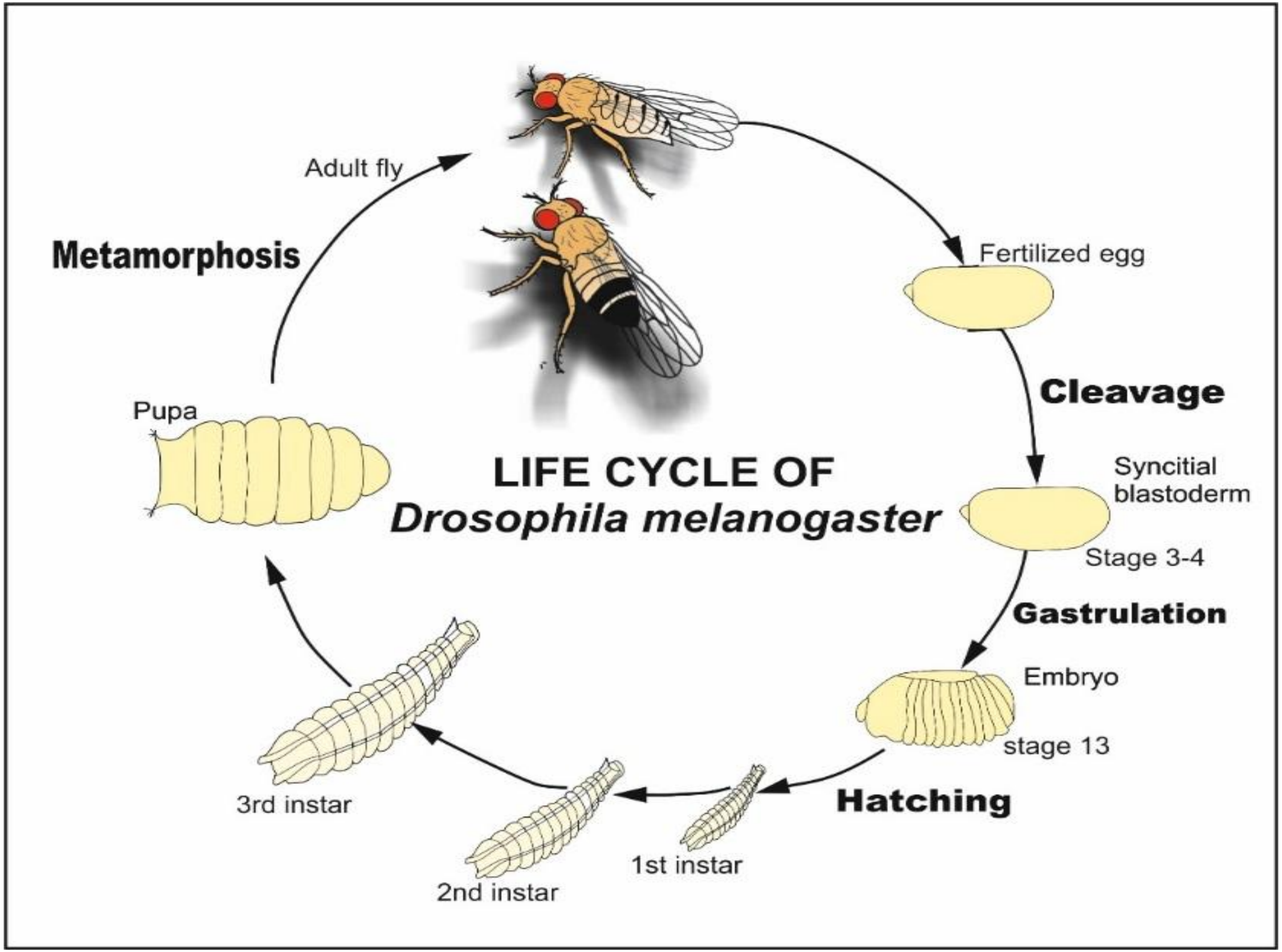
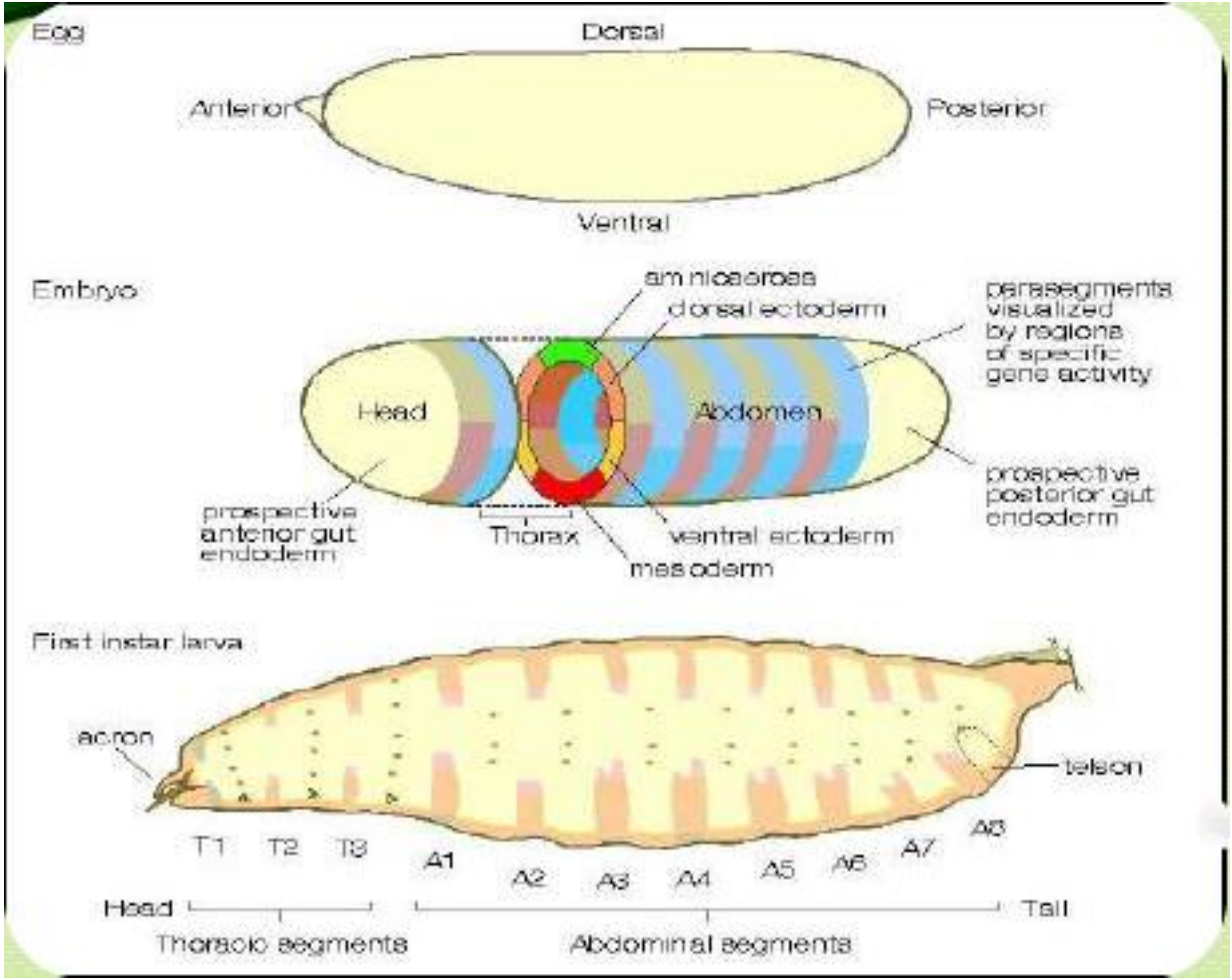


Adult fly
Metamorphosis
Fertilized egg
Cleavage
Pupa
LIFE CYCLE OF
Drosophila melanogaster
Syncitial
blastoderm
Stage 3-4
Gastrulation
Embryo
stage 13
Hatching
3rd instar
1st instar
2nd instar

¤ Controlled by the **differential expression of genes** in Drosophila.

¤ Drosophila has a **holometabolous** method of development, i.e. three distinct stages of body plans: **larva, pupa,** and **adult.**

Life cycle by days	
DAY 0	Female lay eggs
DAY 1	Egg hatch
DAY 2	1st instar
DAY 3	2nd instar
DAY 5	3rd instar
DAY 7	Pupa formation(120 days after egg laying)
DAY 11-12	Eclosion(Adult emerges from the pupa case) Females become sexually active 8-10 hrs after Eclosion.


