

## BIOLOGY (Theory)

[Time allowed: 3 hours]

[Maximum marks:70]

### General Instructions:

- (i) *All questions are compulsory.*
- (ii) *This question paper consists of four sections A, B, C and D. Section A contains 8 questions of one mark each, Section B is of 10 questions of two marks each, Section C is of 9 questions, of three marks each and Section D is of 3 questions of five marks each.*
- (iii) *There is no overall choice. However, an internal choice has been provided in one question of 2 marks, one question of 3 marks and all the three questions of 5 marks weightage. A student has to attempt only one of the alternatives in such questions.*
- (iv) *Wherever necessary, the diagrams drawn should be neat and properly labelled.*

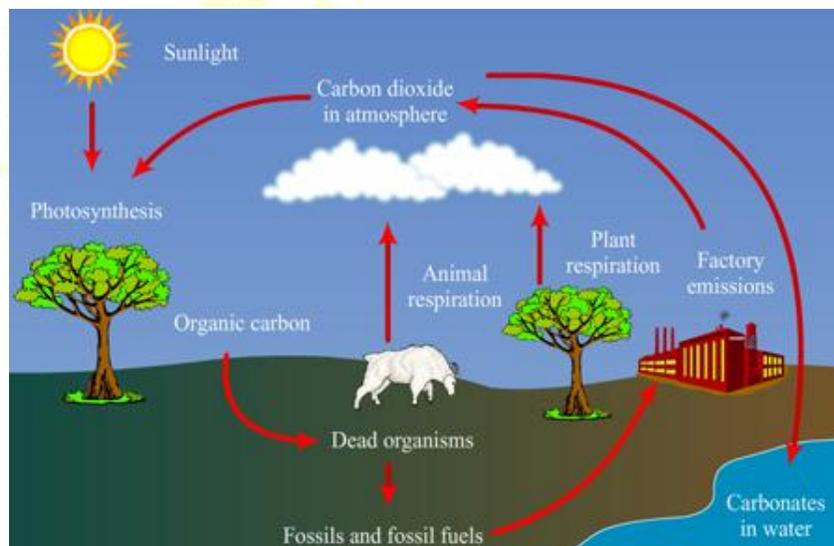
**Q28.** Explain the carbon cycle with the help of a simplified model. (5)

OR

Explain how does:

- (a) a primary succession start on a bare rock and reach a climax community?
- (b) the algal bloom eventually choke the water body in an industrial area?

**Ans:** Key process involved in carbon cycle is photosynthesis and respiration.



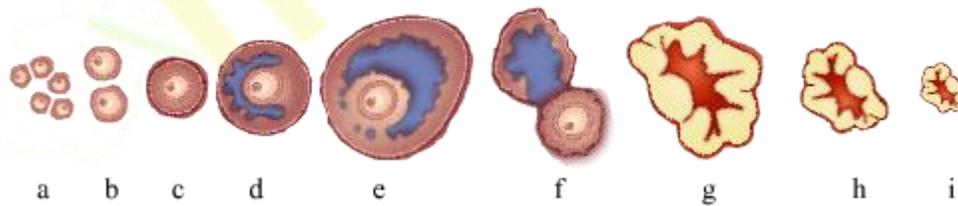
1. In photosynthesis, carbon-dioxide and water produce carbohydrate and oxygen while respiration oxidizes food to give carbon-dioxide and water.

2. In oceans, carbon-dioxide dissolves readily in water. In rock it gets stored as calcium carbonate.
3. Carbon can either be liberated to atmosphere through respiration or can be passed to animal when being eaten or remain in plant even after death.
4. After death of plant or animal, decomposition takes place and carbon dioxide gets released into the atmosphere. They can also be buried inside the earth and converted to coal or natural gas. Natural gas and coal are fuels and on combustion they release carbon dioxide back into the atmosphere.
5. Excess of carbon-dioxide can cause global warming.

