterus. **(Recall)**

OR

- (ii) (a) For artificial hybridisation of pea plants, fresh pollens from the anther can be used, whereas preserved pollens are mandatory for wheat hybridisation. Why? **(Analyse)**
- (b) Study the table below and answer the following questions:

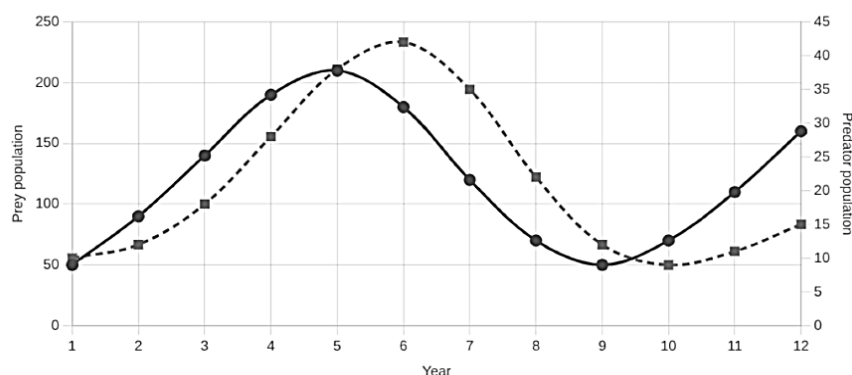
Fruit	Fruit and Seed formation
X	Cells of the integument develop into an embryo
Y	Ovary develops into seedless fruit by the application of phytohormones
Z	Peduncle contributes to fruit formation

- (1) Which of these fruits exhibits polyembryony? Will its embryos exhibit genetic variation? Justify your answer with a reason. **(Evaluate)**
- (2) Identify the fruit type of 'Y'. **(Recall)**

Question 18

[5]

- (i) The graph provided below shows a classic predator-prey interaction, with predator population peaks lagging slightly behind prey population peaks.



Prey population (solid line, ● circle markers); Predator population (dashed line, ■ square markers)

- (a) Assume that a sudden viral disease wipes out 80% of the predator population at Year 6 (instead of the natural decline shown in the graph). Construct a new version of the above graph from Year 6 onward showing both the prey and predator curves. **(Create)**
- (b) Interpret the population dynamics responsible for changes in the constructed graph. **(Analyse)**

OR

(ii) A population of 100 beetles is introduced into an environment with a carrying capacity of 500. The intrinsic rate of natural increase for this beetle species is 0.2 per year.

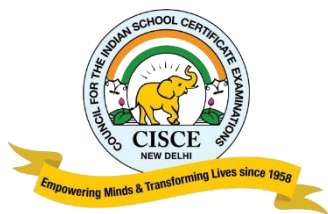
(a) Calculate the change in population size after the first year. **(Apply)**

(b) Using the given data, draw a population growth curve showing how the beetle population changes with time as it approaches the carrying capacity. Label the following in the graph.

- Initial population
- Carrying capacity
- Phase of maximum growth rate
- Stationary phase

(Create)





BIOLOGY

PAPER 1

(THEORY)

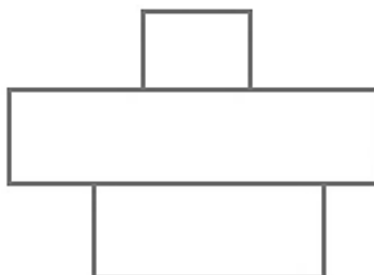
ANSWER KEY

SECTION A – 20 MARKS

Question 1

In answering Multiple Choice Questions, candidates have to write either the correct option number or the explanation against it. Please note that only ONE correct answer should be written.

- (i) (b) Histamine [1]
- (ii) (c) Urn-shaped [1]
- (iii) (a) 1:1 [1]
- (iv) (d) Only (R) and (S) [1]
- (v) (a) Species A (-), Species B (0) [1]
- (vi) (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. [1]
- (vii) (c) Assertion is true and Reason is false. [1]
- (viii) Metastatic tumour [1]
- (ix) Ban Z III [1]
- (x) Legumes have symbiotic association with *Rhizobium* bacteria which fixes the atmospheric nitrogen while cereals do not. [1]
- (xi) Phylum Mollusca [1]
- (xii) [1]



- (xiii) Rho factor [1]
- (xiv) 3' - CCTAGG - 5' [1]

- (xv) Total population = 150×250 [1]
= 37,500
- (xvi) (a) Khadi and Village Industries Commission [1]
(b) Ernest Chain and Howard Florey [1]
- (xvii) Antigen antibody reaction [1]
- (xviii) (a) It prevents illegal misuse for sex-selective abortions (female foeticide). [1]
(b) Gold is inert and non-toxic whereas copper is reactive and toxic. [1]

SECTION B – 14 MARKS

Question 2 [2]

Rivet Popper Hypothesis

Explanation:

- In an airplane (ecosystem), all parts are joined together using thousands of rivets (species)
- If the passengers travelling in it start popping a rivet (causing species to become extinct), it may not affect flight safety (proper functioning of the ecosystem) initially but as more and more rivets are removed, the plane becomes weak over a period.
- If rivets from wings are removed (important species), the flight safety (ecosystem) is affected immediately.

