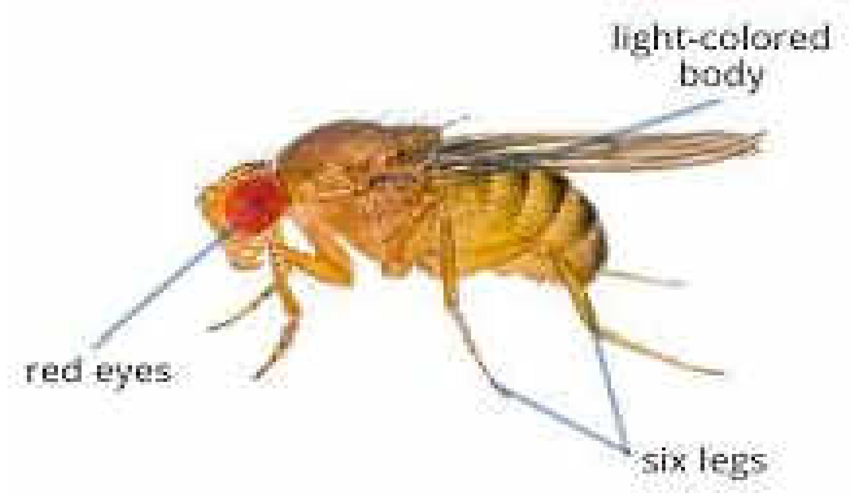
Drosophila axes patterning



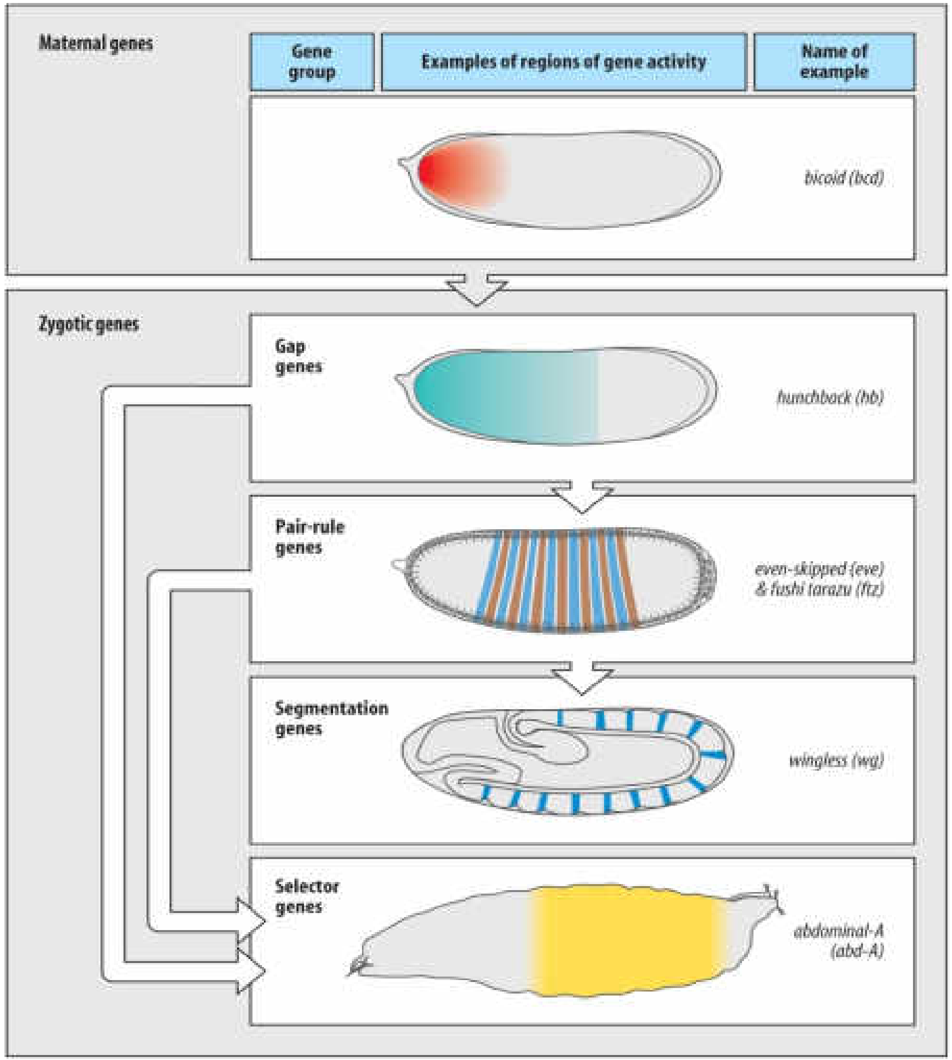
Prof C. R. Sahu

Introduction

- The general body plan of Drosophila issamein the embryo, the larva, and the adult possessing a distinct head end, repeating segmental units and a distinct tail. In the repeating segmental units three segments form thorax, while another eight segments form the abdomen. The first thoracic segment has legs; the second thoracic segment has legs and wings and the third thoracic segment has legs and halters (balancing organs).

A-P Body plan

- Maternal effect genes produce messenger RNAs that are placed in different regions of the egg and encode transcriptional and translational regulatory proteins which after diffusion through the syncytial blastoderm activate or repress the expression of certain zygotic genes.



Maternal genes
Gene group
Examples of regions of gene activity
Name of example
bicoid (bcd)
Zygotic genes
Gap genes
hunchback (hb)
Pair-rule genes
even-skipped (eve) & fushi tarazu (ftz)
Segmentation genes
wingless (wg)
Selector genes
abdominal-A (abd-A)

