Drosophila as a model organism

DROSOPHILA MELANOGASTER
(FRUIT FLY)

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Why is Drosophila a valuable model system?

- It is a multicellular animal – therefore it can be used to study development, physiology and behavior. Many genes only have functions in multicellular organism e.g. cadherins.
- 90 years of genetics - Drosophila has very sophisticated classical genetics and cytogenetics.

Features shared by Drosophila and other animals and higher plants:

Obligate diploid.

Sexually dimorphic gametes.

The Drosophila Genome

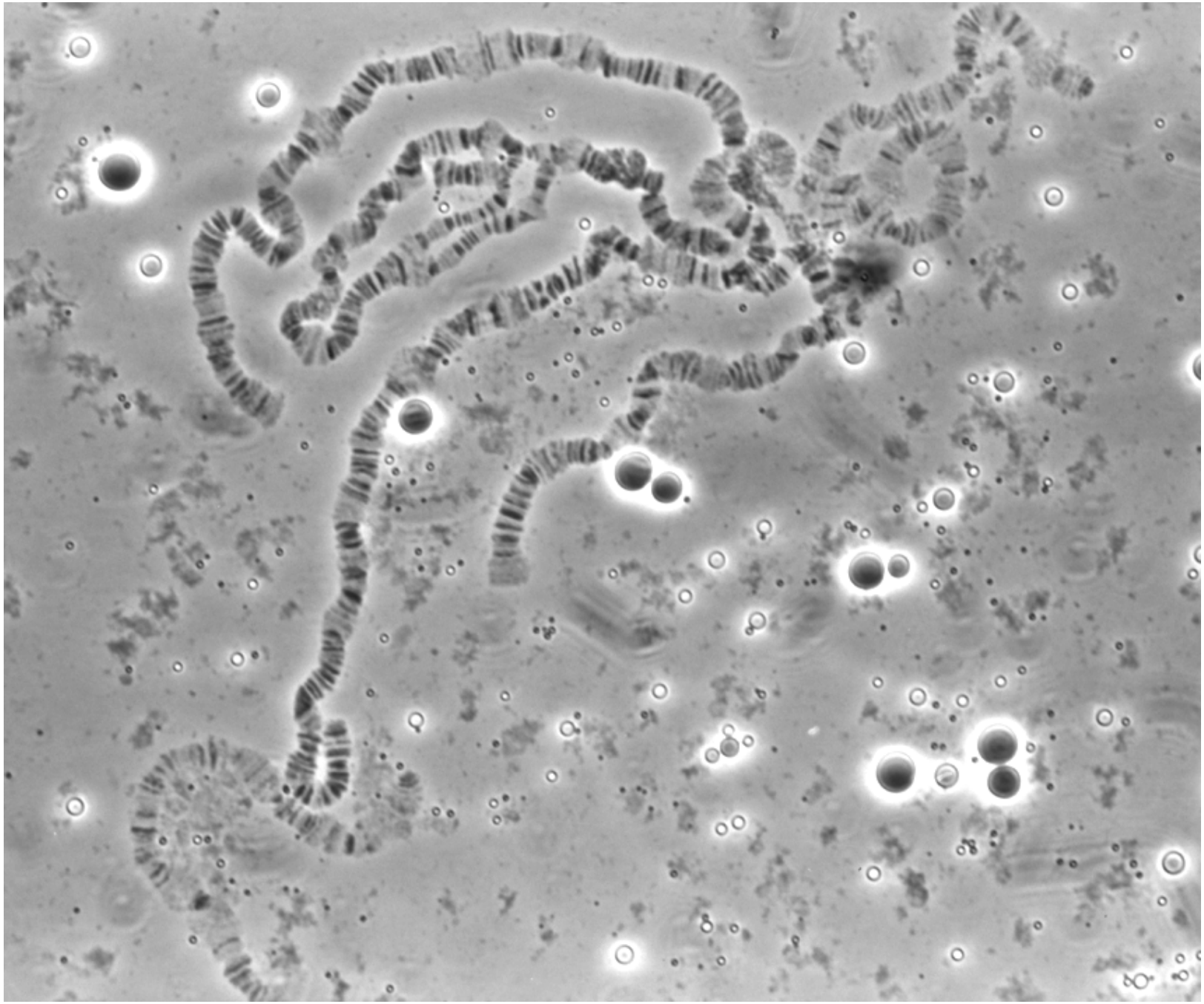
- 3 sets of autosomes
  - 2 and 3 - large metacentric chromosome
  - 4 - very small telocentric chromosome
- X/Y sex Chromosomes
  - X is a large telocentric chromosome

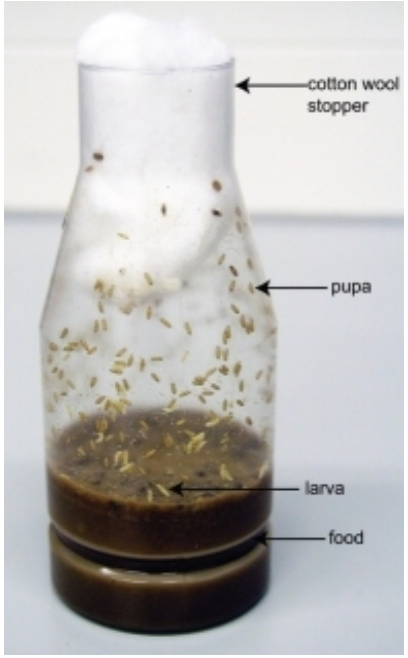
Unusual Features of Drosophila

- No crossing over in male meiosis
- larval cells (e.g. salivary gland cells) do not grow by mitotic cell division
  - they increase in size and become polyploid
  - the many chromosome strands line up to form the giant polytene chromosomes that give Drosophila it's wonderful cytogenetics.

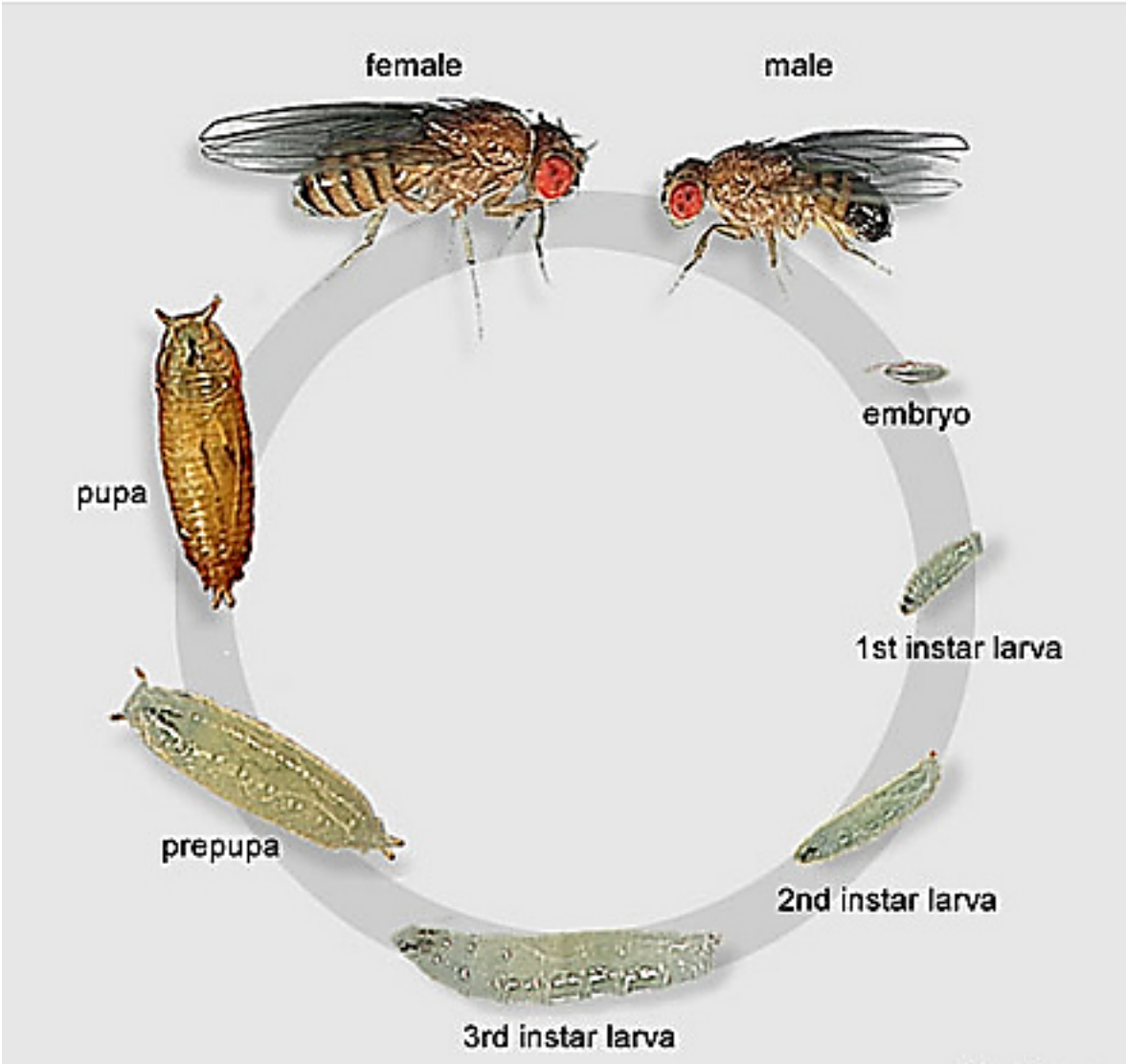
Polytene Chromosomes

- A consequence of lack of cell division in larval life (2000N).
- DNA strands line up in register
- Giant chromosomes, banding pattern (bands 5 – 200 kb).



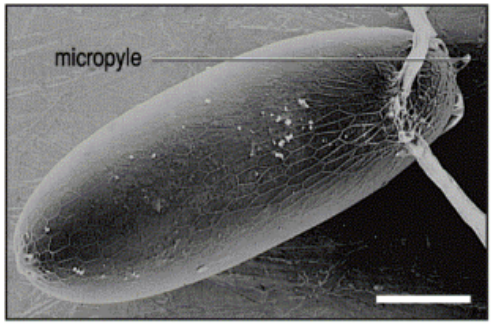

cotton wool stopper
pupa
larva
food

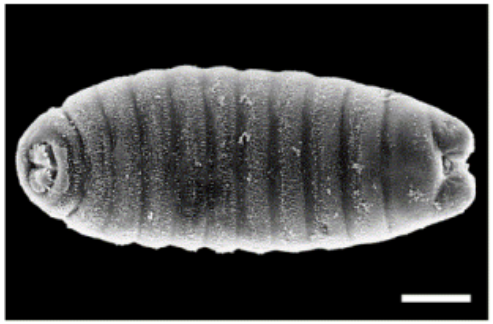
The life cycle of *Drosophila melanogaster*