Question 3 [2]

- (i) Tetracycline resistance (Tet^R) gene
- (ii) Insertional inactivation

Question 4 [2]

- (i) Blastocyst
- (ii) Inner cell mass

Question 5 [2]

- (i) Intrauterine device (IUD)
- (ii) Multiload - 375 is a copper releasing IUD. Copper reduces sperm motility. / Increases phagocytosis of sperms

Question 6**[2]**

- (i) (a) Frequency of dominant allele (T) $p = 0.8$
- (b) The number of heterozygous pea plants = $2pq = 0.32$ of 9000 = 2880

OR

- (ii) (a) First 49 amino acids will remain unchanged.
- (b) 50th amino acid and all subsequent amino acids are likely to be altered due to frame shift mutation.

Question 7**[2]**

- (i) Intracytoplasmic Sperm Injection (ICSI)
- (ii) Abnormality in male's semen: poor sperm motility / abnormal shape of sperm

Question 8**[2]**

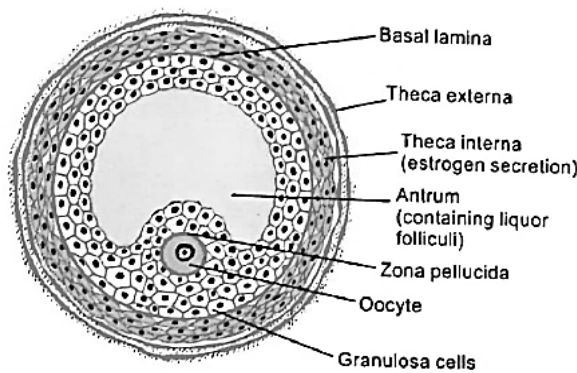
- (i) (a) Methane
- (b) *Methanococcus*

OR

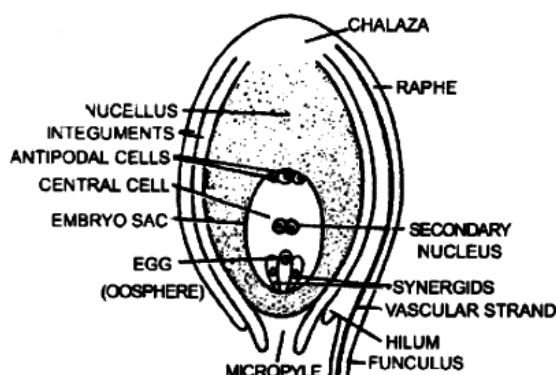
- (ii) (a) Merozoite
- (b) Haemozoin

SECTION C – 21 MARKS**Question 9****[3]**

- (i) Diagram of Graafian follicle

**OR**

- (ii) Diagram of L.S. of anatropous ovule



Question 10

[3]

- (i) (a) Micropropagation / Plant tissue culture
- (b) Major steps:
- Explant is transferred to the culture medium under aseptic conditions.
 - Auxin and cytokinin induce callus formation / differentiation.

OR

- (ii) (a) In the Medium A, only glucose is present and the inducer (lactose) is absent, so the repressor protein remains bound to the operator site, blocking RNA polymerase. Thus, the operon is switched OFF.
- (b) In the Medium B, only lactose is present. It stops the repressor protein from binding to the operator site, allowing RNA polymerase to transcribe the structural genes. The operon gets switched ON.

Question 11

[3]

- (i) Plasmid acted as a suitable vector.
- (ii) No

Reason: It lacks the T-DNA / vir gene system necessary for transferring DNA into plant cells.