Egg
Dorsal
Anterior
Posterior
Ventral
Embryo
amnioserosa
dorsal ectoderm
parasegments visualized by regions of specific gene activity
Head
Abdomen
prospective posterior gut endoderm
prospective anterior gut endoderm
Thorax
ventral ectoderm
mesoderm
First instar larva
acron
telson
T1
T2
T3
A1
A2
A3
A4
A5
A6
A7
A8
Head
Tail
Thoracic segments
Abdominal segments

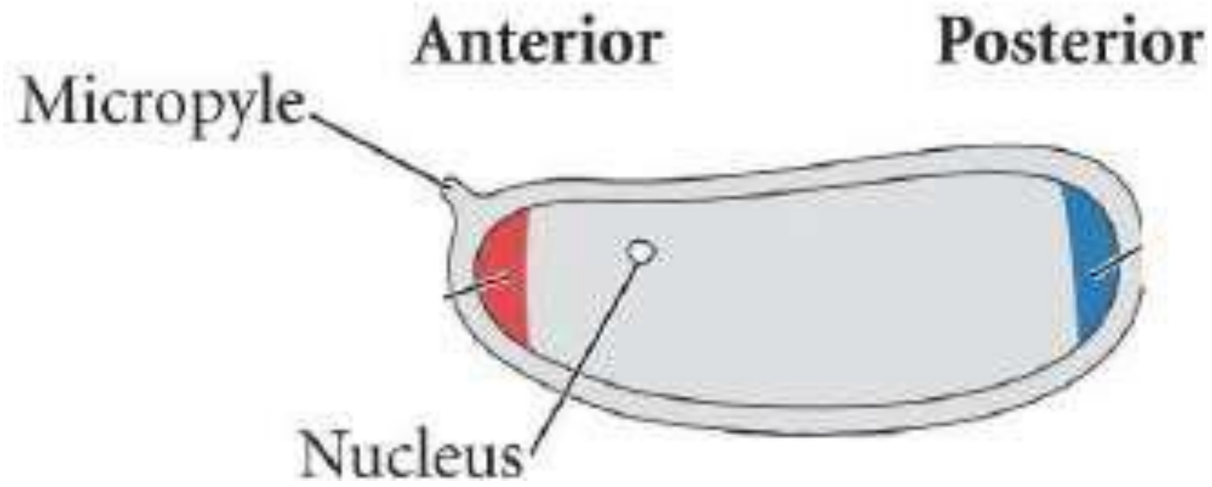
DROSOPHILA FERTILIZATION

Eggs are activated prior to fertilization where the oocyte nucleus has resumed **meiotic division.**

- stored mRNAs in them, begin the translation process.

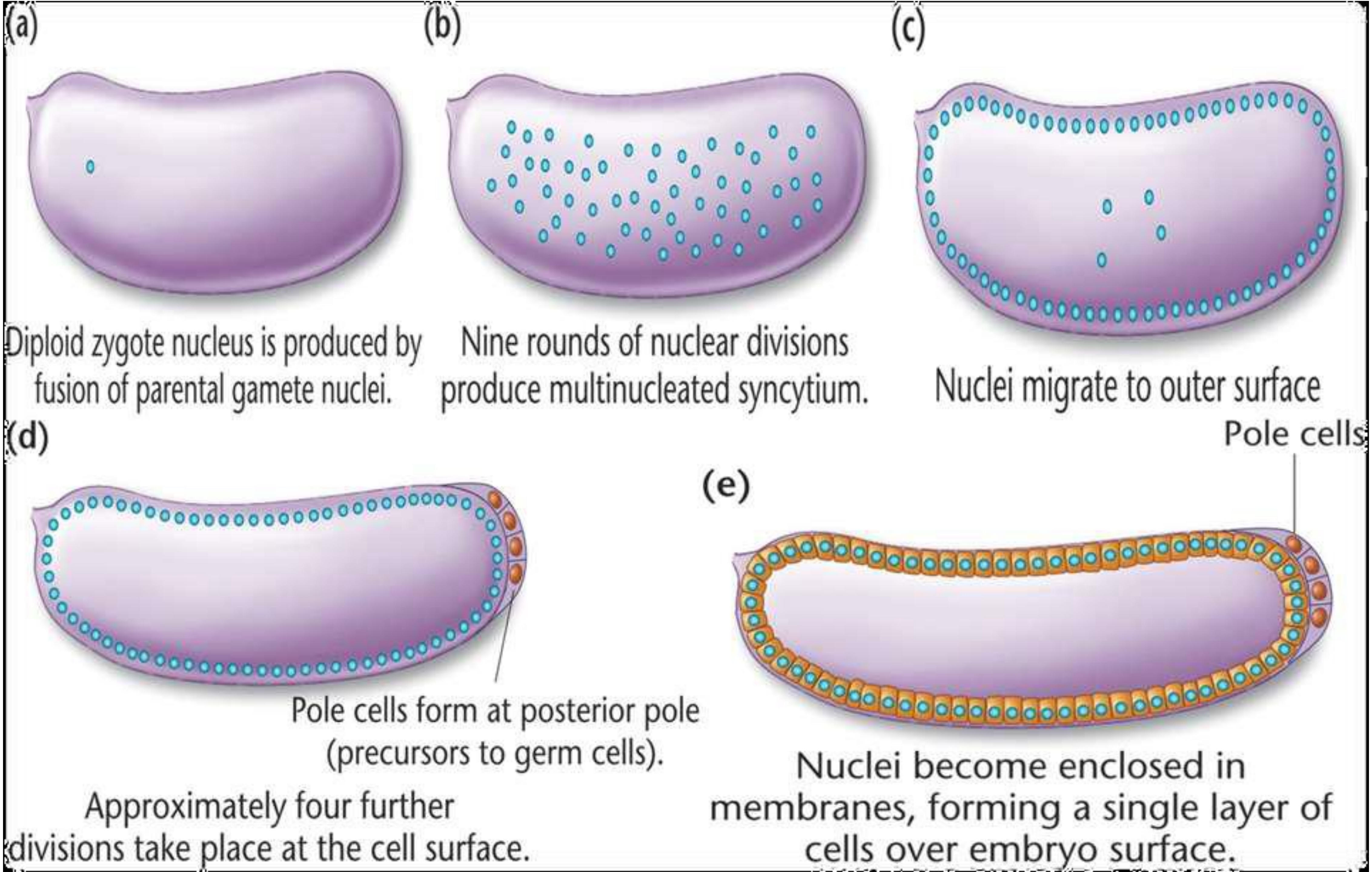
- Sperm enter at the **micropyle.**

- **prevents polyspermy**.



EARLY DEVELOPMENT OF DROSOPHILA

- After fertilization, a series of *superficial cleavages occur.*
- Nuclei begin dividing centrally and migrate toward the edges.
- Few nuclei migrate to the posterior end, to form *pole cells.*
- *pole cells g*ives rise to the adult gametes.


(a)
(b)
(c)
Diploid zygote nucleus is produced by fusion of parental gamete nuclei.
Nine rounds of nuclear divisions produce multinucleated syncytium.
Nuclei migrate to outer surface
(d)
Pole cells
(e)
Pole cells form at posterior pole (precursors to germ cells).
Approximately four further divisions take place at the cell surface.
Nuclei become enclosed in membranes, forming a single layer of cells over embryo surface.

Superficial Cleavage

- **A meroblastic cleavage, where mitosis occurs without cytokinesis.**
- Results in many nuclei, which migrate to the periphery of a **centrolecithal egg**)
- **Syncytial blastoderm stage**

- zygotic nuclei undergo 8 divisions and migrate to the periphery

- karyokinesis continues

- **Cellular blastoderm stage**

- following division 13, the oocyte plasma membrane folds inward

- partitions off each nucleus and associated cytoplasm

- constricts at basal end

GASTRULATION

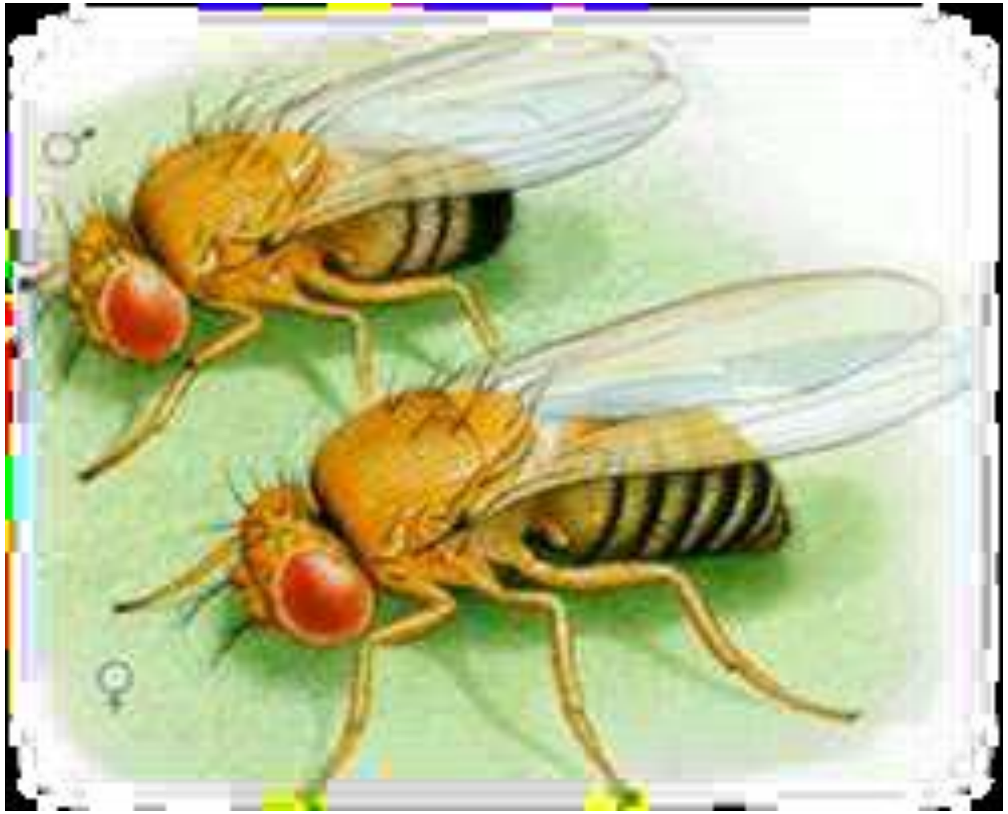
- *it can form* mesoderm, endoderm, ectoderm
- Cells fold inward to form *ventral furrow*
- Embryo bends to from *cephalic furrow*
- Pole cells are internalized, and endoderm *invaginates.*
- Ectoderm converges and extends along midline to form *Germ Band*