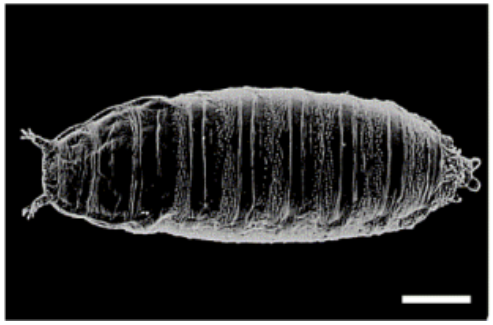


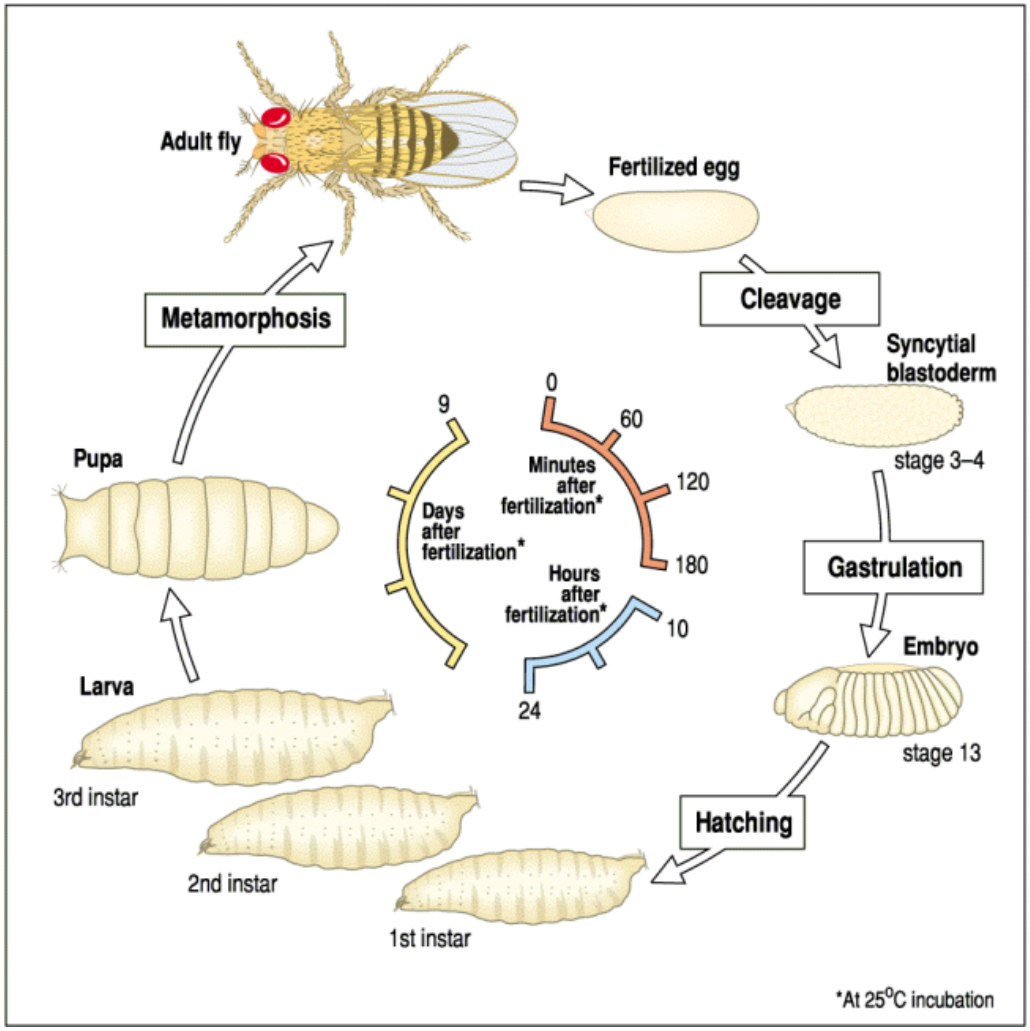
Life cycle of *Drosophila*

4 stages: embryo, larva, pupa, adult

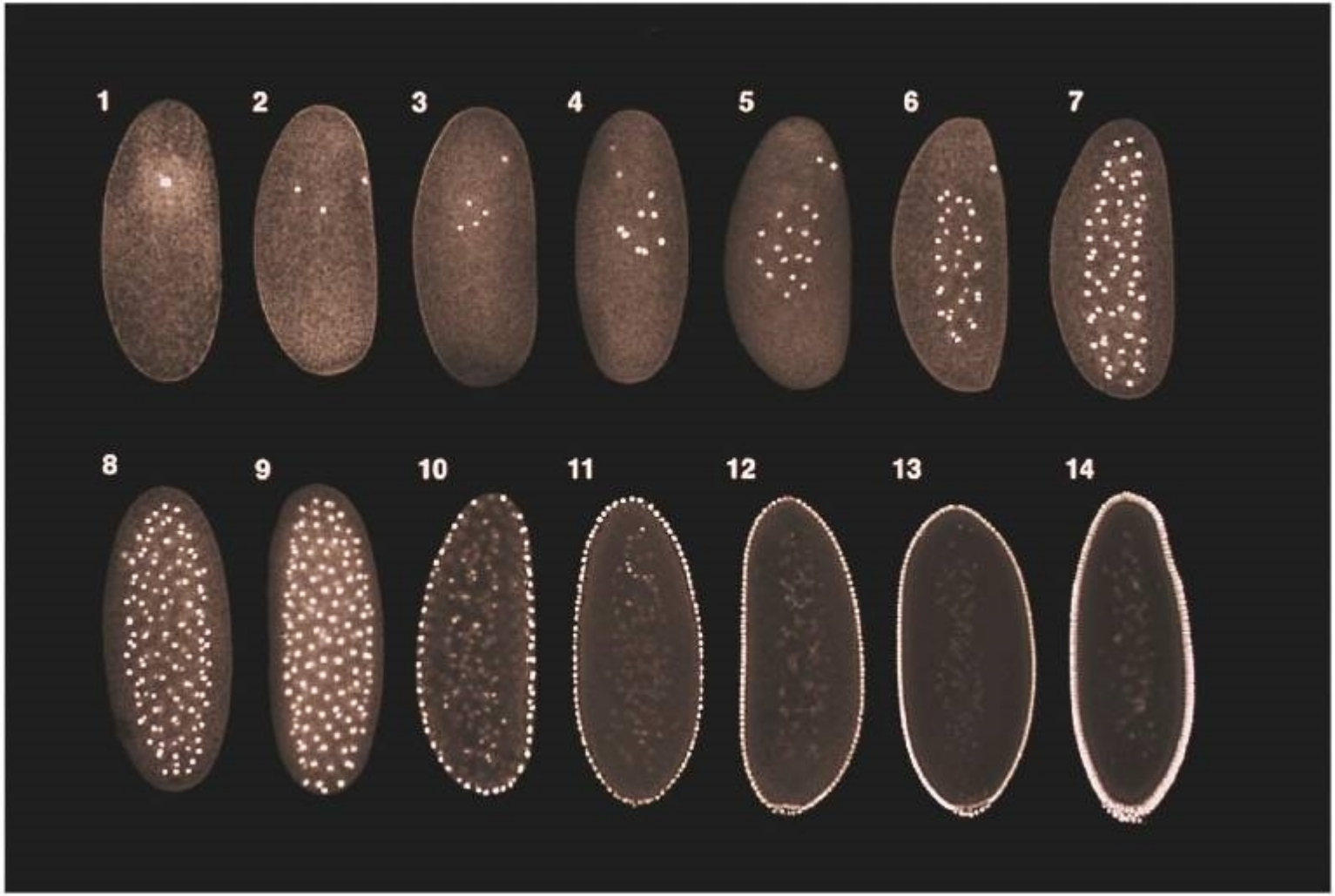




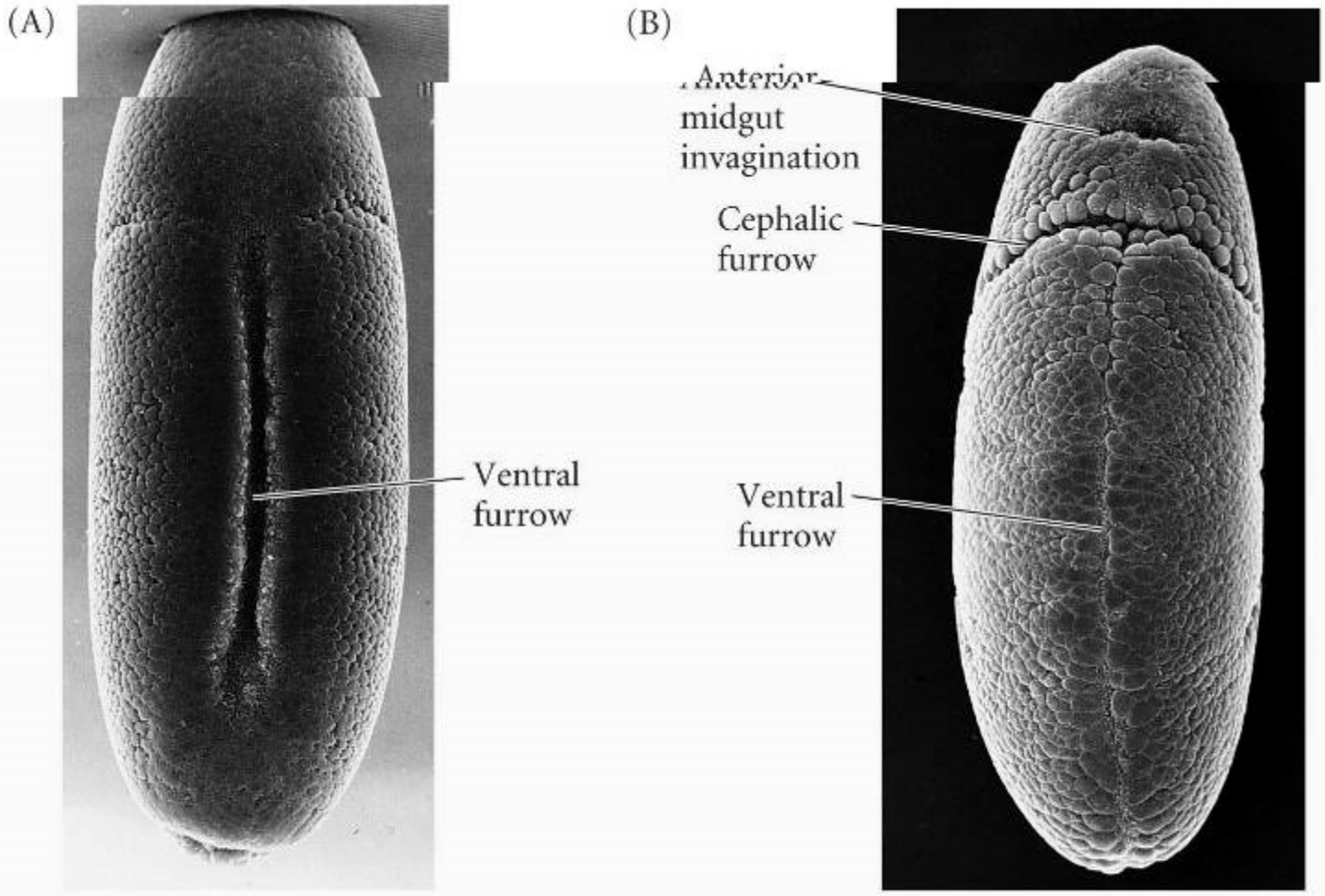


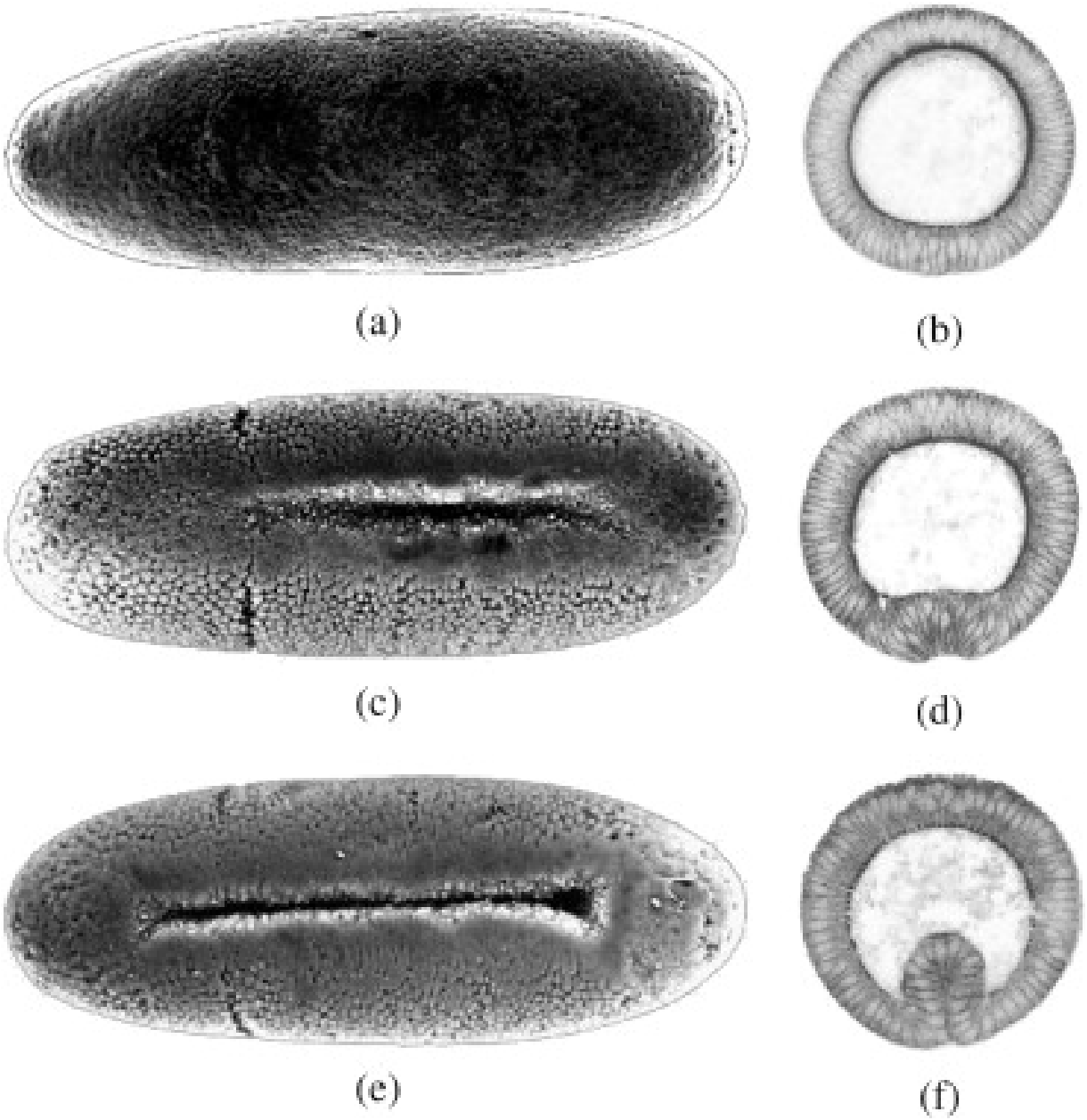


Superficial Cleavage in a *Drosophila* Embryo

