
SECTION I: (10 MARKS)

1. _____ provides the rapid block to polyspermy during sea urchin fertilization? (1).
2. Expression of _____ RNA is associated with the X chromosome that undergoes inactivation during dosage compensation in mammals. (1).
3. The "mid-blastula transition" is the point in development when _____ happens. (1)
4. In mammalian development, _____ cells form the embryo proper. (1)
5. The analogous of acrosomal reaction in sea urchin eggs is _____. (1)
6. Remarkably, Vg-1 and wnt are used in both frogs and chicks to establish a body axis, although in chicks this is the antero-posterior axis instead of the dorso-ventral axis. What is the region of the chick embryo that is thus analogous to the Nieuwkoop center? (1)
7. At the blastocyst stage during mammalian embryonic development, the specification of trophectoderm requires _____; whereas in inner cell mass _____ activation is essential. (1)
8. _____ Ligand is released by the interstitial stem cells during Hydra regeneration to initiate apoptosis. (1)
9. During gastrulation in *Xenopus*, the future mesoderm and endoderm move inside the embryo through the "blastopore"; in contrast, in chickens, gastrulation involves cells moving inward through the _____. (1)
10. The notochord is derived from ____ (germ layer) in vertebrate embryos and lies under the _____. (1)

Section II. Short answers (10). Attempt any 4 questions.

1. Although the vertebrate body plan outwardly displays a mirror-image symmetry with regard to left and right, the internal organs are not symmetrical. How does this left-right asymmetry develop? (2.5)
2. In flies, frogs, and chicks, gradients of morphogens determine the future antero-posterior and dorso-ventral axes of the developing embryo. How is the antero-posterior axis determined in *C. elegans*? (2.5)
3. If cells from the animal pole of a frog blastula (animal cap cells) are placed into contact with cells from the vegetal hemisphere, what will be the fate of these cells and why? (2.5)

4. In which way is the organizer region of the sea urchin similar to that in frogs? (2.5)
5. Overexpression of Homeotic gene Antennapedia in the 1st segment transforms the Antennae into Legs. However overexpression of Labial (required for antennae formation) in the 2nd thoracic segment cannot cause any Antennae specification? Why? (2.5)

Section III.

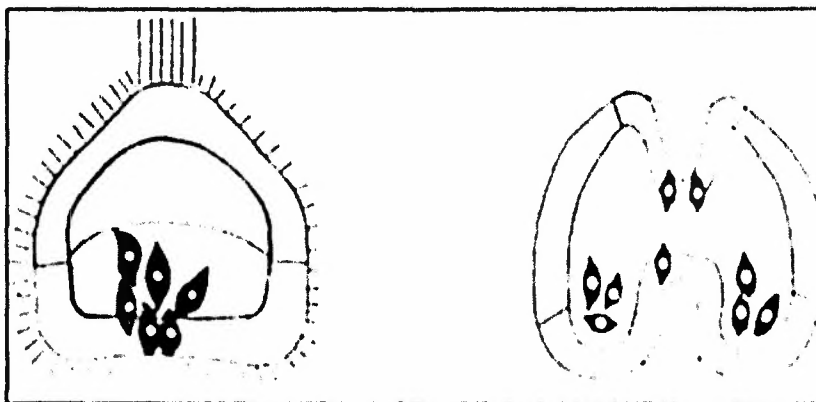
PLEASE ANSWER ANY SIX OF THE FOLLOWING QUESTIONS. EACH QUESTION IS WORTH 3 MARKS. (18 MARKS). BE BRIEF. HIGHLIGHT ATLEAST 3 UNIQUE CONTRARY POINTS.

1. DIFFERENTIATE BETWEEN

- A. INVERTEBRATE FERTILIZATION (SEA URCHIN) & VERTEBRATE FERTILIZATION
- B. SEX DETERMINATION IN FLIES AND MAMMALS
- C. MORPHALLAXIS & EPIMORPHOSIS
- D. PRIMARY NEURULATION AND SECONDARY NEURULATION
- E. DOSAGE COMPENSATION AND GENOMIC IMPRINTING
- F. METAMORPHOSIS IN AMPHIBIAN & METAMORPHOSIS IN HOLOMETABOLOUS INSECTS
- G. SPATIAL AND TEMPORAL COLLINEARITY OF HOMEOTIC GENES

SECTION III: PLEASE ANSWER ANY FOUR OF THE FOLLOWING QUESTIONS. EACH QUESTION IS WORTH 3.0 MARKS (12 MARKS)

1. BELOW IS THE SCHEMATIC REPRESENTING THE GASTRULATING EVENTS IN SEA URCHIN EMBRYO IN WILD TYPE AND AN EXPERIMENTAL SET UP. PLEASE STUDY THE DIAGRAM BELOW AND ILLUSTRATE THE POSSIBLE REASON/S FOR THE PHENOTYPE OBSERVED IN THE EXPERIMENT.



Wild Type

Experiment

2. Injection of the bicoid mRNA to the posterior end of developing embryo (early) results in specification of anterior structures at the posterior end. However injection of nanos mRNA in the anterior region doesn't result in the specification of posterior structures at the anterior end. Can you explain the reason for this contrasting observation?

3. Explain how the organization of microtubules regulates polarity generation in *Drosophila* development?
4. What role AER (Apical Ectodermal Ridge) plays during limb development?
5. What is Retinoic acid teratogenesis? Explain

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