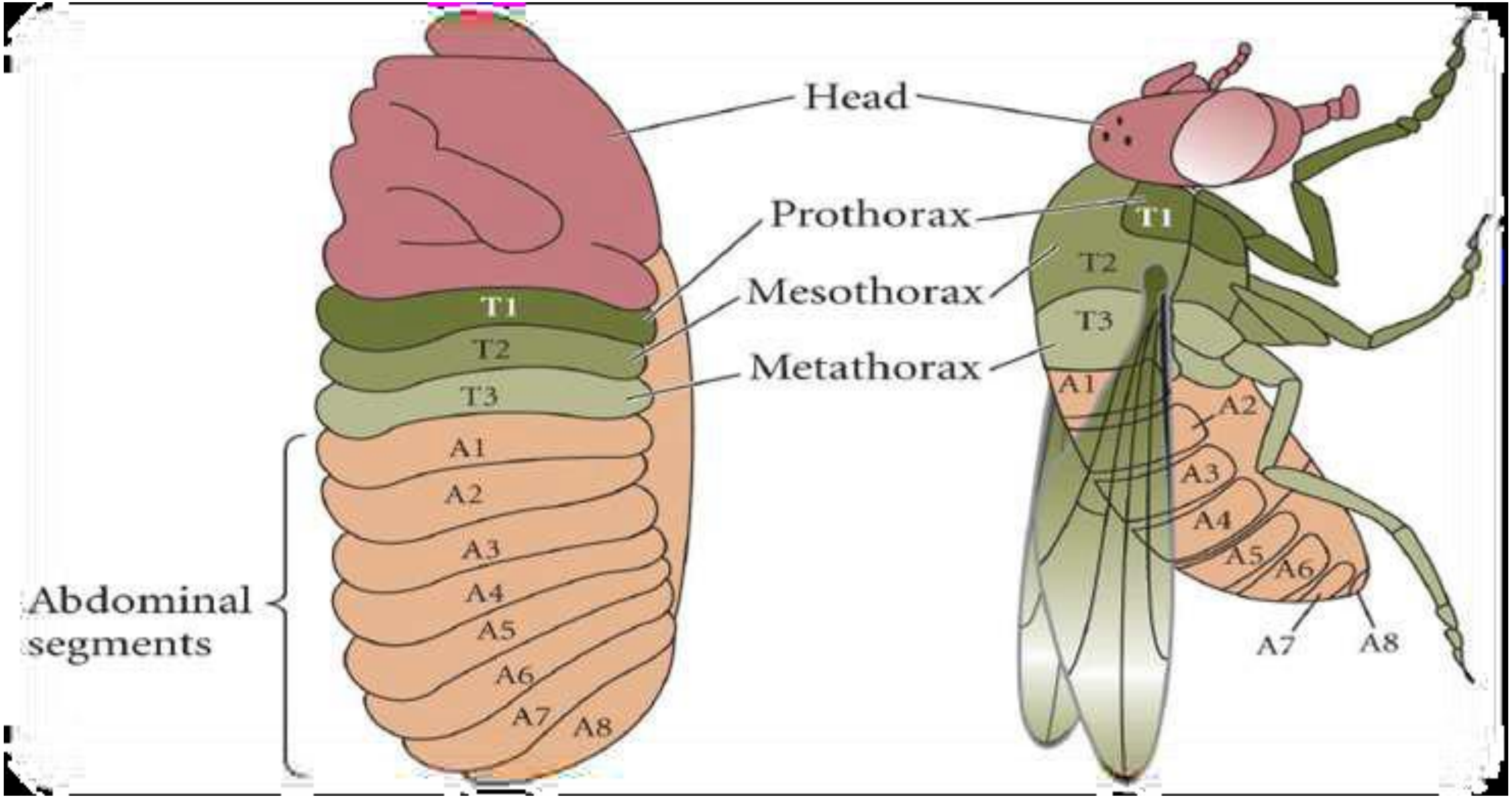
GERM BAND

- Wraps around the embryo(dorsal surface), the A-P axis of the embryo is marked
- Body segments begin to form.
- Organs are beginning to form
- Groups of cells called *imaginal discs* are developed, these cells will form adult organs

DROSOPHILA LARVAE

- *3 larval stage.*
- After gastrulation, 1st instar larvae is formed
- Has head and tail end
- Generally the same type of body plan as adult
- 3rd “*instar*” larvae:- form *Pupae and* Adult





T1- legs

T2 – legs & wings

T3 – legs & halteres

A/P and D/V axes established by interactions between the developing oocyte and its surrounding follicle cells

DROSOPHILA BODY PLAN

- *3 thoracic segments*
- *8 abdominal segments*

GENETICS OF AXIS SPECIFICATION IN DROSOPHILA

Controlled by a variety of genes:-

- **Maternal effect genes**
- **Gap genes**
- **pair-rule genes**
- **Segment polarity genes**
- **Homeotic selector genes**

Anterior-Posterior Body Plan

A *hierarchy* of gene expression controls the anterior-posterior body plan.

1. Maternal effect genes (e.g. *bicoid*, *nanos*)

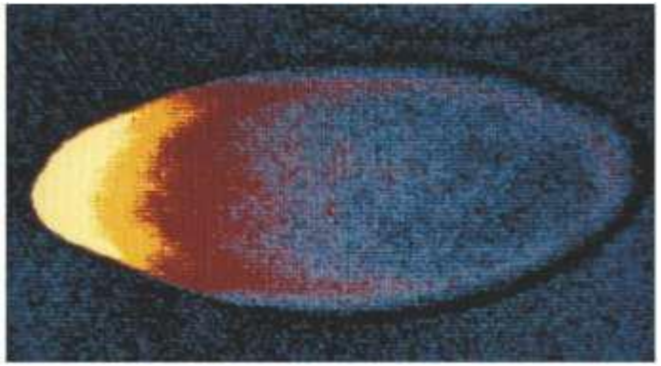
Establish polarity:

- Their mRNAs are differentially placed in eggs

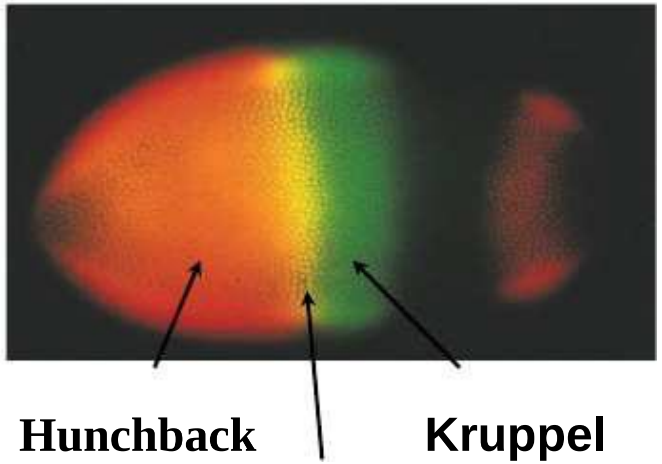
- activate or repress zygotic genes

2. **Gap genes**: first **zygotic** genes which is expressed.

- Divide embryo into regions.
- Map out the embryo's **anterior-posterior axis**
- activated or repressed by **maternal effect genes**



bicoid gradient

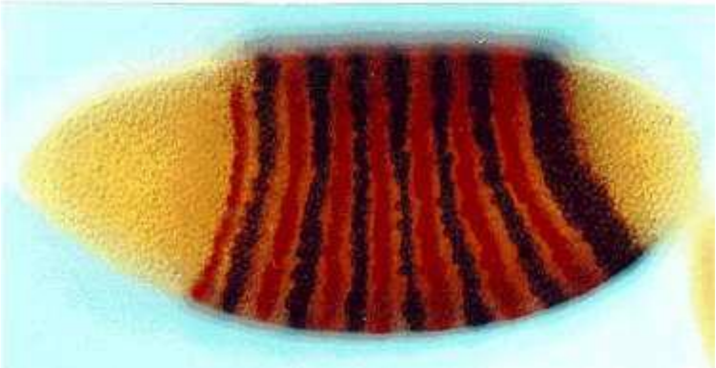


3. pair-rule genes;

Establish segmental plan

- regulated by combinations of **gap genes**

- divide the embryo into the periodic pattern of seven transverse bands:- **parasegments**

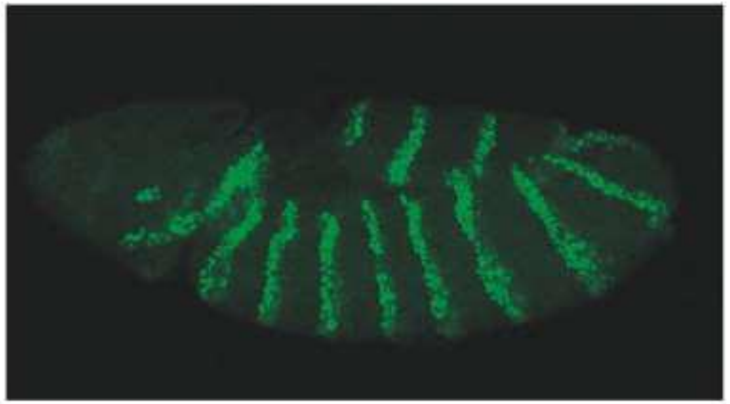


even-skipped (red), fuschi tarazu (black)