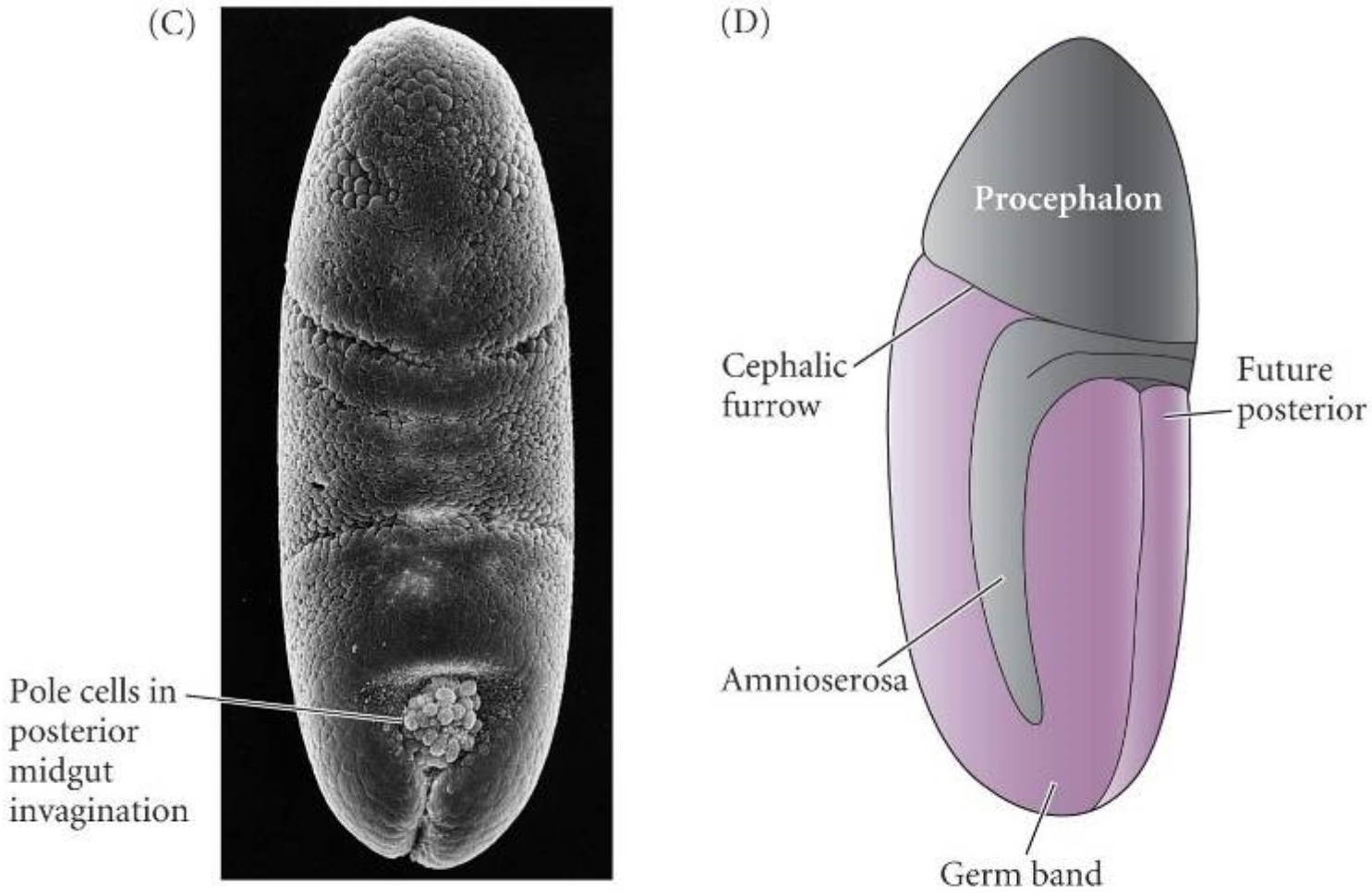


Gastrulation in *Drosophila*

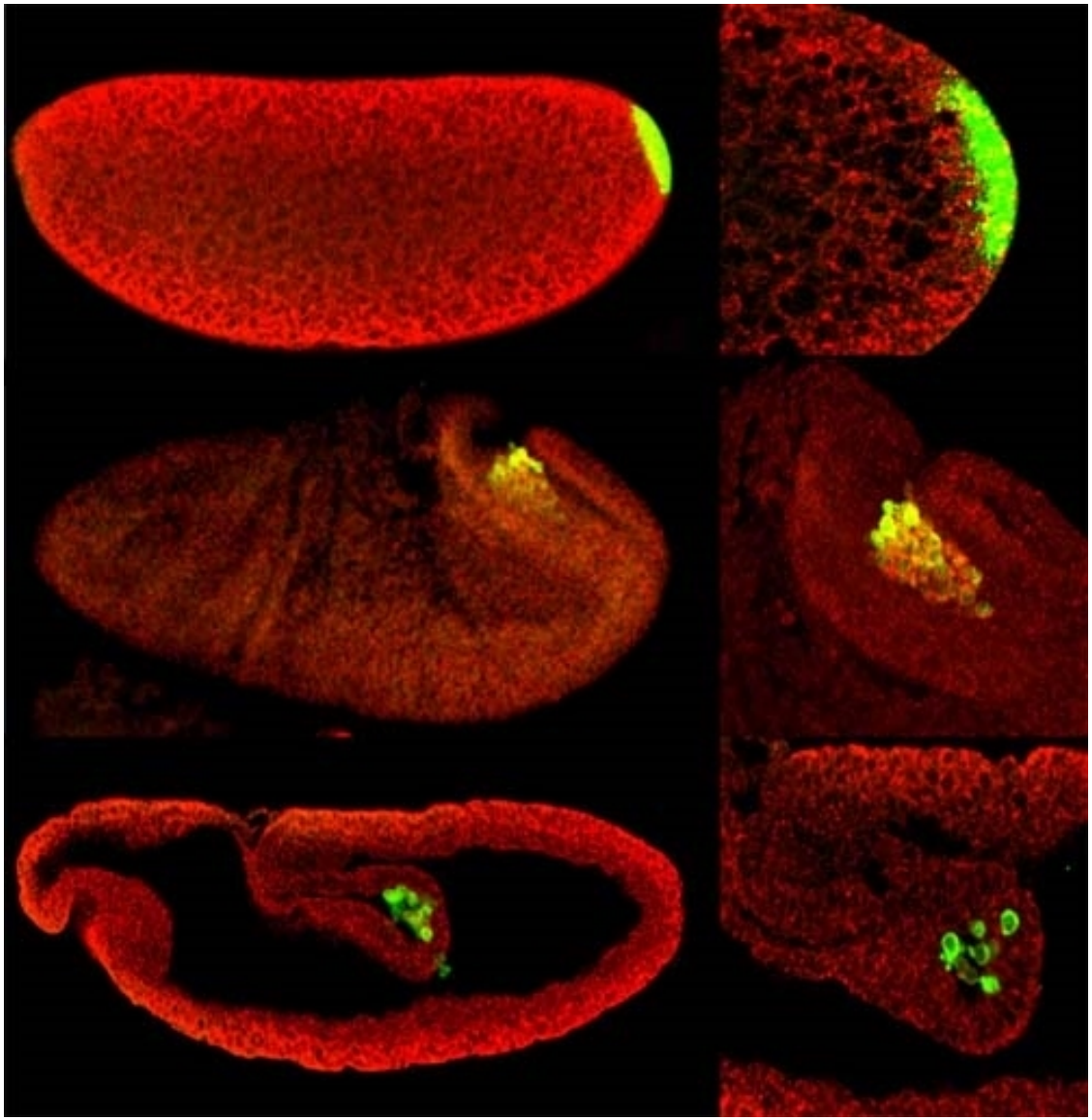


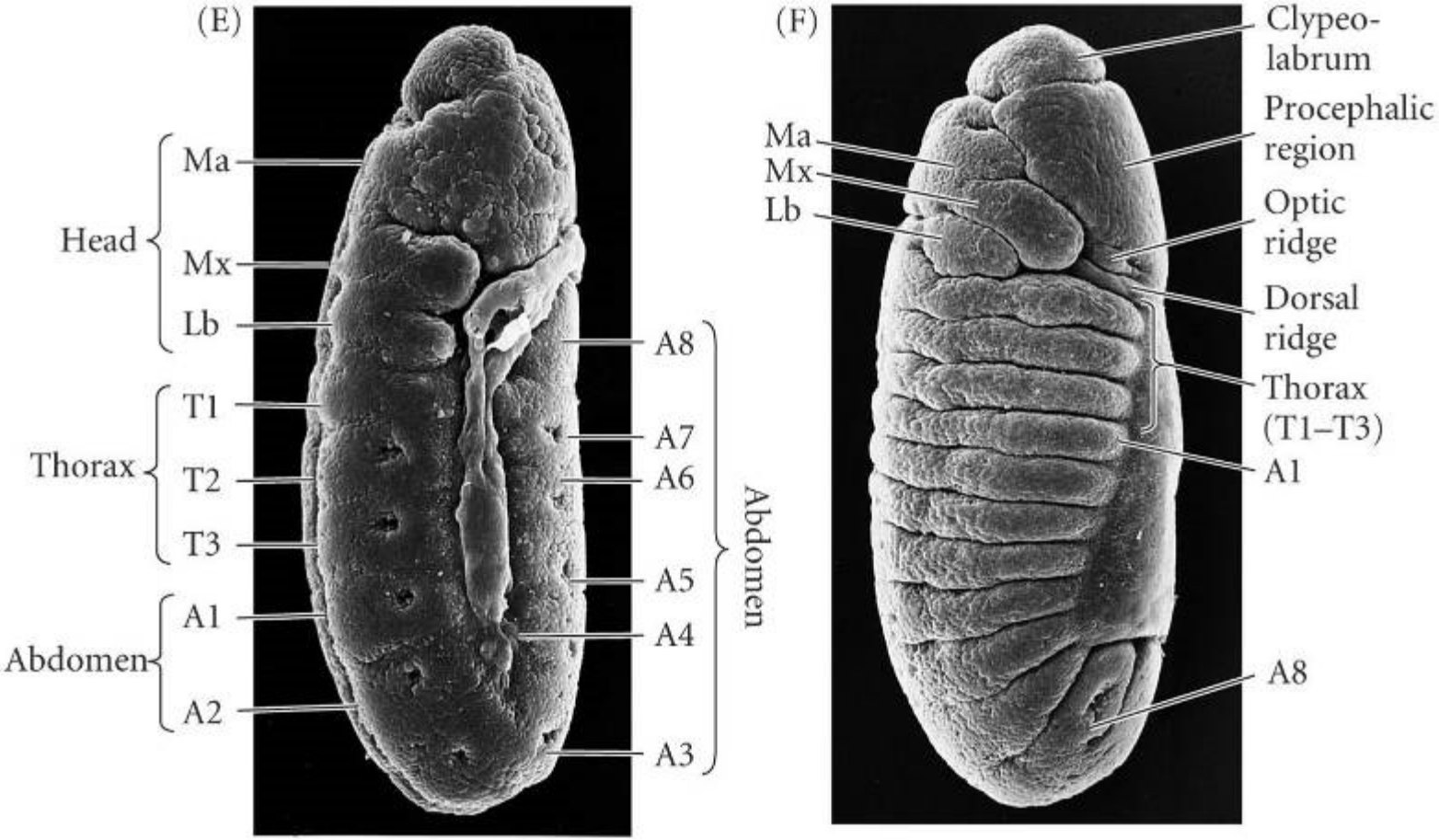

(a)
(b)
(c)
(d)
(e)
(f)

Germ band extention

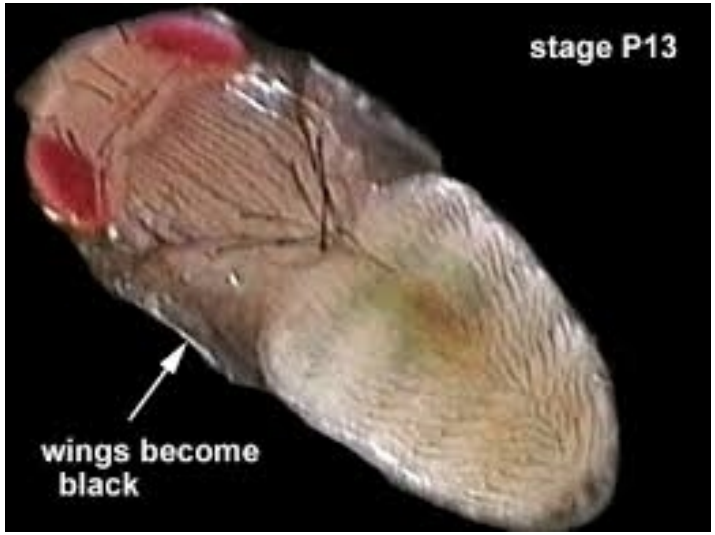


DROSOPHILA – Pole cell migration

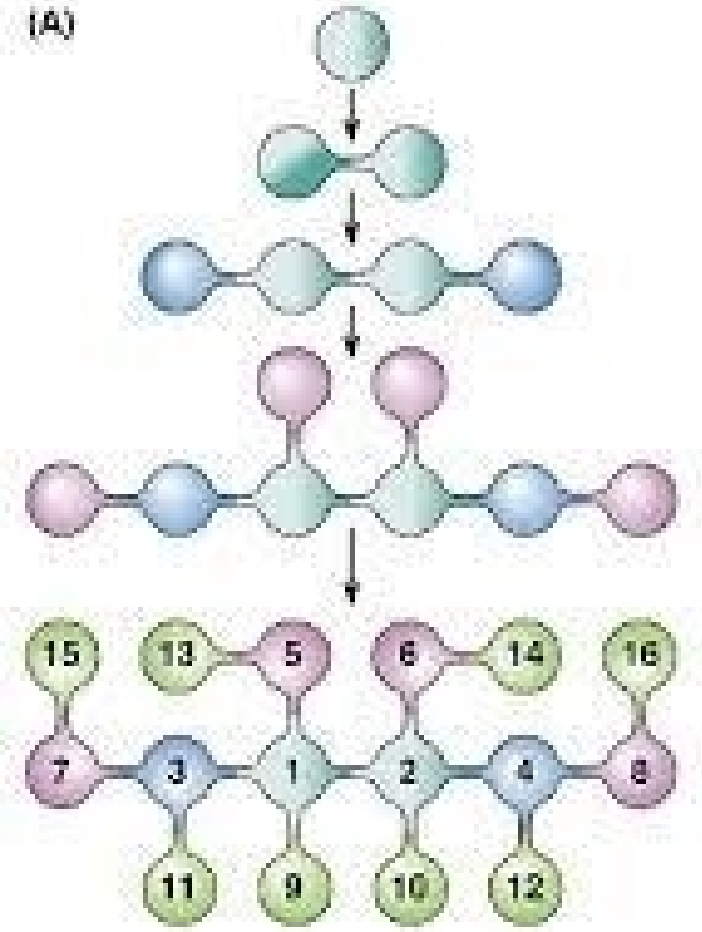


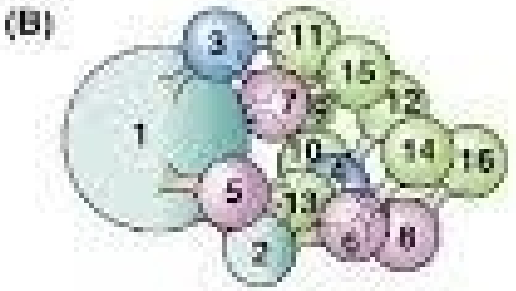