Drosophila development: the A/P axis

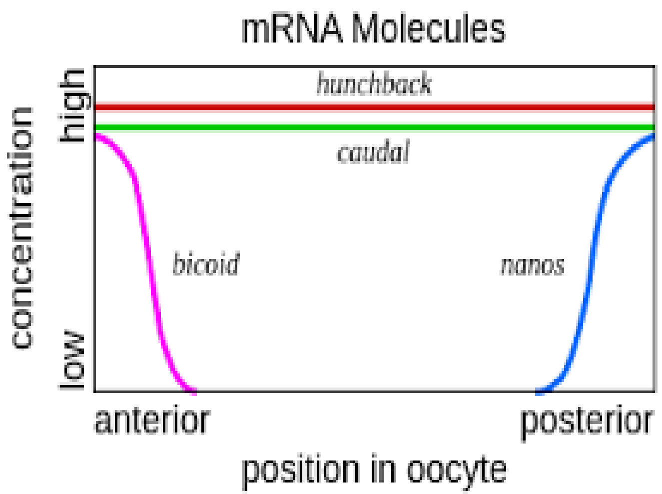
- Three classes of maternal genes set up the A/P axis
  Maternally expressed genes distinguish the anterior from the posterior.
  Maternal effect mutants result in females that can not produce normal progeny.
  Three mutant classes are 1) anterior, 2) posterior and 3) terminal classes.
  Anterior class: loss of head and thorax (sometimes replaced with posterior).
  Posterior class: loss abdominal segments.
  Terminal class: missing acron and telson.
  bicoid, hunchback, nanos and caudal are key to A/P axis.

Drosophila development: maternal genes

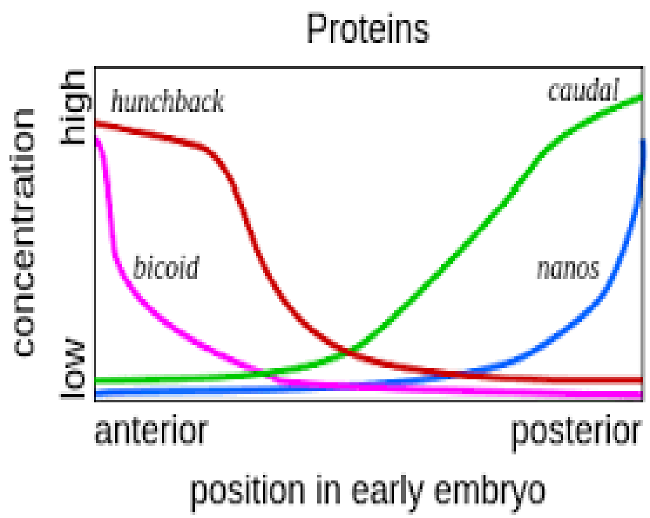
- bicoid is sequestered in the oocyte during oogensis.
  bicoid sets a A/P morphogenic gradient and controls the first steps in embryo development and, thus, is essential to the developing organism.
  bicoid mRNA is localized to the anterior end of the unfertilized egg.
  After fertilization, the mRNA is translated and a concentration gradient is formed along the A/P axis.
  bicoid was the first evidence of a morphogen gradient.