4. Segment polarity genes;

Set boundaries of segments:- establish A-P for each segment

- activated **by pair-rule genes**
- code for variety of proteins
- divide the embryo into **14** segmental units



engrailed

5. **Homeotic selector genes**; **Master regulatory genes**

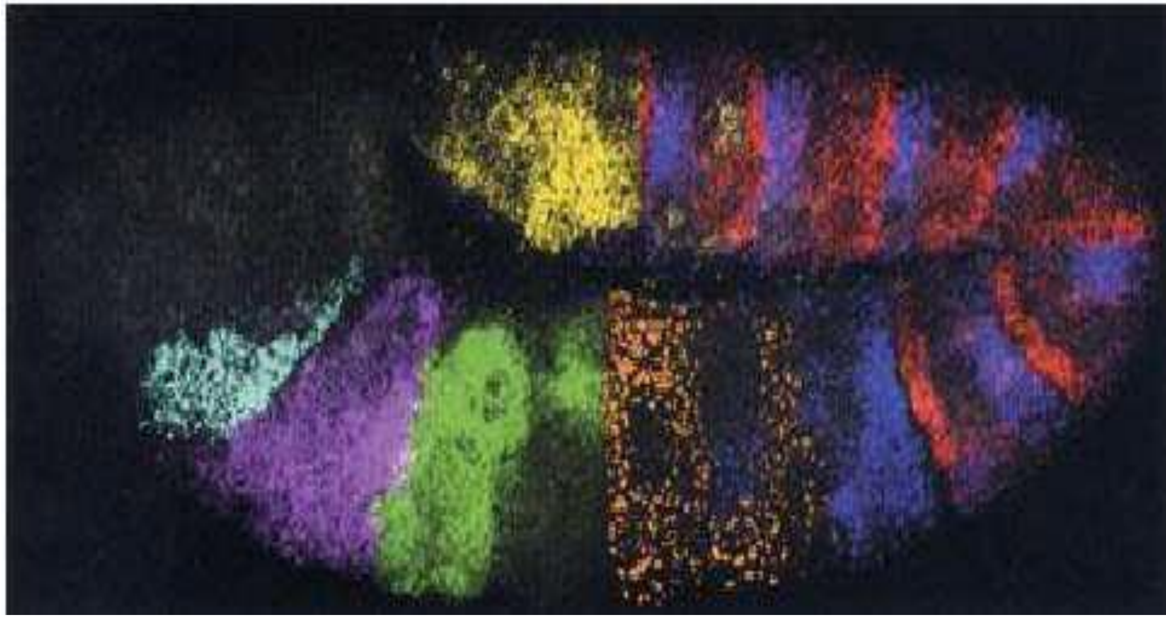
- Provide segmental identity

- By interactions of gap, pair-rule, and segment polarity proteins

- determines **developmental fat**

- They possess homologous segments.

- 180-nucleotide sequence = **homeobox**
- Encodes **60-amino-acid** homeodomain



Hox genes :-

Homeotic genes(**Hox genes**) encode nuclear proteins

- have a DNA binding motif:-**homeodomain.**
- The products are transcription factors that specify segment identity
- The genes are activated by the concentration gradients of **gap gene** products.

e.g. *Ubx* is switched on by hunchback.

fushi tarazu and even skipped can sharpen:- *Ubx* expression, to specify parasegments..

Hierarchy of Gene Activity

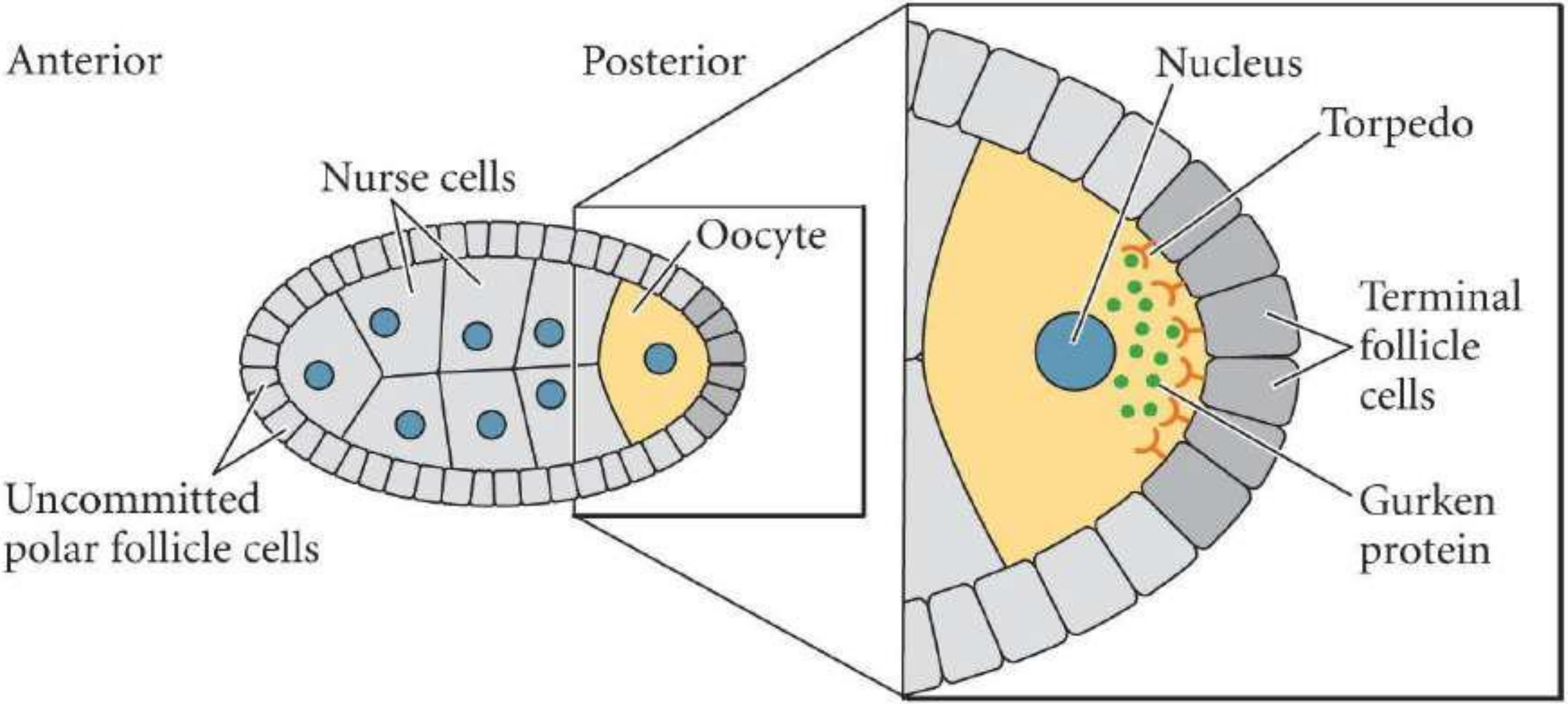
- Maternal genes
- Segmentation genes of embryo
  - Gap genes
  - Pair-rule genes
  - Segment polarity genes
- Homeotic genes of the embryo
- Other genes of the embryo

Drosophila Body Plan - Egg Stage

Oogonium divide into 16 cells

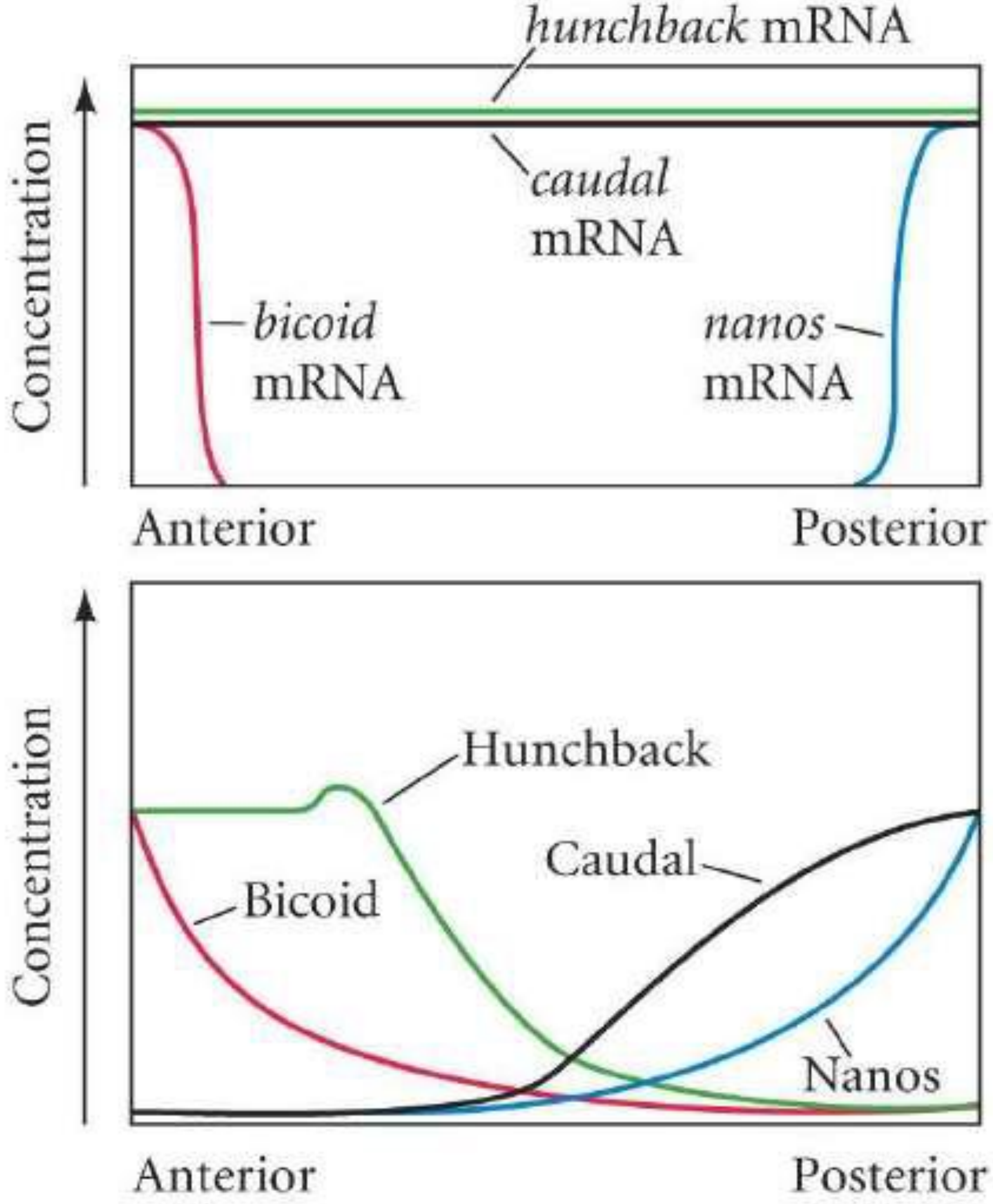
- **1 oocyte.**
- **15 nurse cells(**nurse cells contribute mRNA, proteins, and cytoplasm) **all interconnected.**
- Body axes are determined in the egg by the distribution of Maternal mRNAs and proteins.