stage P7
eye cup becomes
yellow


stage P13
wings become
black

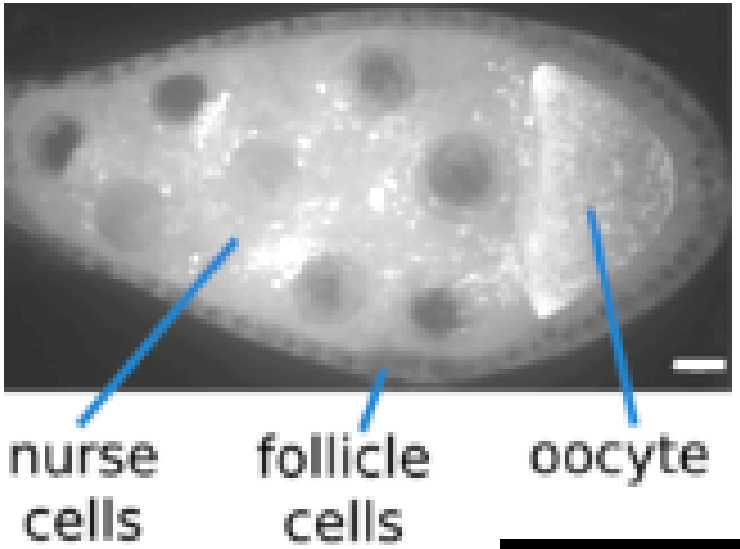
DROSOPHILA - OOGENESIS

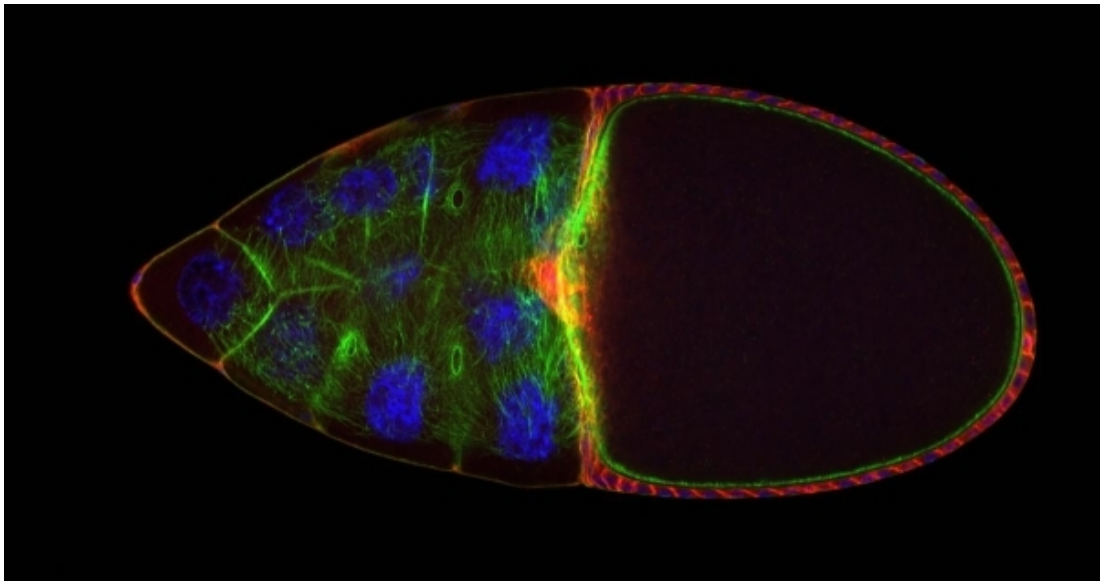




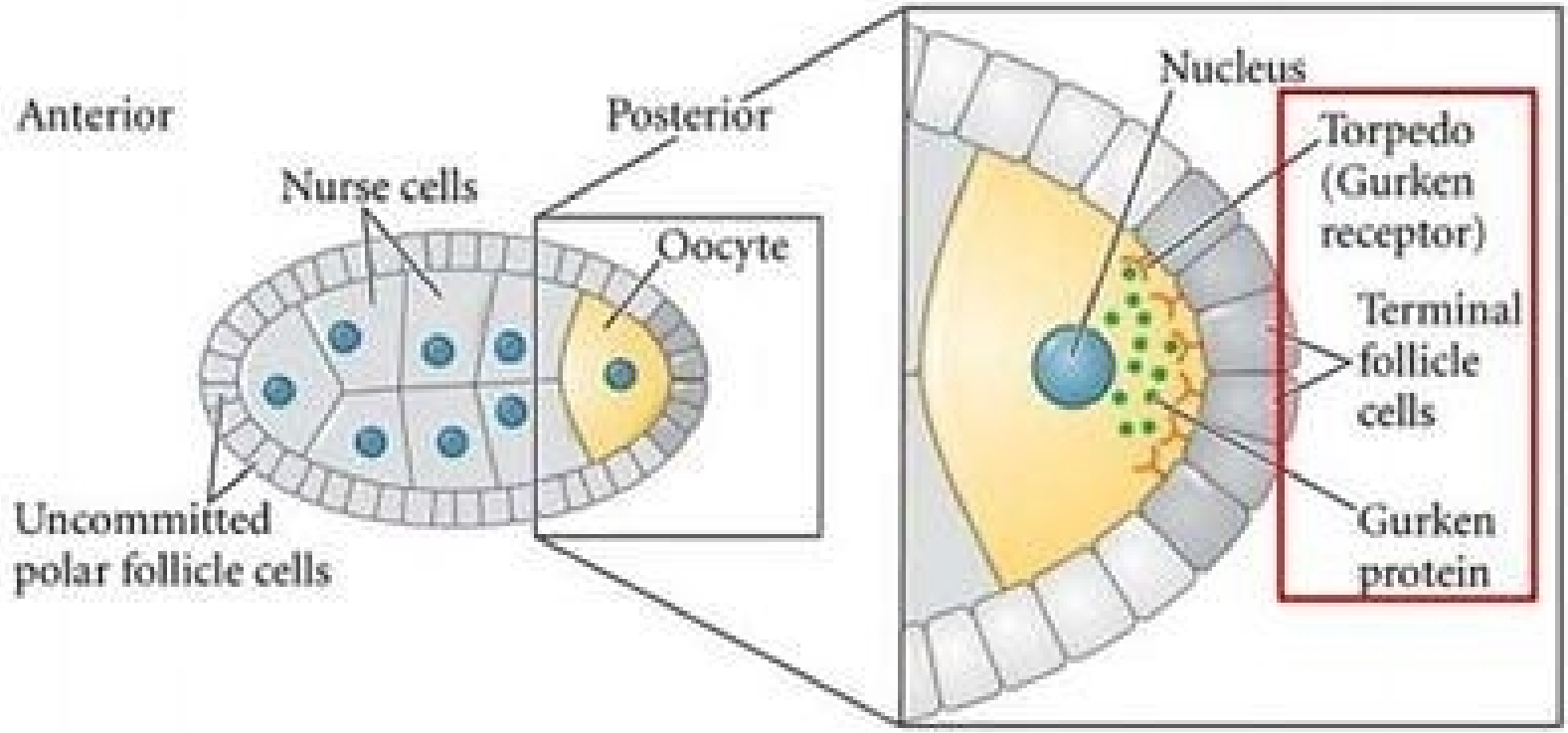
Spatial organization of the oocyte and nurse cells. In this case, cell 1 becomes the oocyte and all other cells are nurse cells.

