1. **(15 pts) Briefly describe (you may list the 5 or 6 major steps) gastrulation in mammals. What structure in mammals functions like the dorsal lip of the blastopore in amphibians? What is the term given to this type of structure? How do mammals deal with the fact that their eggs do not contain a large yolk to nourish the embryo during development?**

Inner cell mass forms the epiblast layer.

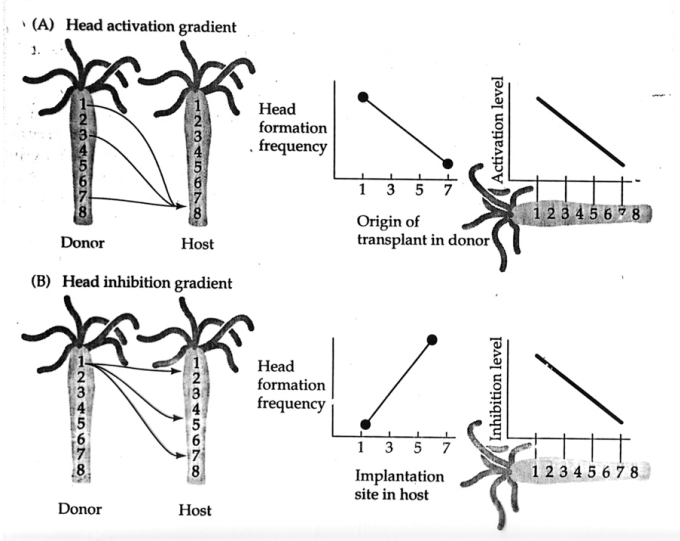
The Primitive streak, composed of ingressing epiblast cells and hypoblast cells, migrates from the posterior end toward the anterior end.

The Hensen's node is the structure that acts as the ORGANIZER, the same general function of the dorsal lip of the blastopore in amphibians. Hensen's node forms at the anterior end of the primitive streak, and lengthens as the primitive streak regresses.

Cells ingress medially to the midline of the embryo, then ventrally and laterally. At the anterior end (near Hensen's node) they also travel anteriorly.

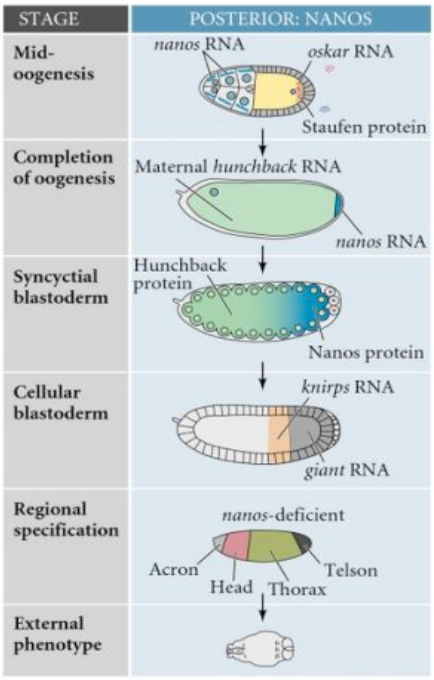
Mammals cope for the lack of a large yolk by developing inside of the mother. During early development, the trophoblast becomes the cytotrophoblast, then the synctiotrophoblast which invades the uterine wall during the implantation of the embryo. Resources for further development can then be obtained by the maternal blood supply.

2. **(10 pts) What is the interpretation of the figure below? Explain the rationale behind the two experiments in A and B and the interpretation of the results.**




Tissue taken from closest to the head contains the highest amount of head activator, so transplantation of this region leads to the highest frequency of new head formation. Tissue transplanted to regions the farthest from the head encounter the lowest level of head inhibitor in these areas, which leads to the higher frequency of head formation.

3. (15 pts) **There are three major groups of genes that specify anterior, posterior, and terminal pattern in Drosophila. Tell me about the POSTERIOR GROUP. What are the posterior embryonic pattern elements and how are they specified by the posterior group genes?**