Anterior-Posterior Axis Formation



Model of Anterior-Posterior Patterning

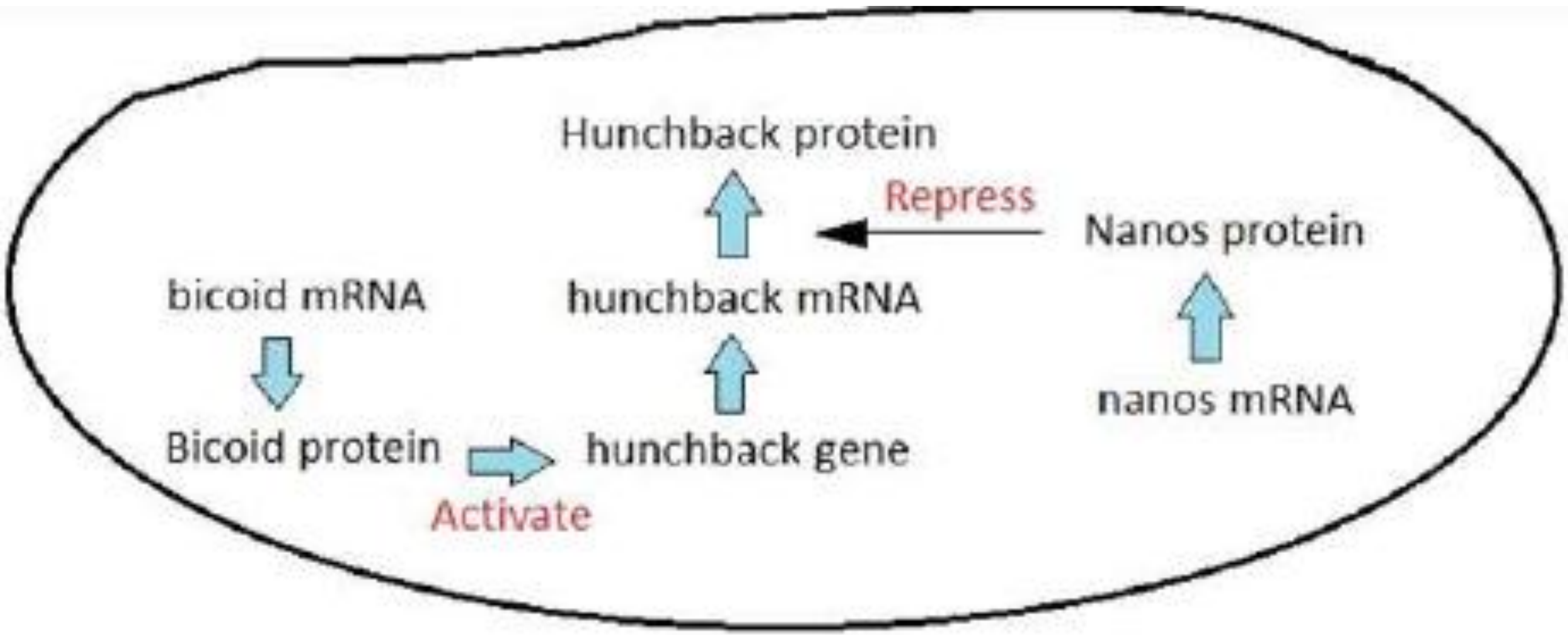
By mRNA found in **oocytes** (maternal messages)



Early cleavage:-

embryo proteins

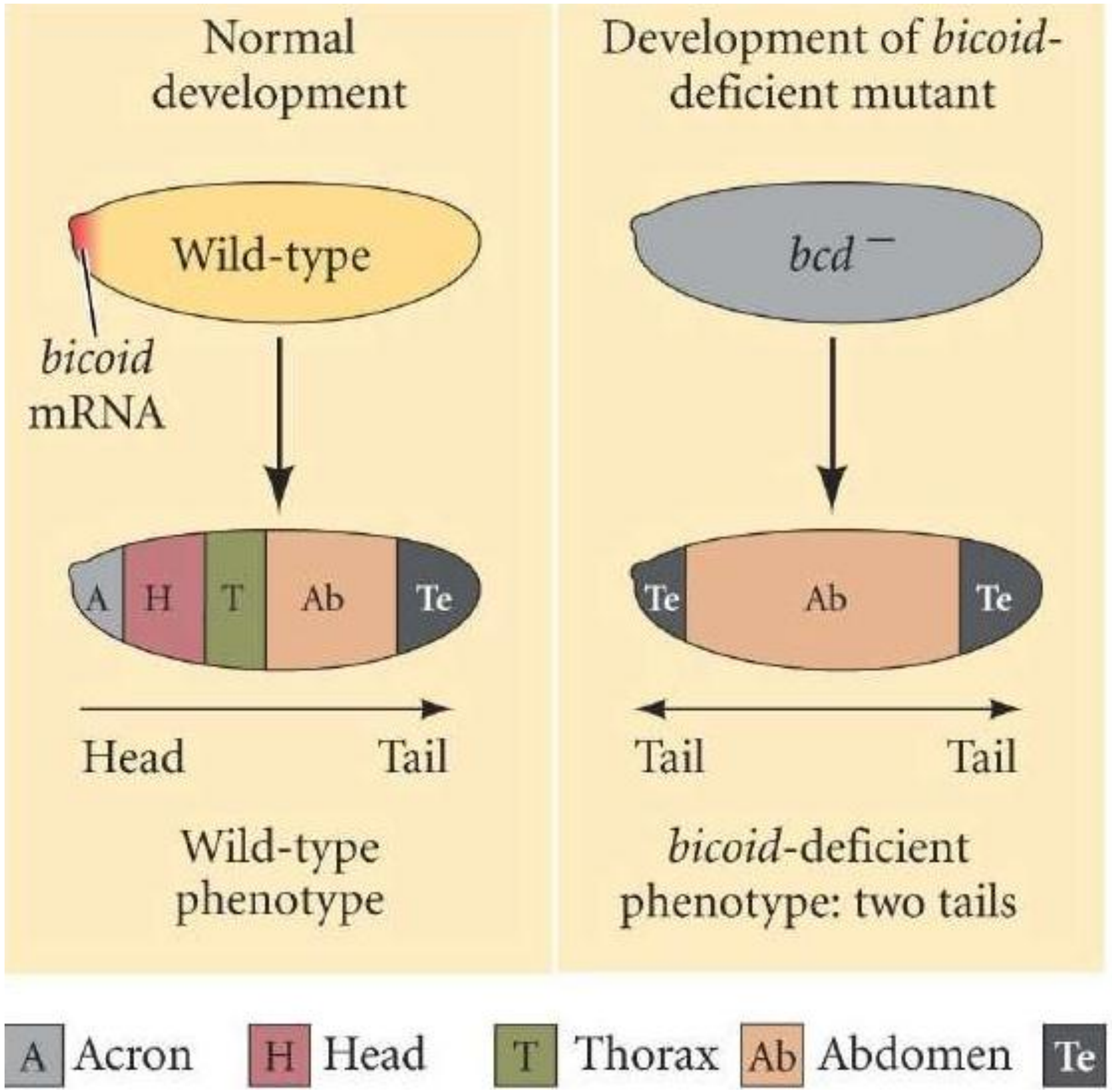
- ***hunchback*** translation repressed by Nanos.
- ***caudal*** translation repressed by Bicoid.