Maternal genes effect

In Oocyte



In early embryo



The posterior pattern

- **The posterior pattern is controlled by nanos & caudal protein gradients**

- nanos mRNA is localized to the posterior pole of the egg.
  nanos is NOT a morphogen like bicoid but acts to suppress translation of another maternal gene, hunchback (hb).

  The P-A gradient of caudal is established by inhibition of caudal protein synthesis by bicoid.
  Anterior and posterior extremes are specified by cell-surface receptor activation

A/P axis

- **A/P axis is divided into broad regions by gap genes**

- The gap genes, the first genes expressed along the A/P axis are transcription factors.
  The gap genes are initiated by bicoid in the synctial blastoderm.

  Gap gene proteins are short lived (half-life of minutes) and extend only slightly outside of where the gene is expressed (bell-shaped concentration distribution.)

Pair-rule genes

- **Pair-rule genes delimit the parasegments**
  Pair-rule genes delimit the parasegments and are expressed in 7 transverse stripes (every 2nd parasegment).
  Pair-rule expression determined by gap gene activity to interpret a series of broad expression patterns to make a repeated series of stripes.

Segment polarity genes

- **Segment polarity genes pattern the segments and stabilize parasegment and segment boundaries**
  Each larval segment has an A/P pattern: the anterior part has denticls while the posterior part has naked cuticle.

  Segment polarity genes are expressed in a restricted subset of the cells of each parasegment.

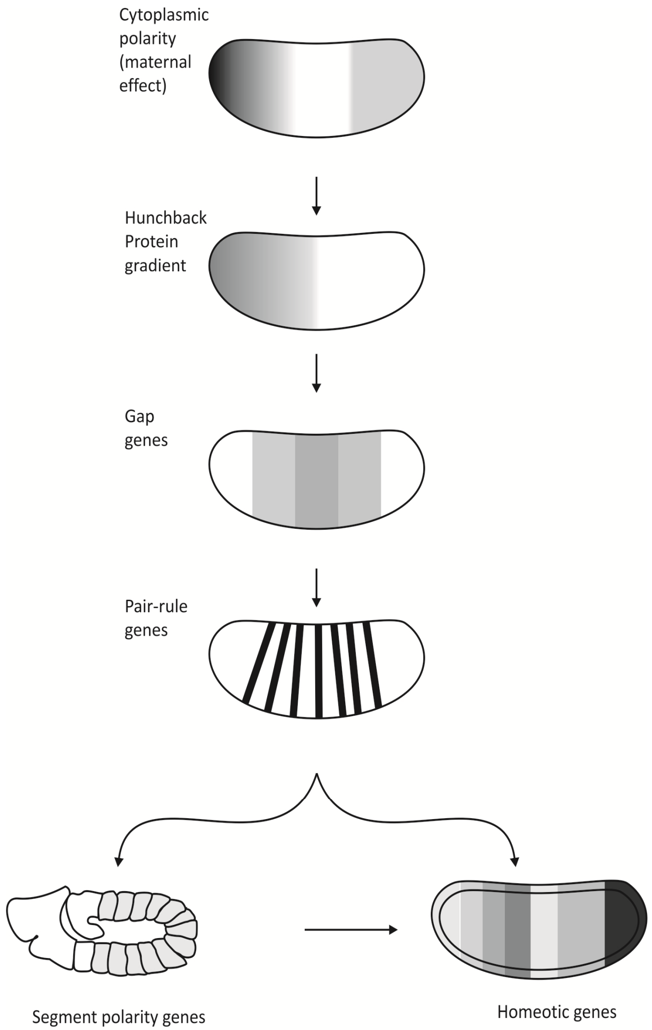


Fig. : Anterior-posterior axis differentiation in drossopila

Homeotic genes

- **Homeotic genes of the bithorax complex (BX-C) are responsible for the posterior segments**
  Bithorax complex (BX-C) consists of three homeobox genes (Ubx, abd-A & Abd-B).
  Ubx is expressed from PS 5 and posterior.
  abd-A is expressed in PS 7 and posterior.
  Abd-B is expressed in PS 10 and posterior (and suppresses Ubx).

Homeotic gene effect