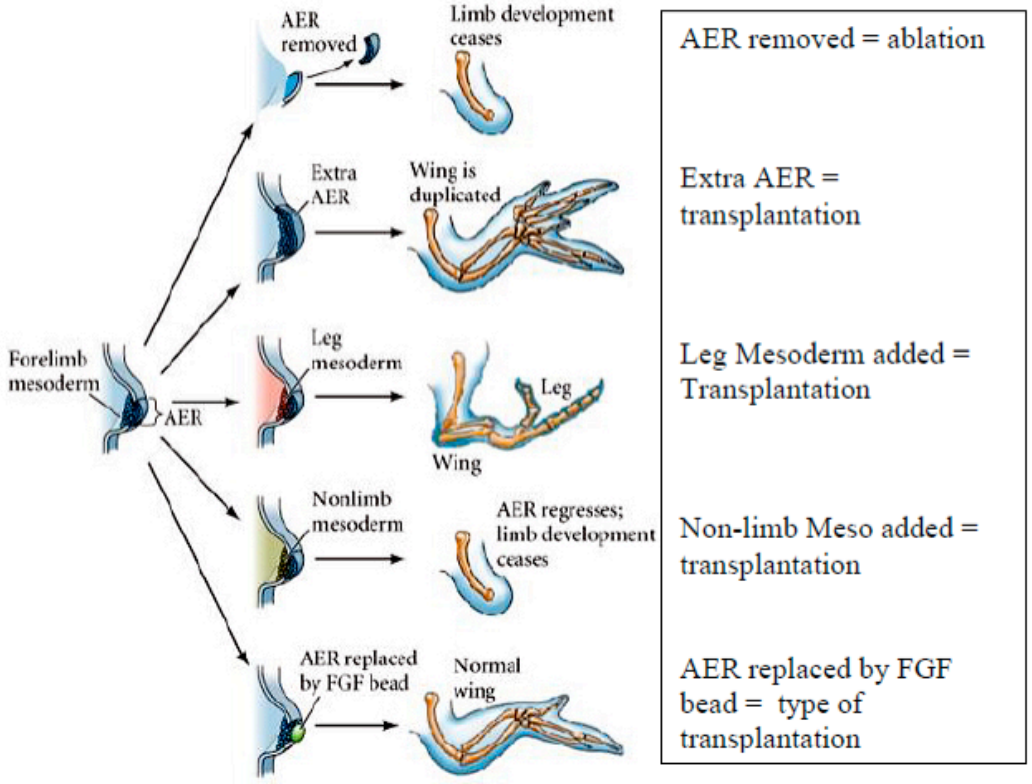

Nanos mRNA is the posterior cytoplasmic determinant and Nanos protein is the posterior morphogen. Other posterior group genes (oskar, staufen) are involved in the transport and localization of Nanos mRNA. Just as with Bicoid the ovarian nurse cells express and export Nanos mRNA to the oocyte. At the end of oogenesis nanos mRNA is localized to the posterior pole while hunchback mRNA distributed throughout the mature egg. Fertilization triggers translation of Nanos protein and establishment of the nanos gradient. Nanso acts to limit the posterior influence of hunchback by repressing hunchback mRNA translation and destablizing the mRNA. Caudal mRNA is translated into protein in the posterior region of the embryo, specifying abdomenal structures by activating the posterior GAP genes knirps and giant. Notice that embryos missing maternal Nanos mRNA lack any abdominal structures but still have terminal structures.

**4.(15 pts) What is a homeodomain? Is there any significant conservation in the homeodomain between mouse, human, and fly? What experiment lead to that conclusion?**

A[redacted]main is a helix-loop-helix DNA binding motif, characteristic for transcription factors. The homeodomain is so highly conserved that human and mouse homeodomains can rescue fly mutants!
Bespeaks an essential and conserved role in evolution. ie this is one reason to study flies - to learn about our own biology.

**5. (15 pts.) The functional roles of the limb mesoderm and the AER have been determined through experimentation. In the figure you can see the results of many of these experiments, complete the diagram by describing (in words or in words and cartoons) the resulting forelimb structure. What conclusions can be drawn from these experiments? What type (of the three classic ones) of experiment is being utilized for each approach?**

4. (20pts) Conclusions from these experiments suggest that the limb mesoderm both supports limb development and also specifies the identity of the limb (fore limb vs. hind limb). The AER is important both for supporting limb development and also in patterning the limb. Notice in the last experiment that a bead of Fgf can support limb development in the absence of an AER. This strongly suggests that the AER secretes Fgf to maintain proliferation of the limb mesoderm.



**6. (15 pts) What kind of molecule is Sonic Hedgehog? From what structure is it secreted? What happens to a limb's development when an additional Sonic Hedgehog-secreting structure is transplanted to the anterior limb primordium? Describe a model that accounts for the results of the extra transplanted structure.**

Sonic Hedgehog is a morphogen, secreted from the ZPA (zone of polarizing activity). Limb duplication occurs with the transplantation of an additional ZPA. Any reasonable model is acceptable.

**7. (15 pts) Briefly describe in 5 or six steps how RNAi is achieved in worms. Include a method that is used to introduce the RNA into the organism, and the steps involved in the interference of endogenous RNA.**

Any acceptable model from the lecture is acceptable, some examples shown below:
Some ways to introduce RNA into worms is injection, feeding, and soaking