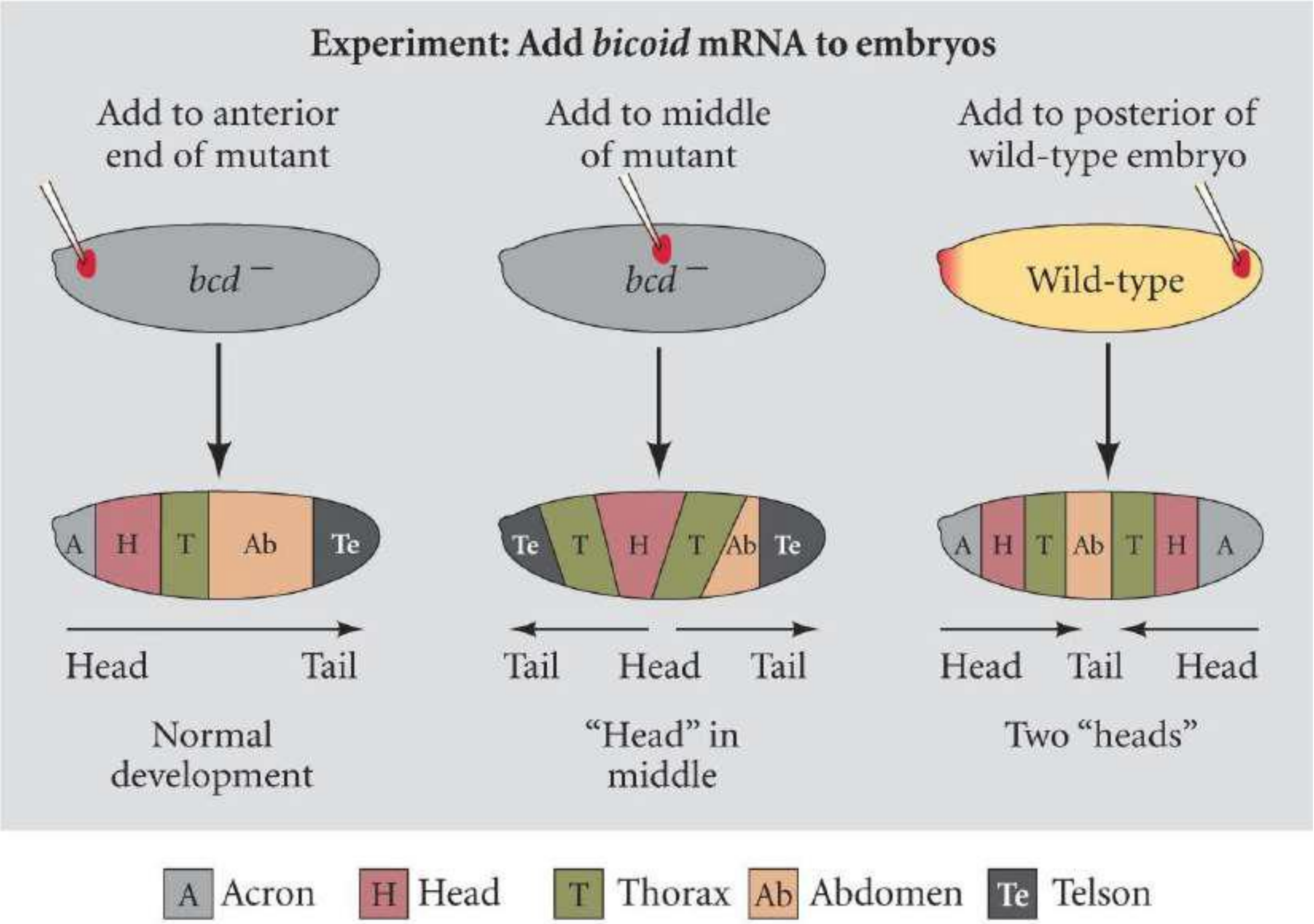
Coordinate action of bicoid and nanos protein :-