DROSOPHILA – OOCYTE NURSE CELLS COMPLEX

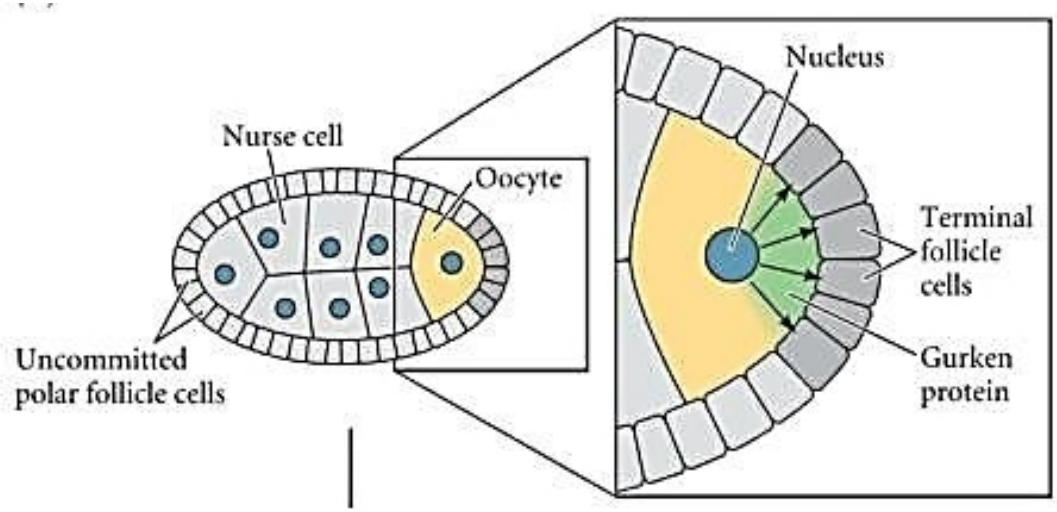


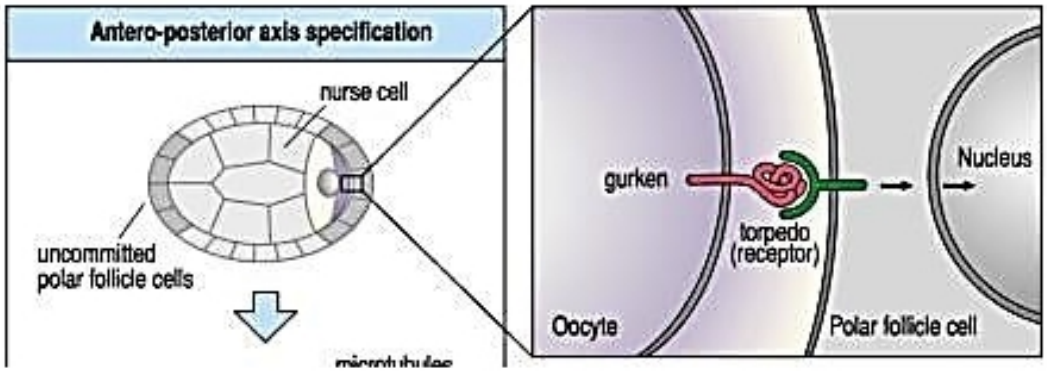


DROSOPHILA – DORSAL VENTRAL AXIS FORMATION



DROSOPHILA – DORSAL VENTRAL AXIS FORMATION
Gurken signaling





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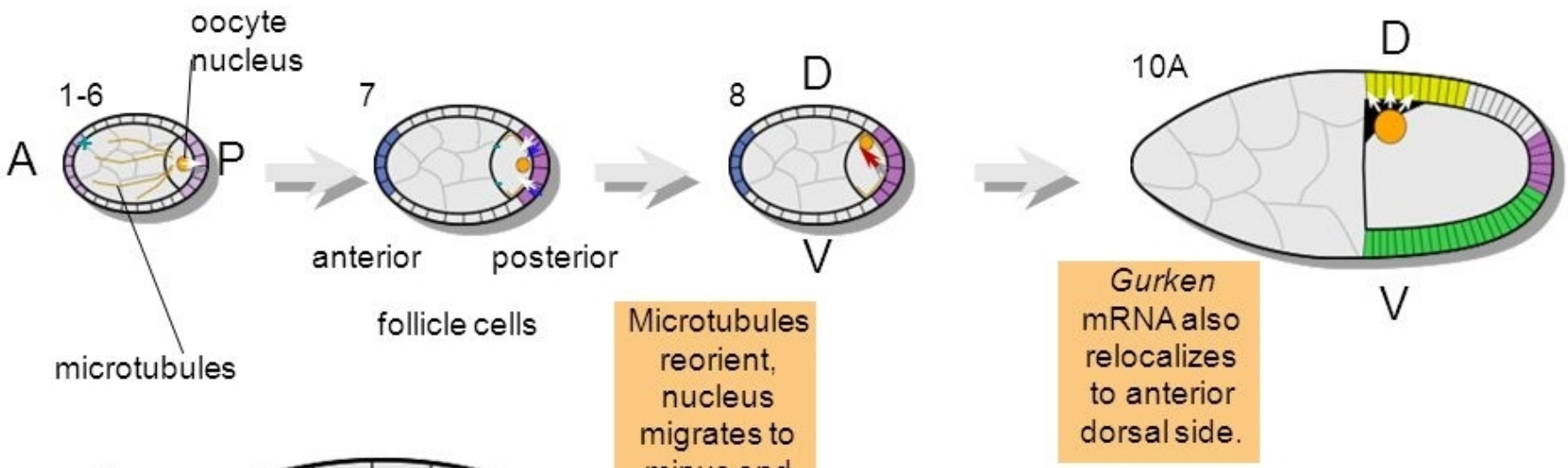
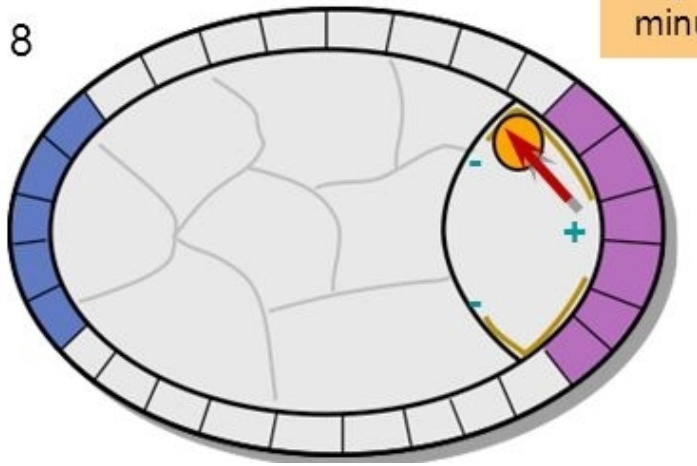
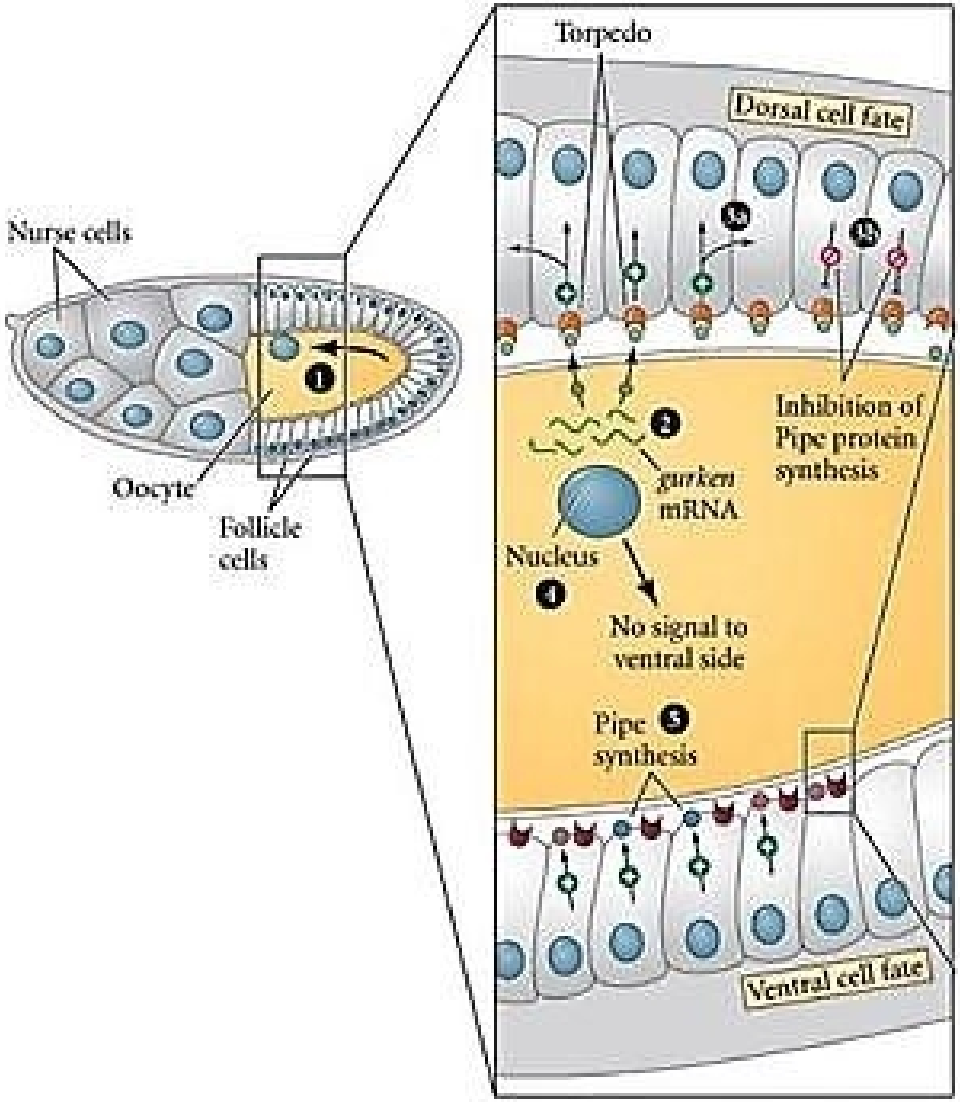
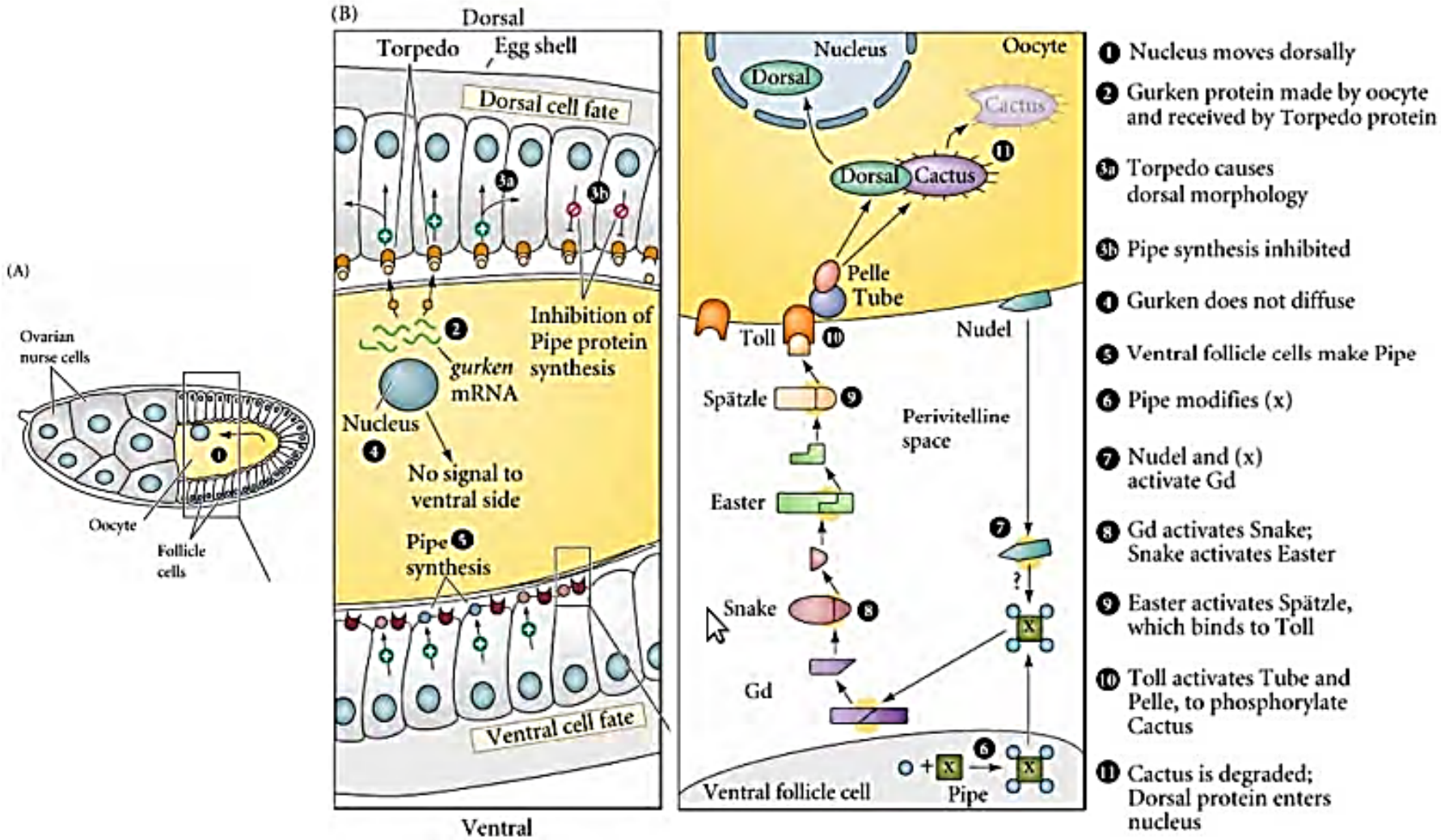