**OR**

- (a) The species of organisms that first invade a bare area are called pioneer species. The pioneer species on a bare rock are usually lichens. Lichens secrete acids which dissolve rocks, thereby leading to weathering and soil formation. This paves the way for small plants which hold the soil. They are succeeded by bigger plants, and ultimately, an entire forest gets established. Forests represent the climax community in this succession.
- (b) The algae and plants are the primary producers in a lake in which the algae contribute to the maximum productivity. In an industrial area the runoff of nutrients such as inorganic chemicals and sewage, leads to an increase in the fertility of the lake. As a result, it causes a tremendous increase in the primary productivity of the lake ecosystem. This leads to an increased growth of algae, resulting in algal blooms. Later, the decomposition of these algae depletes the supply of oxygen, leading to the death of other aquatic animal life. This ageing process of a lake caused due to nutrient enrichment is called **Eutrophication**.

**Q29.** The following is the illustration of the sequence of ovarian events (a – i) in a human female. (5)



- (i) Identify the figure that illustrates ovulation and mention the stage of oogenesis it represents.
- (ii) Name the ovarian hormone and the pituitary hormone that have caused the above mentioned event.
- (iii) Explain the changes that occur in the uterus simultaneously in anticipation.
- (iv) Write the difference between 'c' and 'h'.
- (v) Draw a labeled sketch of the structure of a human ovum prior to fertilization.

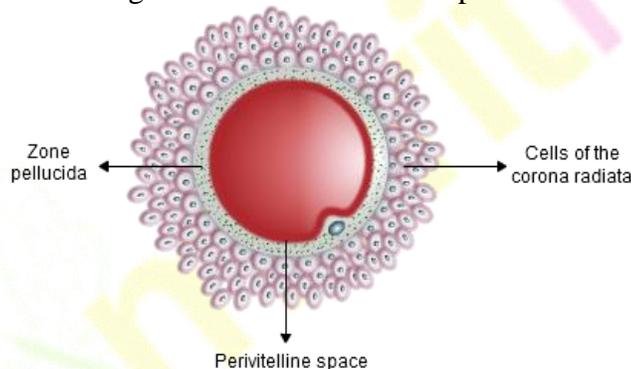
**OR**

How does the megaspore mother cell develop into 7-celled, 8 nucleate embryo sac in an angiosperm? Draw a labeled diagram of a mature embryo sac.

- Ans:** (i) Figure 'f' illustrates ovulation. It represents the ovulatory stage of oogenesis.
- (ii) **Progesterone** is the ovarian hormone released during ovulation. **Follicle stimulating hormone (FSH) and Luteinizing hormone (LH)** are the pituitary hormone released during ovulation.
- (iii) In anticipation of receiving the fertilised egg, the endometrium of the uterus gets thickened and also the blood supply to the endometrium increases.
- (iv) In the figure, (c) stage represents the secondary follicle and the (h) stage represents the degenerating corpus luteum.

Secondary follicle	Corpus luteum
It is Surrounded by layers of granulosa cells	Layers of granulosa cells absent
Presence of theca layer	No theca layer is present

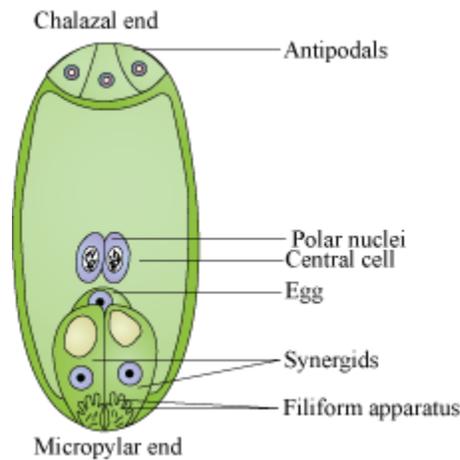
- (v) Labeled diagram of the human ovum prior to fertilization.



**OR**

The megaspore mother cell undergoes mitosis to form two nuclei which migrate to opposite poles, forming a 2-nucleate embryo sac. Further mitotic divisions lead to the formation of 4-nucleate followed by 8-nucleate stages of the embryo sac. In these mitotic divisions, nuclear division is not followed by cell division.

After the 8-nucleate stage, cell walls are laid down and a typical female gametophyte or embryo sac is formed. Among the eight nuclei, six are enclosed by cell walls and organised into cells, while the remaining two nuclei (called polar nuclei) are situated above the egg apparatus in a large central cell. Out of the six cells, three are grouped at the micropylar end, and constitute the egg apparatus made up of two synergids and one egg cell. The other three cells are located at the chalazal end, and are called antipodals. Thus, a typical angiosperm embryo sac after maturity is 8-nucleated and 7-celled.