produces the A-P axis of the early embryo

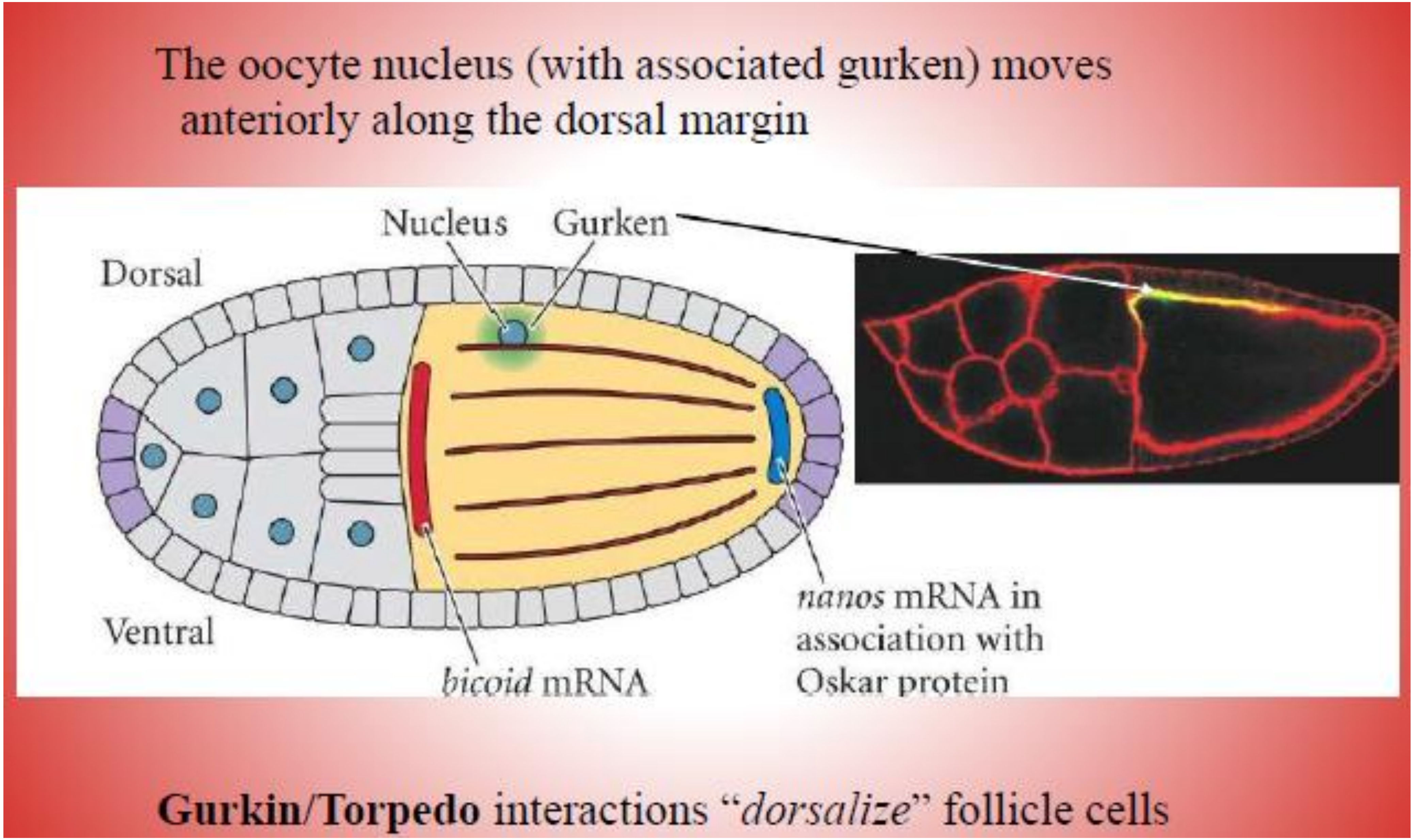
Bicoid Mutants



Manipulating Bicoid



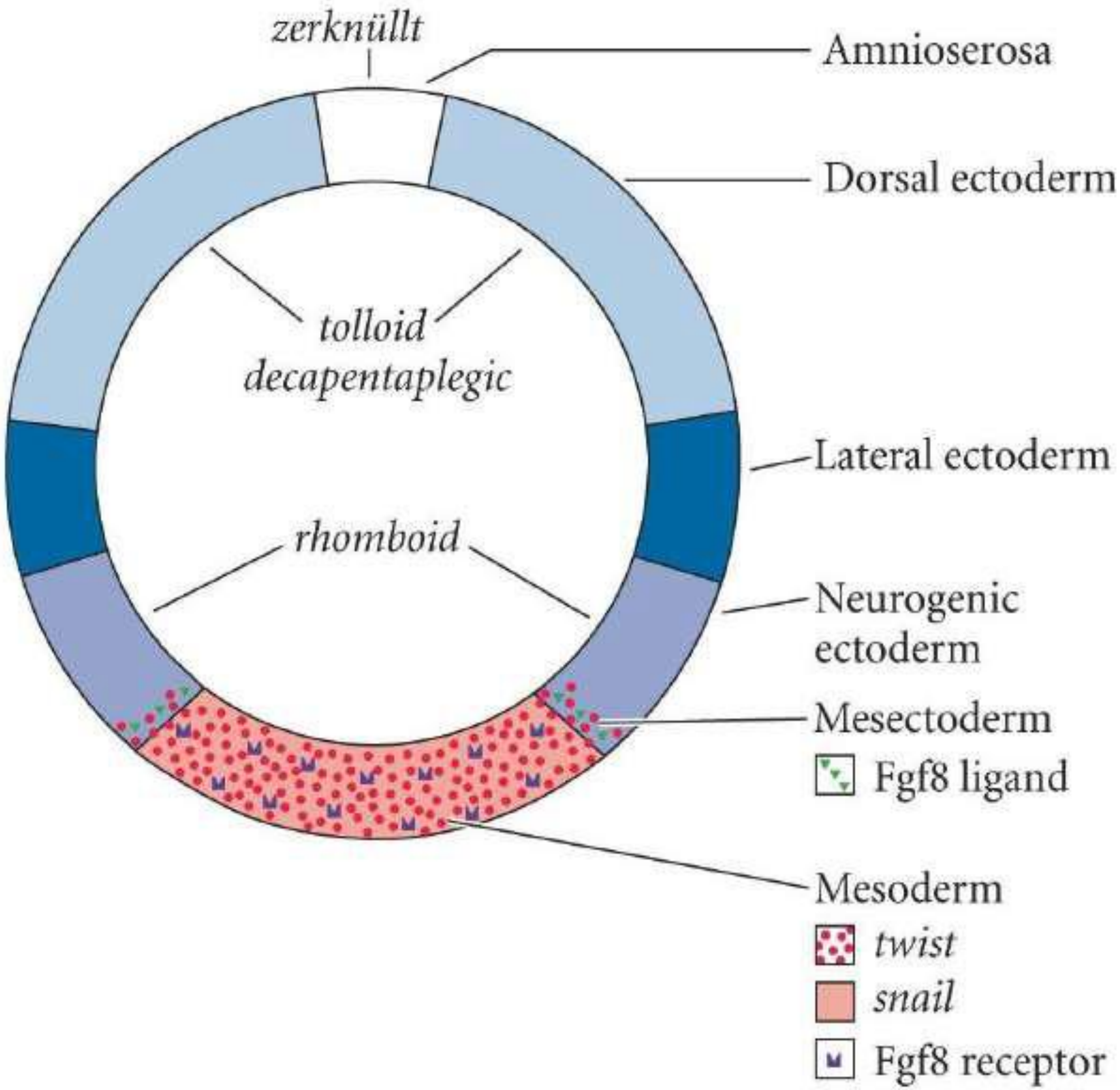
Dorsal - Ventral Axis Formation:- Gurken Effects



Zygotic Patterning Genes

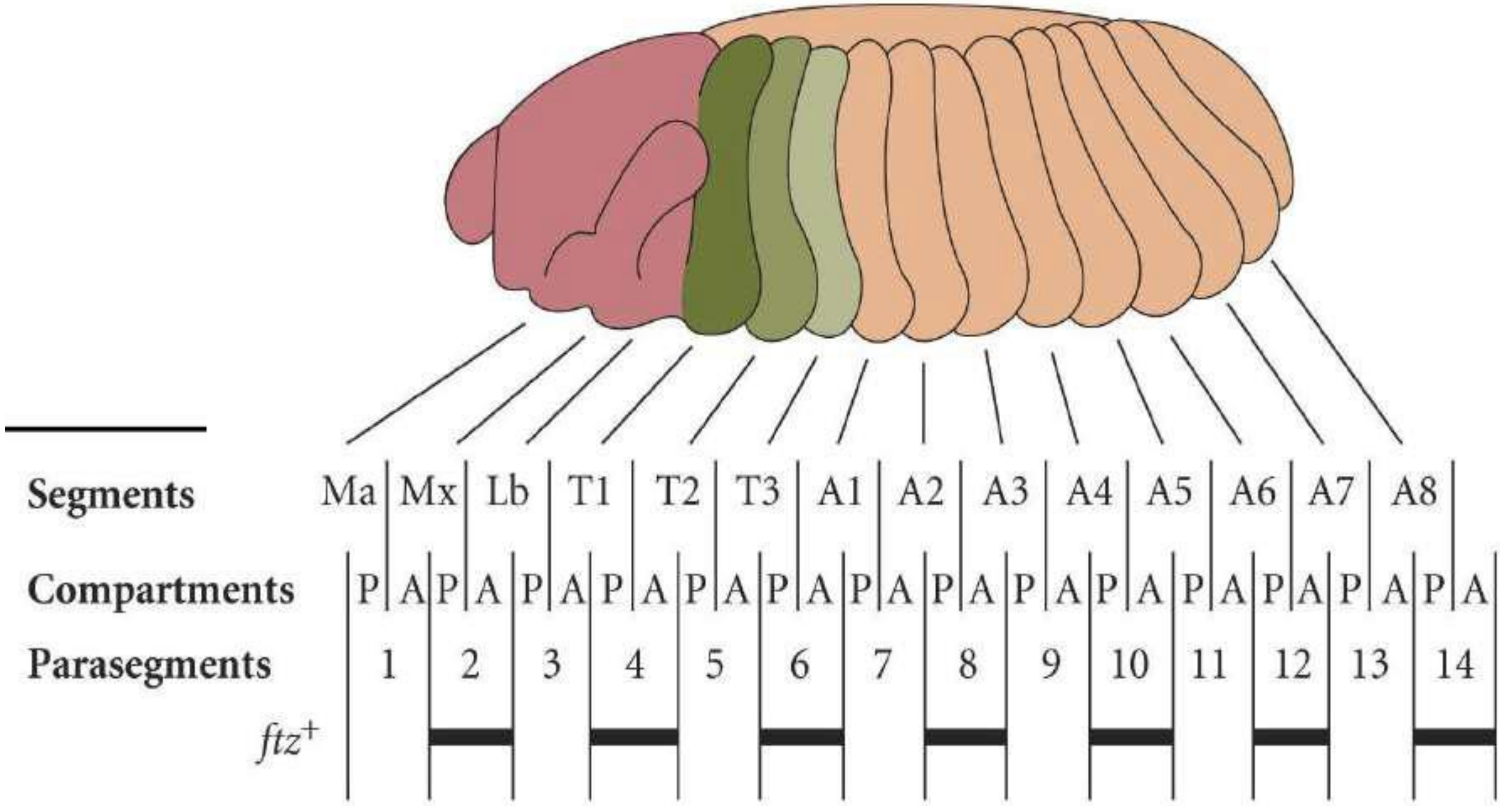
- ***decapentaplaegic (dpp), zerknüllt (zen), tolloid*** are dorsal patterning genes

- repressed by Dorsal Intermediate
- dorsal activates ***rhomboid*** - determines neural ectoderm



Segments and Parasegments

- Segments and parasegments organized from A/P **compartments**
- Cells are found adjacent to each other but Compartments **do not mix**
- Expression patterns in early embryos are controlled by **parasegments**: so these are the fundamental units of embryonic gene expression



Eight Homeotic Genes Regulate the Identity of Adult and Embryo

labial (lab)

proboscipedia (pb)

Deformed (Dfd)

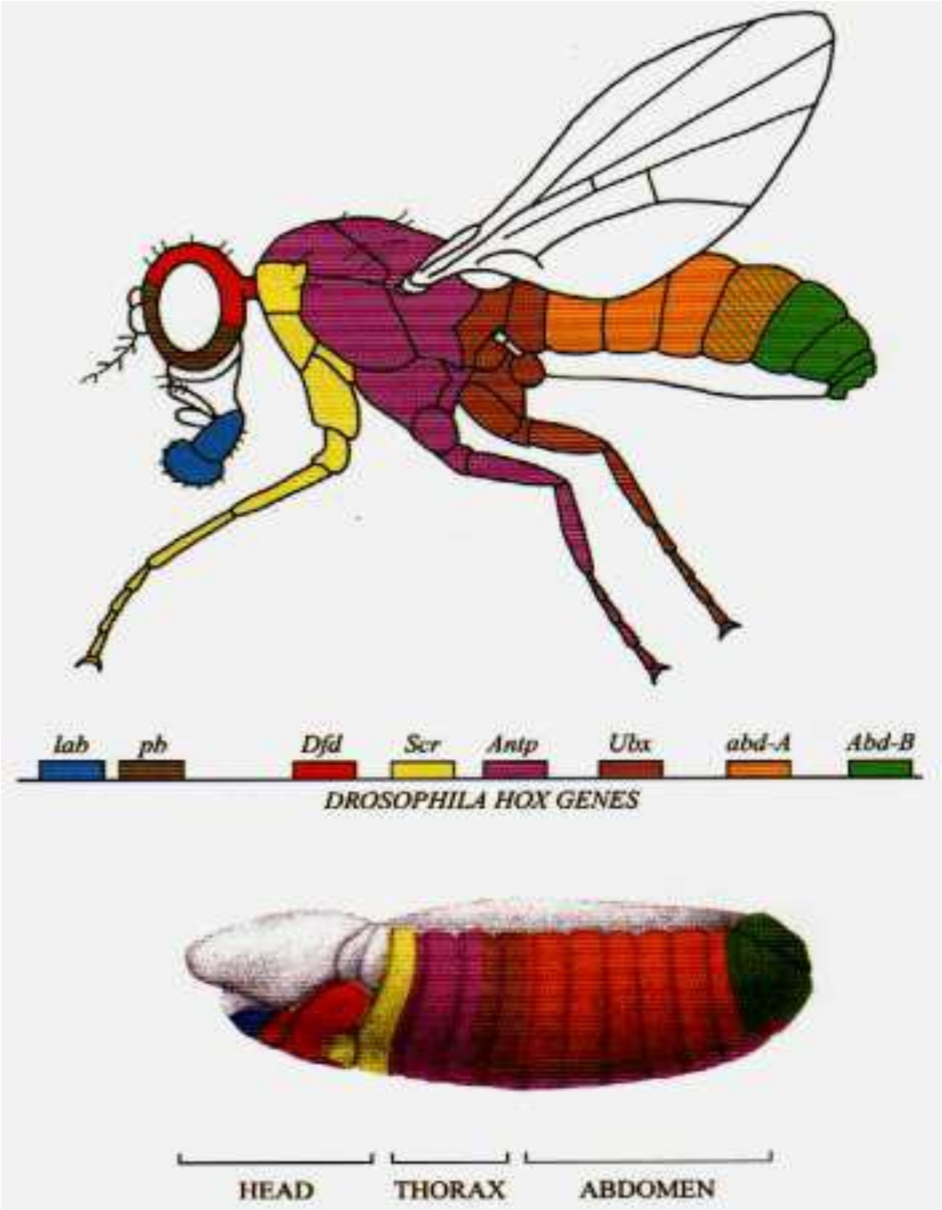
Sex combs reduced (Scr)