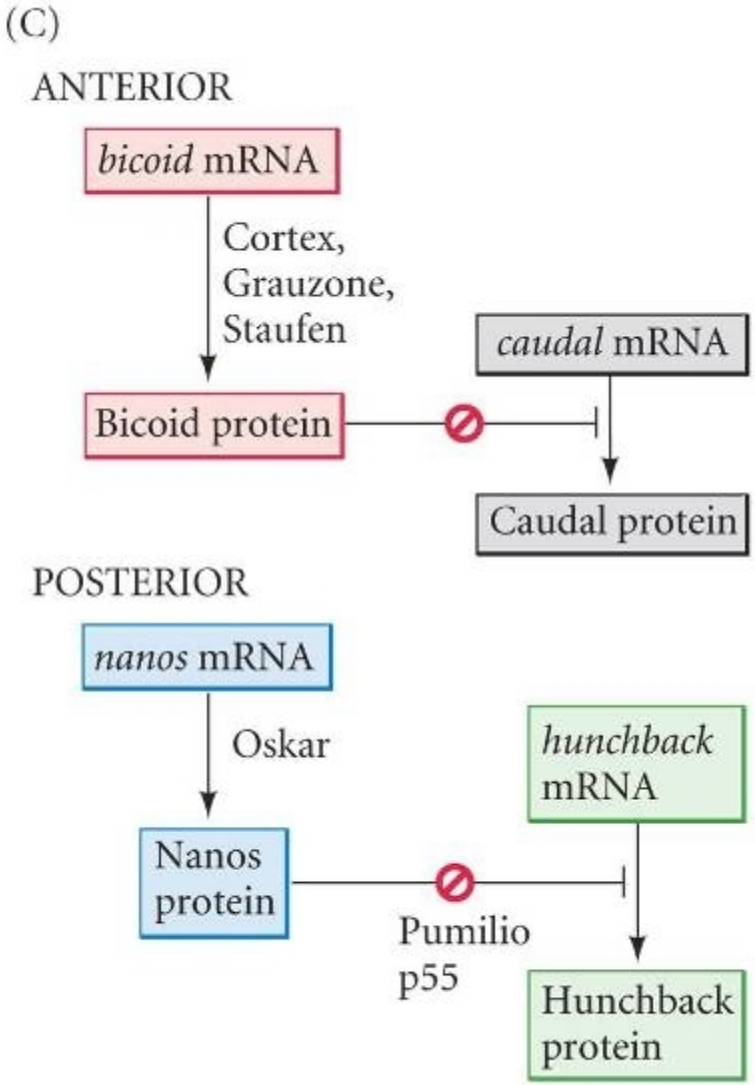
DROSOPHILA – DORSAL VENTRAL AXIS FORMATION
Gurken signaling



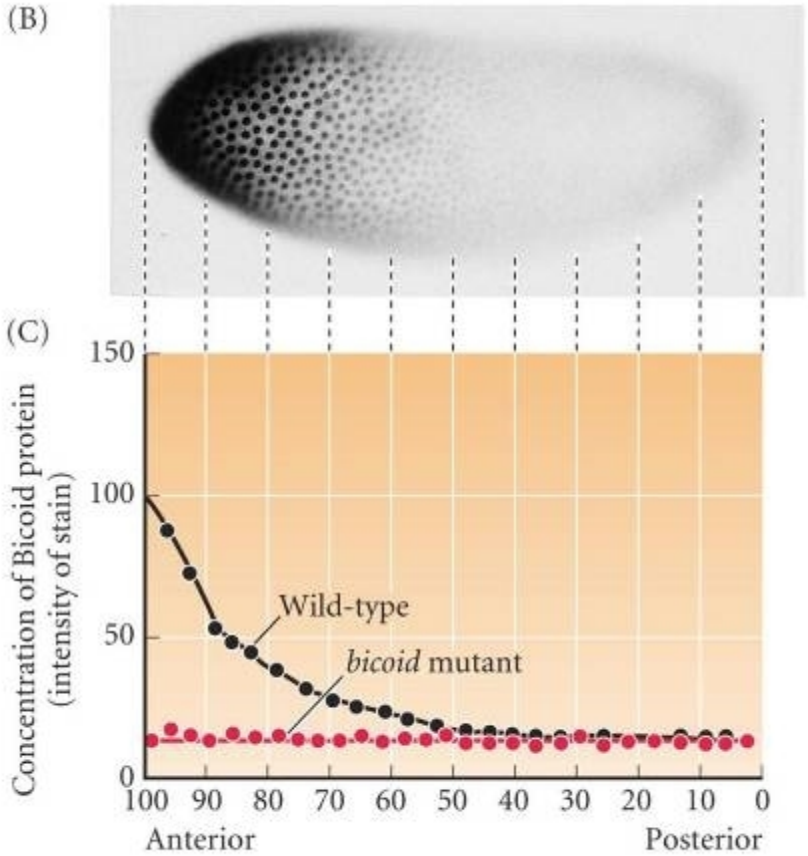
DROSOPHILA – DORSAL VENTRAL AXIS FORMATION
Signaling cascade in ventral cells



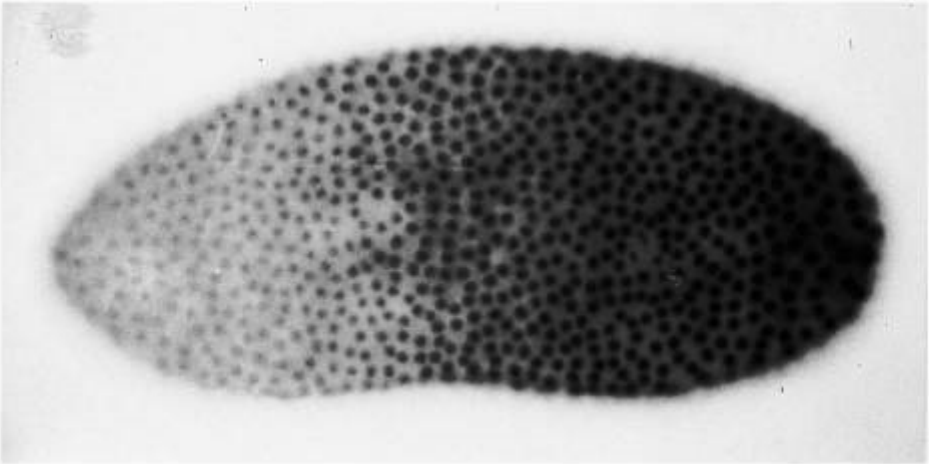
Anterior-Posterior Pattern Generation by the *Drosophila* Maternal Effect Genes



Gradient of Bicoid Protein in the Early *Drosophila* Embryo



Gradient of Caudal Protein in the Syncitial Blastoderm of a Wild-type *Drosophila* Embryo

