

SET 4 – FULL ANSWER KEY

Section – A Answers (1×16 = 16 Marks)

1. **C** – 8 nuclei
2. **B** – 20% recombination frequency
3. **B** – 4 sperms
4. **A** – 20% cytosine
 - A = 30%
 - T = 30%
 - Remaining 40% = G + C
 - C = 20%
5. **C** – Random mating
6. **C** – Expanding population
7. **C** – Release factors
8. **A** – 200 amino acids
 - $600 \text{ nucleotides} \div 3 = 200 \text{ codons}$
9. **B** – Dicer
10. **B** – Reduced organic load
11. **C** – Lepidoptera
12. **C** – 0.48
 - $2pq = 2 \times 0.6 \times 0.4$
 - = 0.48
13. **A**
14. **A**
15. **A**
16. **A**

Section – B Answers (2×5 = 10 Marks)

17A. Inbreeding & Outbreeding Depression

Inbreeding depression:

- Reduced biological fitness
- Increased homozygosity
- Expression of deleterious recessive genes

Outbreeding depression:

- Crossing of genetically distant individuals
- Loss of co-adapted gene complexes

18. Meselson & Stahl Experiment

- Used N¹⁵ and N¹⁴ isotopes
- Grew E. coli in heavy nitrogen
- Shifted to light nitrogen
- Density gradient centrifugation showed hybrid DNA

Conclusion: DNA replication is **semi-conservative**.

19. Hardy-Weinberg Numerical

Total population = 10,000

Homozygous recessive = 3600

$$q^2 = 3600 / 10000 = 0.36$$

$$q = \sqrt{0.36} = 0.6$$

$$p = 1 - 0.6 = 0.4$$

Heterozygotes = $2pq$

$$= 2 \times 0.4 \times 0.6$$

$$= 0.48$$

→ 48% heterozygotes

20A. Cloning Vector Features

- Origin of replication (ori)
- Selectable marker
- Unique restriction sites
- Small size
- High copy number

21A. Energy Transfer

Producers = 1,000,000 kcal

Primary = 100,000 kcal

Secondary = 10,000 kcal

Tertiary = 1,000 kcal

Section – C Answers (3×7 = 21 Marks)

22. Polydactyly Problem

Polydactyly (P) dominant

Male = Pp

Female = pp

Cross:

Pp × pp

Offspring:

50% Pp (affected)

50% pp (normal)

(i) Probability affected child = **1/2**

(ii) Probability unaffected daughter =
1/2 (normal) × 1/2 (female) = **1/4**

(iii) Exactly 2 affected out of 4:

Using binomial formula:

n = 4

p = 1/2

Probability = $6 \times (1/2)^4$

= 6/16

= **3/8**

23. Linkage Problem

Genes 10 map units apart

Recombination frequency = 10%

Parental types = 90%
Recombinant types = 10%

Test cross result:

Parental = 45% + 45%
Recombinant = 5% + 5%

24. Double Fertilisation

- Pollen tube enters ovule
- One male gamete + egg → Zygote (2n)
- Second male gamete + two polar nuclei → Endosperm (3n)

Unique to angiosperms

25. Transcription in Prokaryotes

Steps:

- Initiation (sigma factor binds promoter)
- Elongation
- Termination

Sigma factor ensures correct promoter recognition.

26. Xerarch Succession

Bare rock → Lichens → Moss → Herbs → Shrubs → Trees

Soil formation gradual

27. Immunity

Humoral → B cells → Antibodies

Cell mediated → T cells destroy infected cells

28. Population Growth

Formula:

$$N_t = N_0 e^{(rt)}$$

$$N_0 = 200$$

$$r = 0.3$$

$$t = 2$$

$N_t \approx 364$ individuals

(Same as previous because numbers identical)

Section – D Answers (4×2 = 8 Marks)

29. ABO + Rh Case

Mother = A-

Father = B+

Possible groups: A, B, AB, O

Erythroblastosis fetalis = Hemolytic disease due to Rh incompatibility

Affects second child more because mother develops antibodies after first pregnancy

Prevention: Anti-Rh antibody injection

30. Insertional Inactivation

Foreign gene inserted into tetracycline resistance gene

Recombinants:

Ampicillin resistant

Tetracycline sensitive

ori = replication origin

Section – E Answers (5×3 = 15 Marks)

31. DNA Replication

- Helicase unwinds
- Primase forms primer
- DNA polymerase synthesizes
- Ligase joins fragments

Lagging strand discontinuous due to 5'→3' synthesis direction.

32. Agrobacterium & RNAi

Ti plasmid transfers gene

Restriction enzymes cut at palindromic sequences

RNAi degrades specific mRNA

33. Ecology

- Competitive exclusion → Gause experiment
- Resource partitioning → Warblers
- Keystone species → Pisaster
- 10% law → Lindeman
- Latitudinal gradient → Higher biodiversity in tropics