Antennapedia (Antp)

Ultrabithorax (Ubx)

abdominal A (abd-A)

Abdominal B (Abd-B)



Homeotic Mutations

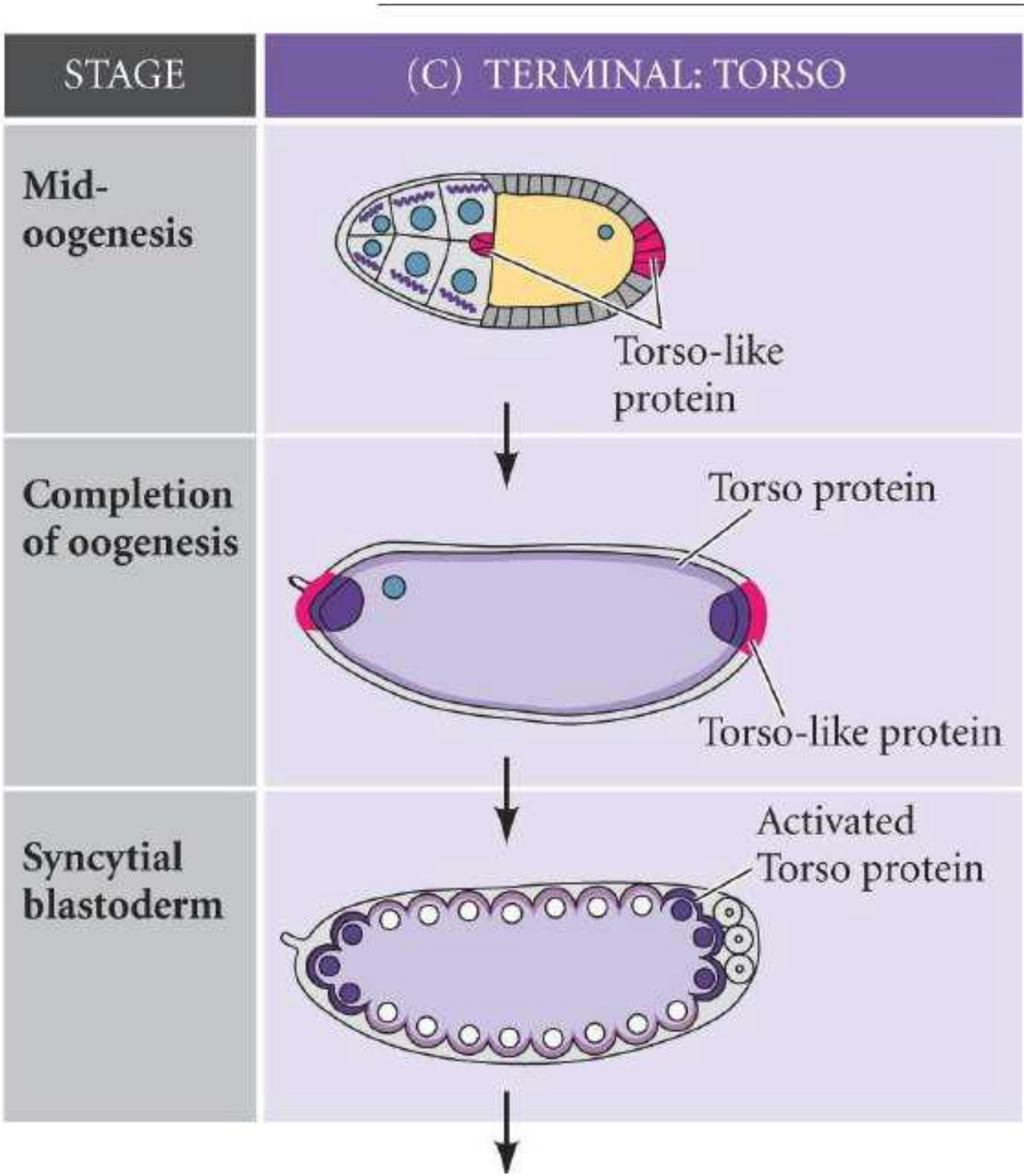
- **Homeotic transformations** depends on whether the mutation causes loss of homeotic gene function .
- *Ultrabithorax* (*Ubx*) :-acts in the haltere, promote haltere development and repress wing development.
- Loss of function mutations in *Ubx* transform the haltere into a wing.
- Dominant mutations that cause *Ubx* to gain function,transform that structure again into a haltere.

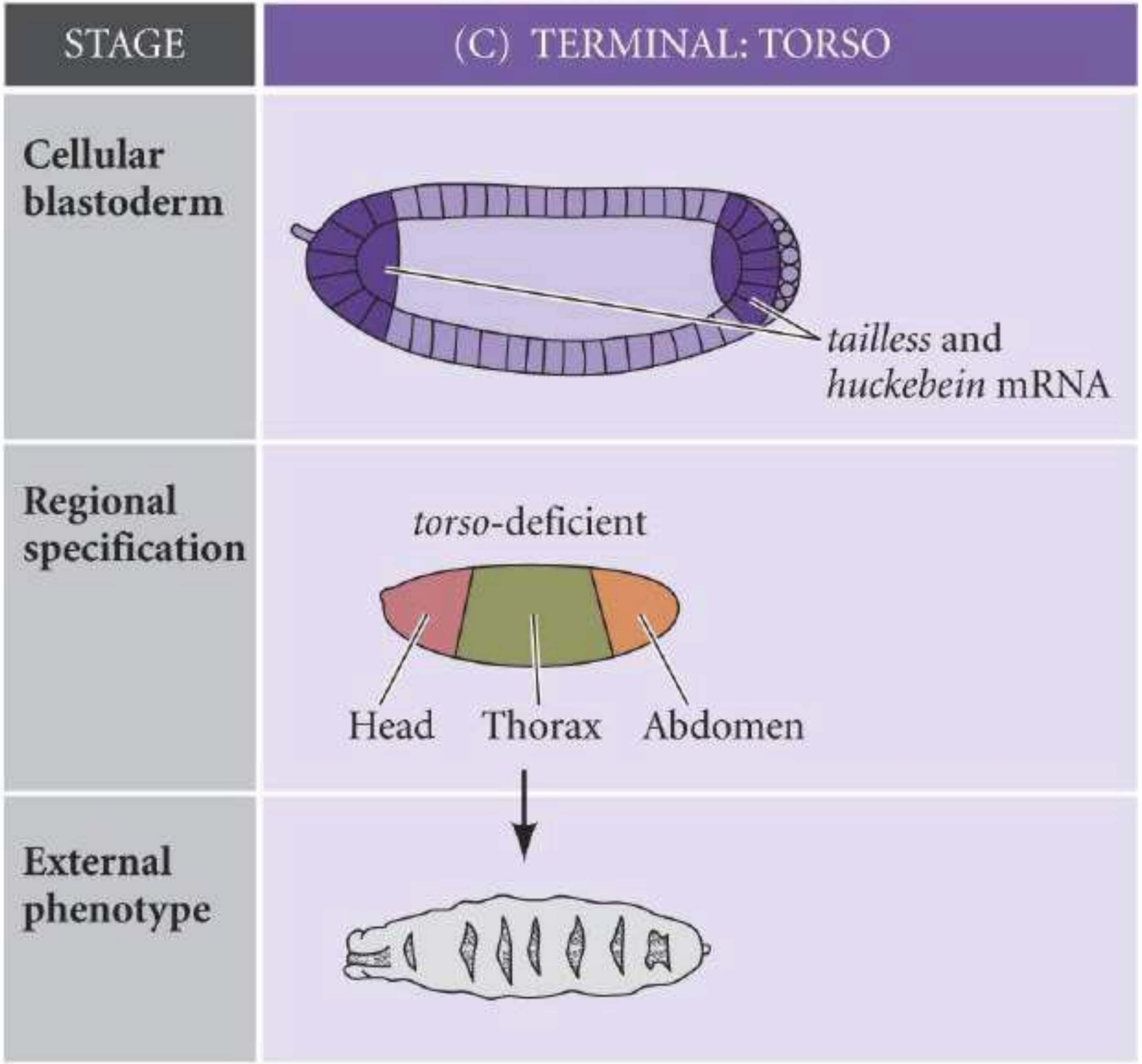
Terminal Specification

Torso – transmembrane protein

- Torso activated by Torso-like protein

- Present only at ends of egg





Torso kinases inactivate an inhibitor of ***tailless* and *huckebein***

Tailless and Huckebein specify terminus

Distinction between The anterior and posterior region, by **Bicoid genes**

Bicoid (**acron)** Formation