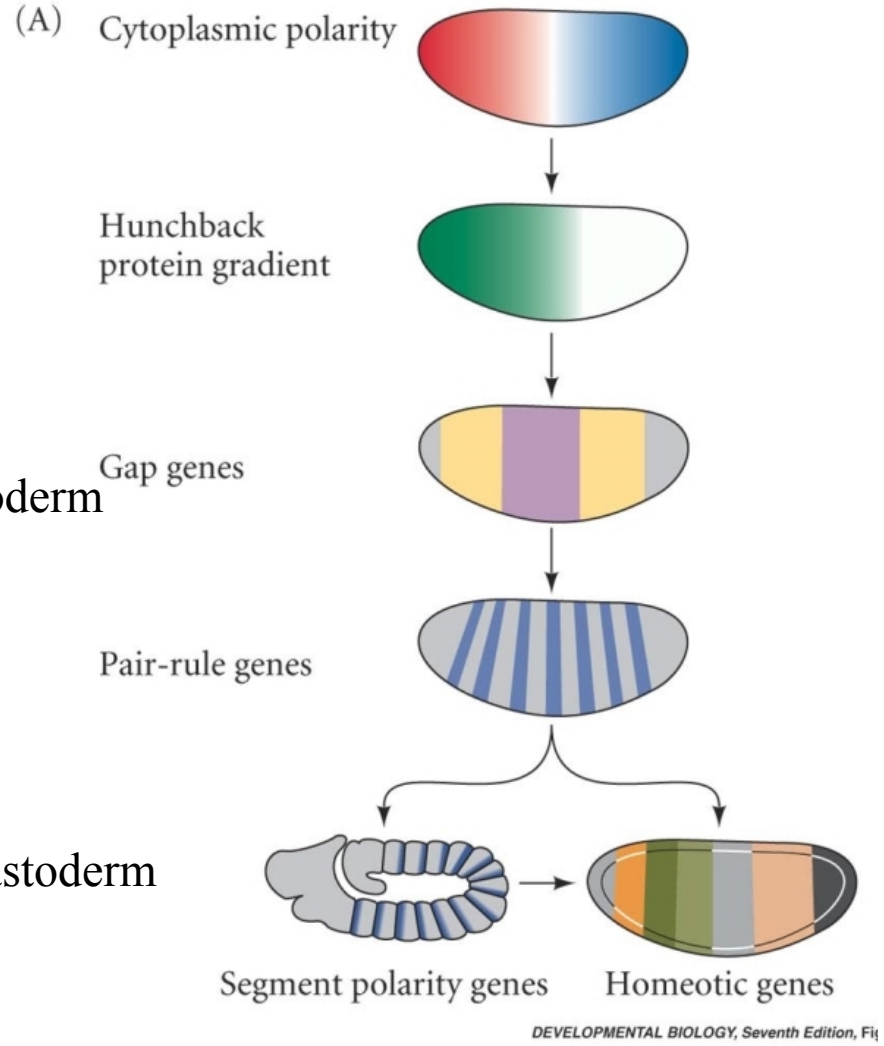


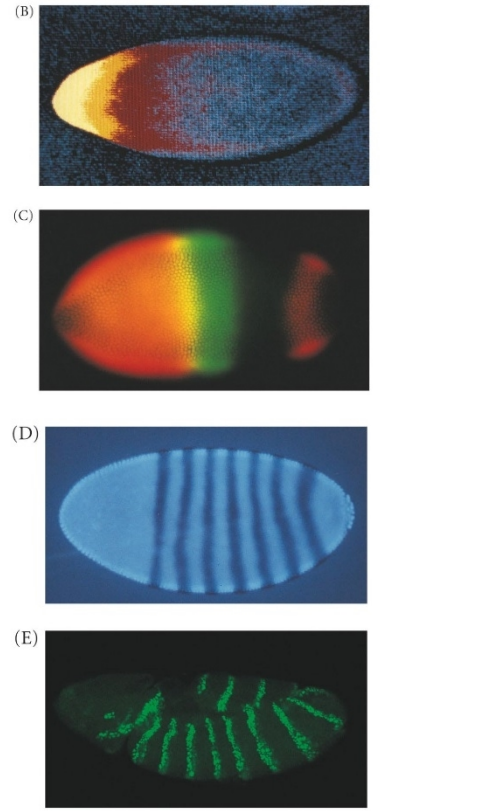
Model of *Drosophila* Anterior-Posterior Pattern Formation

