**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**

**SECOND SEMESTER 2015-16**

**BIO F341 DEVELOPMENTAL BIOLOGY**

**Comprehensive Examination (CLOSED BOOK)**

**Maximum Marks: 20 Time: 90 min Date: 06/12/16**

**1.** A fruit fly researcher accidentally knocked off a gene that determines future germplasm cells and their location. What associated morphogenic (patterning) defect do you expect the fruit fly to suffer from due to knock out of that vital gene. How by adding exogenous factors you can partially rectify the patterning issue. Give justifications for your answer. **(3+3=6)**

**2.** Using a diagram, draw where in the Xenopus embryo the Nieuwkoop center and Spemann's organizer will form. Illustrate the distribution of different molecules that determine and distinguish the Nieuwkoop center and Spemann's organizer. If this Xenopus embryo was injected with a drug that increases the activity of GSK-3, what would the developing embryo look like? What would this do at the molecular level to the embryo? **(3+3+3=9)**

**3.** In an experiment performed by a researcher he introduced ***Drosophila* Hunchback** protein midway in cellular non-syncytial blastoderm stage of *Drosophila* embryo to observe effects on spatial expression of gap genes. All other known influences were held constant. The embryo was wild type for all other genes too. What do you think would be the consequences on gap gene expression? Justify. **(3)**

**4.** The Decapentaplegic protein of *Drosophila* specifying dorsal region belongs to TGF-B family of proteins. A protein secreted from the ventral region represses it. Mention the name of ***Xenopus*** homologs of both the genes acting in a similar manner in embryo patterning? **(2)**

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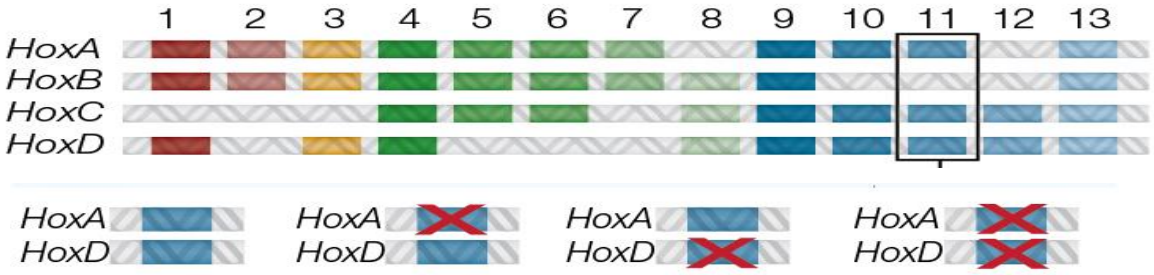
**Maximum Marks: 25** **Time: 90min** **Date: 06/12/16**

**1.** Dr Vincent runs a Drosophila lab. His students created transgenic flies capable of transcribing mRNAs without the 3'-UTR for a specific gene that is required for development of the posterior end of the fertilized embryo. Do you think that the not having a UTR would have any effect on the development of the embryo. Justify. **(4)**

**2.** What do you think would be the effect of Chordin and Noggin removal from organizer region to the germinal layer formation in a developing Xenopus embryo. What is a primitive streak and why is it important. **(3+3=6)**

**3.**You have just joined a Drosophila research lab for small term project. As a preliminary study, your supervisor asks you to prove experimentally that bicoid protein activates Hunchback gene by binding to its promoter. How would you proceed. Reagents are not a constraint for the lab. **(4)**

**4.** The following figure shows the **Hox genes** provided by Mario Capecchi's research group at the University of Utah; the box region controls mouse fore legs. Explain the effect of knockdown of each paralog as depicted below. **(2)**




**5.** A "transplant" experiment was performed where the future neural plate of a *Xenopus* embryo was moved from its usual dorsal position to a more upper ventral region of a host embryo. The host and donor embryos were either at the early gastrula or late gastrula stage when the transplant was performed and all were examined when embryos reached a mid-neurula stage.

**a.** In order to perform this experiment, you need to know which piece of tissue is going to give rise to the normal neural plate, How would you determine this? What is this type of experiment called? **(3)**

**b.** Mention the fate of the cells transplanted in the two embryos. Give justifications. **(2)**

**6. 5.** You discover a mouse mutant called "gutless", where the gut fails to form and embryos die early due to multiple problems. Initial analyses indicate that the transcription factor **otx2** is expressed in all cells of the mutant, whereas in wild type embryos, otx2 is expressed only in the nervous system.

**a.** Does the "gutless" mutant necessarily correspond to a mutation in the otx2 gene? Explain. **(1)**

**b.** Assuming that the gutless mutation does lie in the otx2 gene, describe one region in the otx2 gene that, when mutated, could lead to its expression throughout the embryo (ubiquitous expression)? Provide the mechanism by which the gene expression could be altered. **(3)**