- Q30.** What is the inheritance pattern observed in the size of starch grains and seed shape of *Pisum sativum*? Workout the monohybrid cross showing the above traits. How does this pattern of inheritance deviate from that of Mendelian law of dominance? (5)

OR

State the aim and describe Messelson and Stahl's experiment.

- Ans:** The starch synthesis in pea plants is controlled by a single gene. It has two alleles **B** and **b**. **BB** homozygotes produced large starch grains as compared to that produced by **bb** homozygotes. After maturation it was observed that BB seeds were round and bb were wrinkled. When they were crossed the resultant progeny were intermediate-sized Bb seeds. The cross involved is

P generation	BB × bb						
	↓						
F <sub>1</sub> Generation	Bb × Bb						
	B      b						
F <sub>2</sub> Generation	<table style="border-collapse: collapse; width: 100%;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">B</td> <td style="padding: 5px;">BB</td> <td style="padding: 5px;">Bb</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">b</td> <td style="padding: 5px;">bB</td> <td style="padding: 5px;">bb</td> </tr> </table>	B	BB	Bb	b	bB	bb
B	BB	Bb					
b	bB	bb					

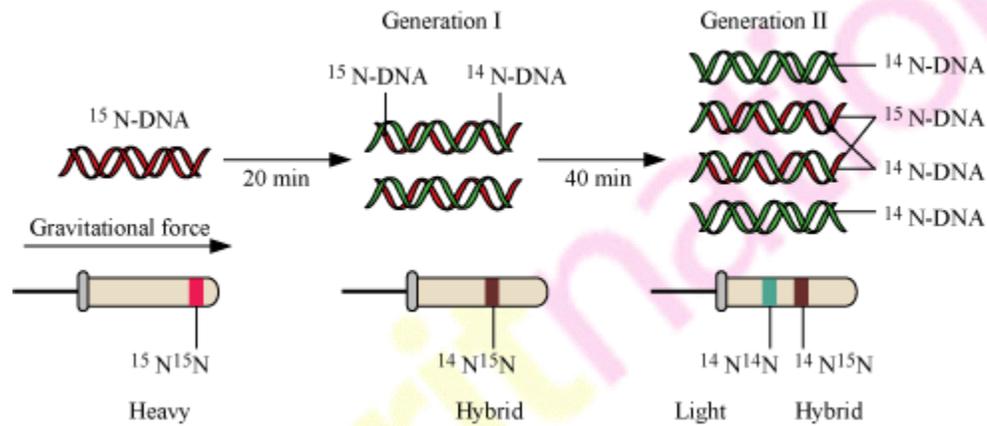
**Deviation from Mendel's law of dominance:** If starch grain size is considered as the phenotype, then from this angle, the alleles show incomplete dominance. Thus, dominance is not an autonomous feature of a gene, it depends on gene product and production of particular phenotype from this product.

OR

Messelson and Stahl in 1958 aimed at proving that the DNA replicates in a semi-conservative fashion. The semi-conservative DNA replication suggests that after the completion of replication, each DNA molecule will have one parental and one newly-synthesised strand.

### Experimental proof

- (1) *E. coli* was grown in a medium containing  $^{15}\text{NH}_4\text{Cl}$  ( $^{15}\text{N}$  is the heavy isotope of nitrogen) as the only nitrogen source for many generations. As a result,  $^{15}\text{N}$  was incorporated into the newly-synthesised DNA. This heavy DNA could be distinguished by centrifugations in  $\text{CsCl}$  density gradient.
- (2) Then, these *E. coli* cells were transferred to a medium with normal  $^{14}\text{NH}_4\text{Cl}$  and the DNA was extracted as double-stranded helix. The various samples were separated on  $\text{CsCl}$  gradients for measuring the density of DNA.
- (3) After 40 minutes, the DNA of the second generation was extracted from the  $^{14}\text{NH}_4\text{Cl}$  medium and was found to have equal amounts of hybrid and light DNA.



☺ End of the Exam ☺