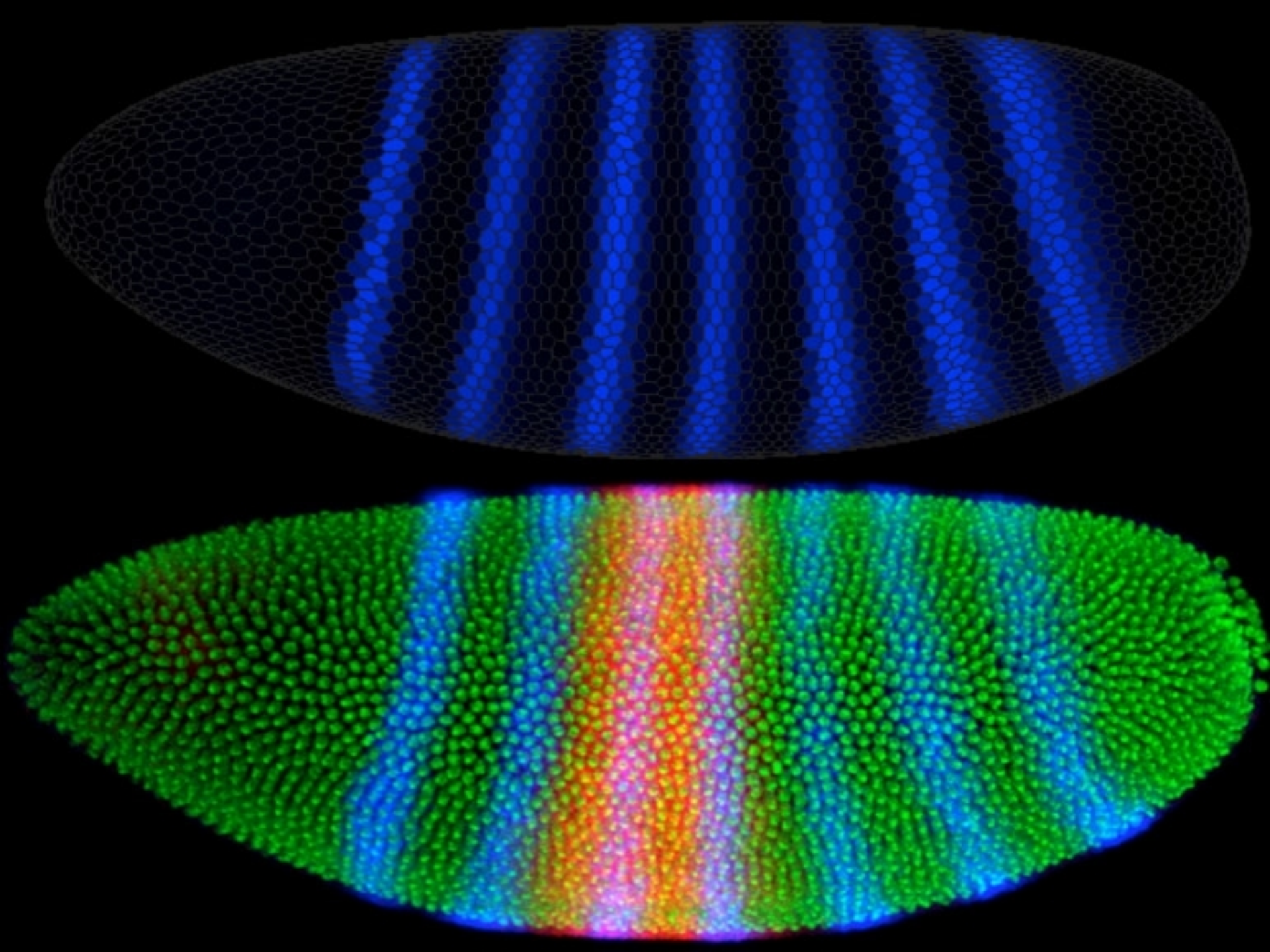
Maternal effect genes

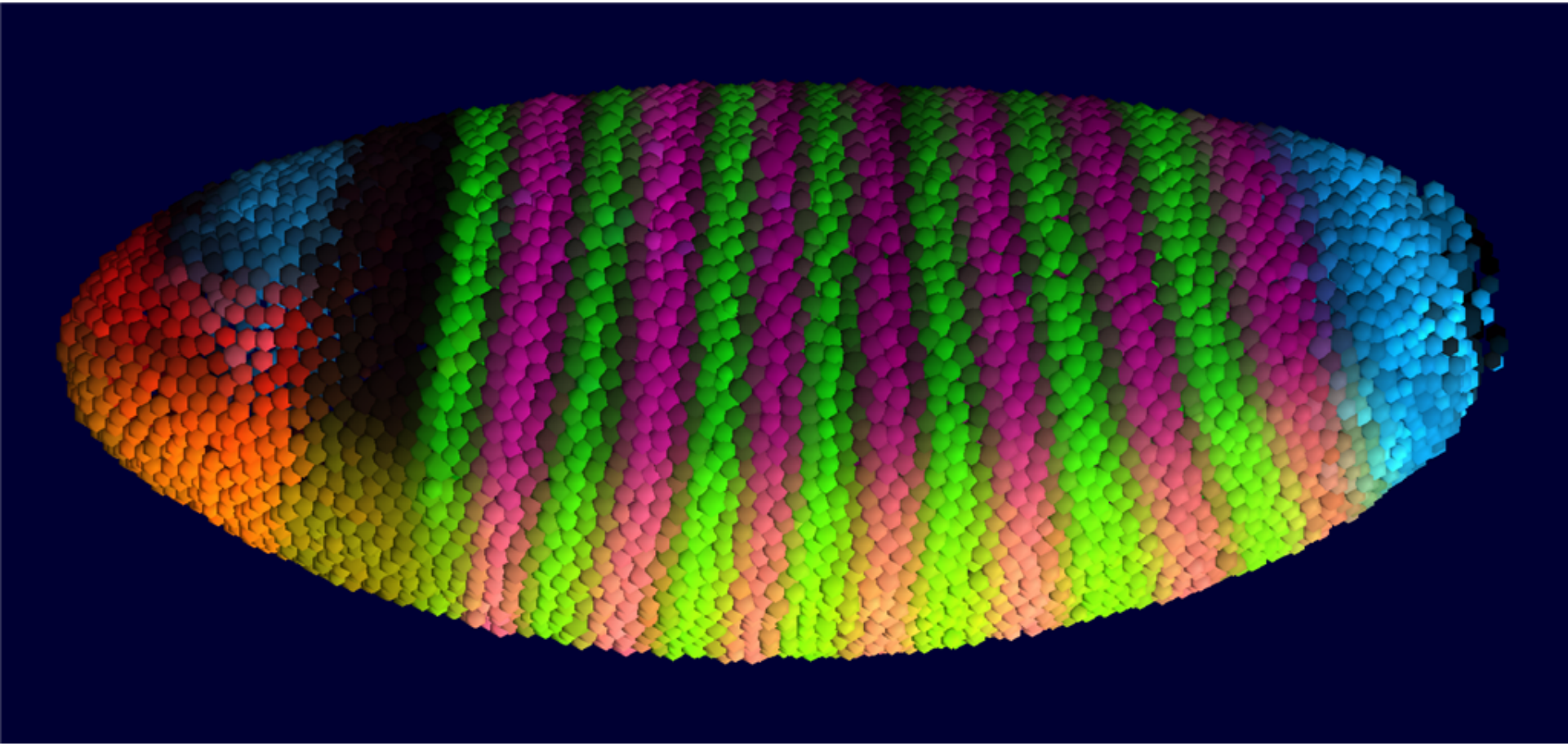
Zygotic genes
Syncytial blastoderm

Cellular blastoderm

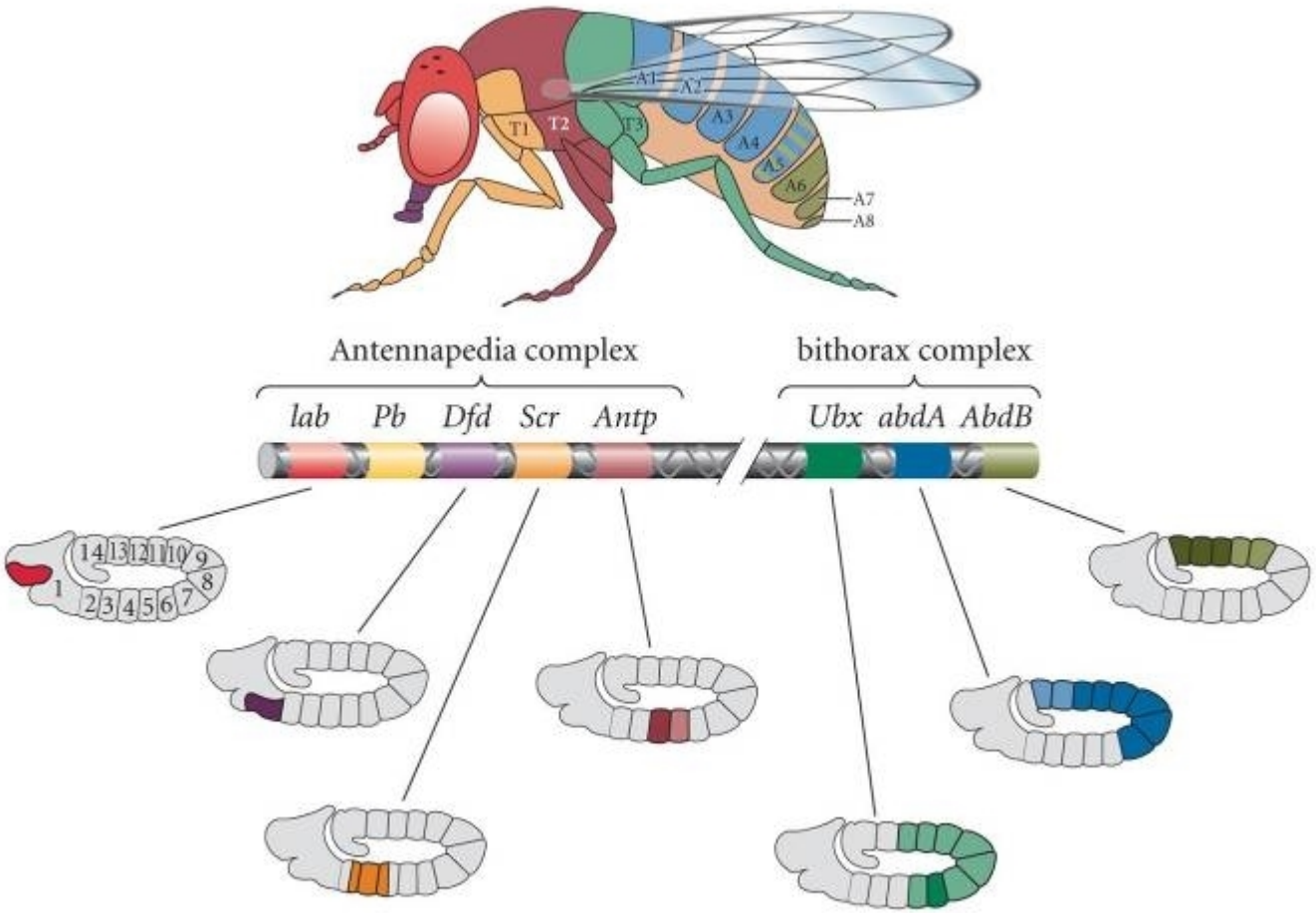




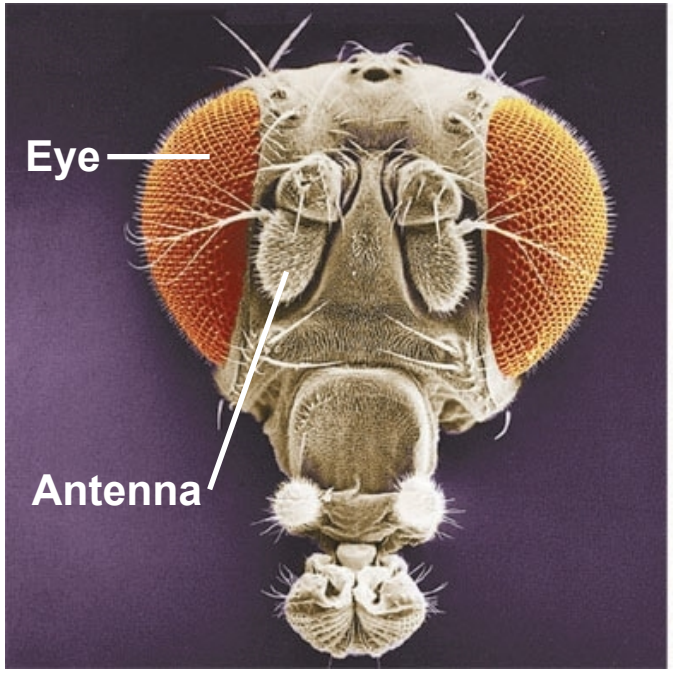




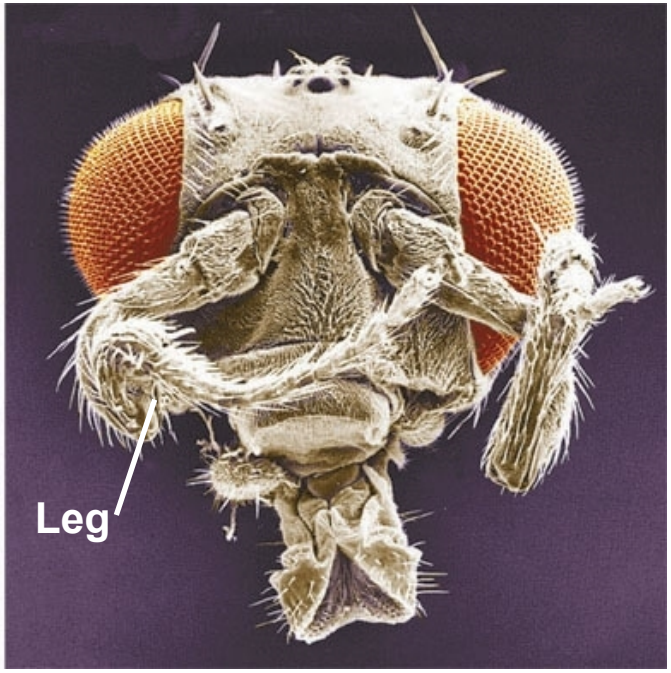
Homeotic Gene Expression in *Drosophila*



Homeotic Gene - Mutation



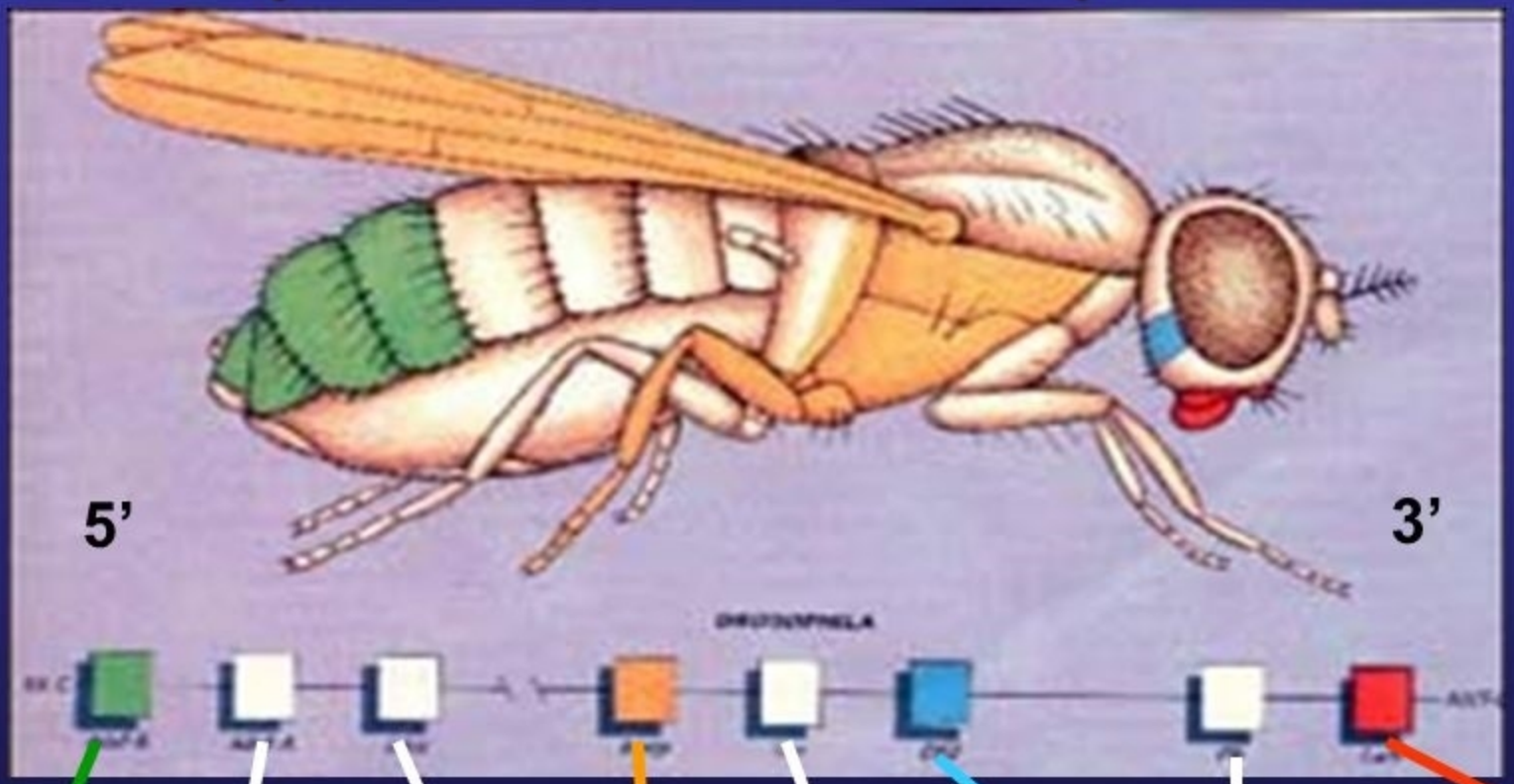
Wild type



Mutant

Homeotic Gene - Mutation

The pattern of *Hox* expression



Abdominal B

Abdominal A

Ultrabithorax

Antennapedia

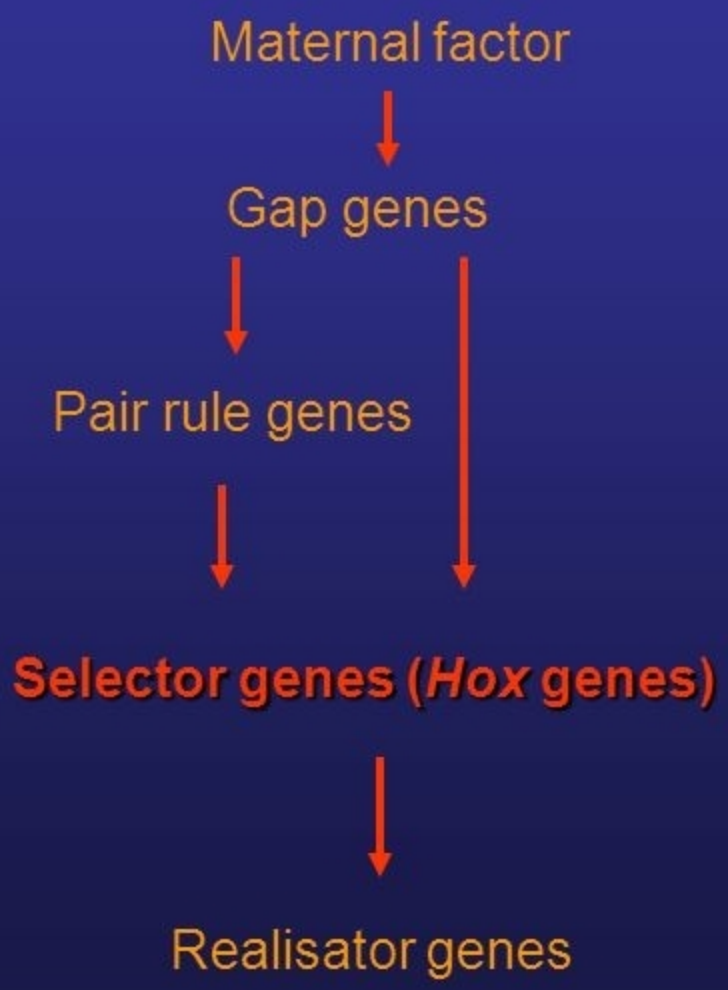
Sex comb reduced

deformed

proboscipedia

labial

Hierarchy of genes in *Drosophila* development



Development of the number of segments

Development of the features of the segments