Question 12

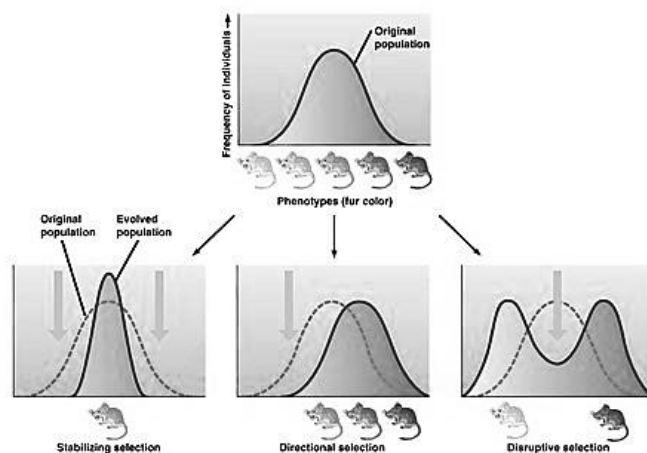
[3]

- (i) Primary productivity decreases with decrease in temperature.
- (ii) $R = \frac{3}{10} \times 2700 = 810 \text{ kg/m}^2/\text{yr}$
- $\text{NPP} = \text{GPP} - R$
- $\text{NPP} = 2700 - 810$
- $\text{NPP} = 1890 \text{ kg/m}^2/\text{yr}$

Question 13

[3]

Types of natural selection



- Stabilising - More individuals acquire mean character value.
- Directional - More individuals acquire value other than the mean character value.
- Disruptive - More individuals acquire peripheral character value at both ends of the distribution curve.

Question 14

[3]

- Due to degeneracy of codon, because one amino acid is coded by more than one codon.
- Genetic code is universal.
- Anticodon sequence 5' UUG AGC CAC 3'

Question 15

[3]

- X: Antibodies, Y: Interferons
- Interferons stimulate the cellular DNA to produce a series of antiviral proteins or enzymes. These enzymes bind to viral mRNA and block their protein synthesis.

SECTION D – 15 MARKS

Question 16

[5]

- (i) (a) Autosomal dominant
(b) Probability of unaffected child = 25%

	A	a
A	AA	Aa
a	Aa	aa

OR

- (ii) Prisha should choose Nucleotide (2).
- The 2-OH group present in the nucleotide (1) is a reactive group. It will make the genetic material unstable and easily degradable.
 - Nucleotide (2) is non-reactive.

Question 17

[5]

- (i) (a) (1)

Leydig cells	Sertoli cells
Located in the interstitial spaces (connective tissue) surrounding the seminiferous tubules.	Located in the seminiferous epithelium within the seminiferous tubules.

- (2)

Corpus luteum	Placenta
Secretes progesterone	Secretes chorionic gonadotropin, estrogen, progesterone, relaxin, hPL

- (b) Without zona pellucida, which prevents adhesion, the morula may prematurely attach to the wall of the Fallopian tube and may lead to ectopic pregnancy.
- (c) Myometrium
It brings about powerful contractions of the uterus during parturition.

OR

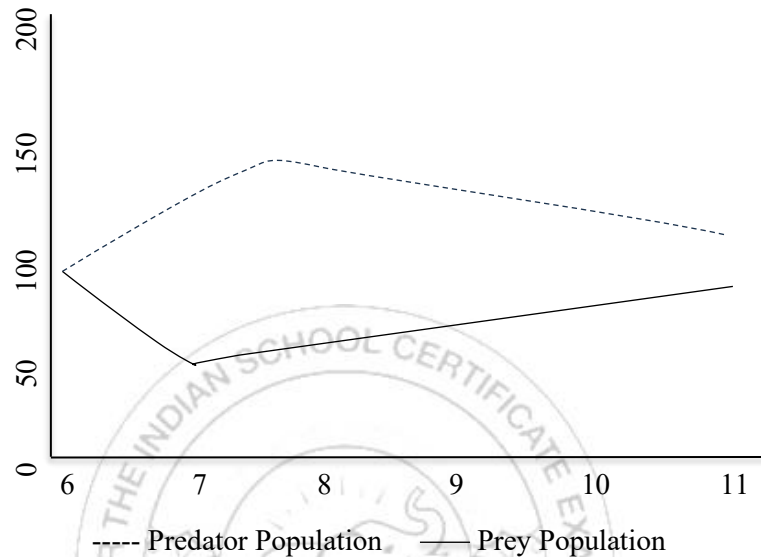
- (ii) (a) Pea plant belongs to the Leguminosae family whose pollen can remain viable for several months and years. But pollens of wheat remain viable for only 30 minutes.
- (b) (1) Fruit X
It will not exhibit genetic variation.
This is so because the embryo develops from the cells of the integument by mitosis and not by fertilisation.

- (2) 'Y' is a parthenocarpic fruit.

Question 18

[5]

- (i) (a)



- (b)
- The abundant prey provides more food, allowing the predator population to recover gradually over the following years.
 - As predators recover, the prey population begins to decline, approaching a new ecological balance.

OR

- (ii) (a) The change in population size after the first year.

$$\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$$

$$\frac{dN}{dt} = 0.2 \times 100 \left(\frac{500 - 100}{500} \right)$$

$$\frac{dN}{dt} = 20 \times 0.8 = 16$$

(b)

