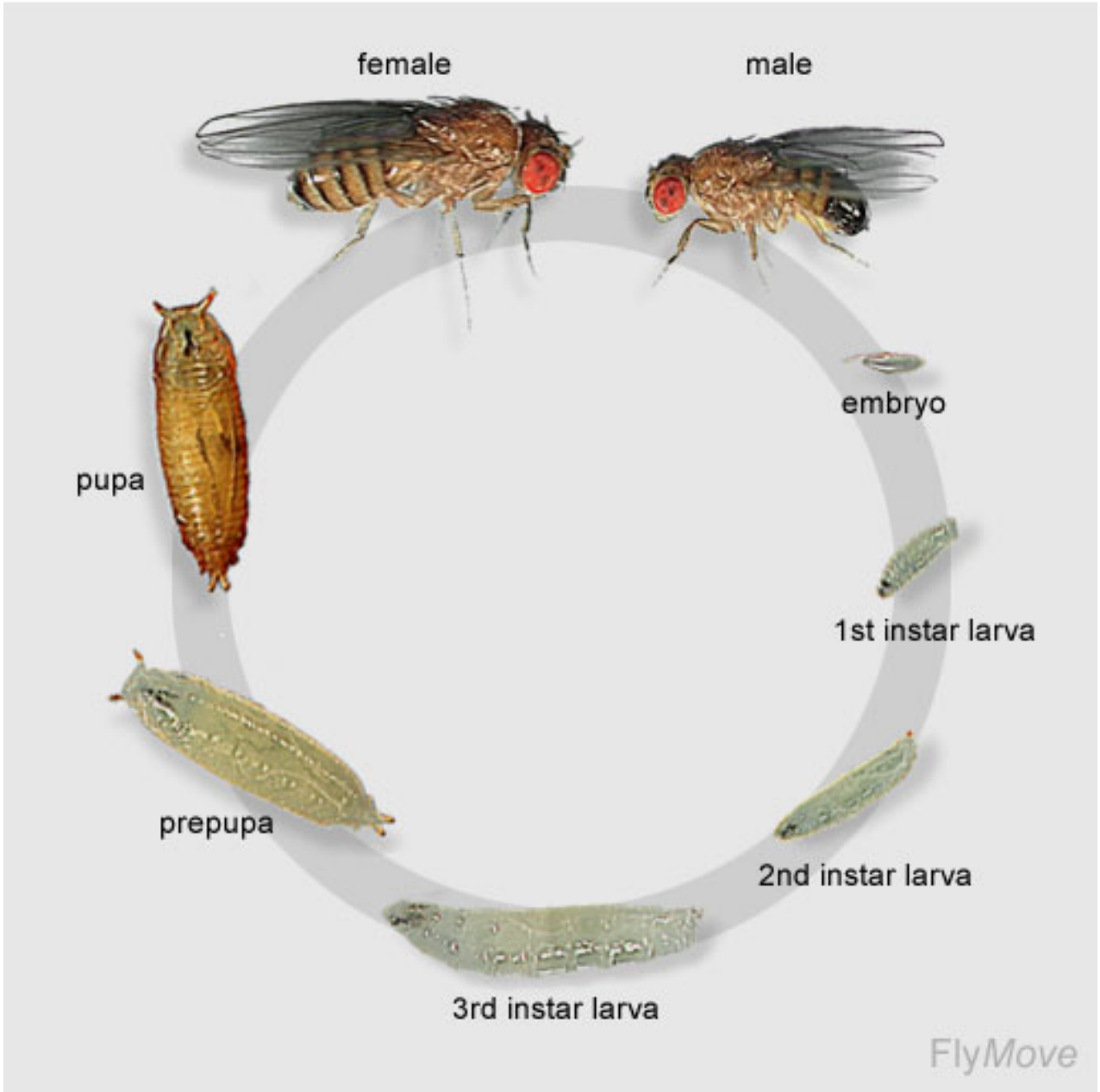
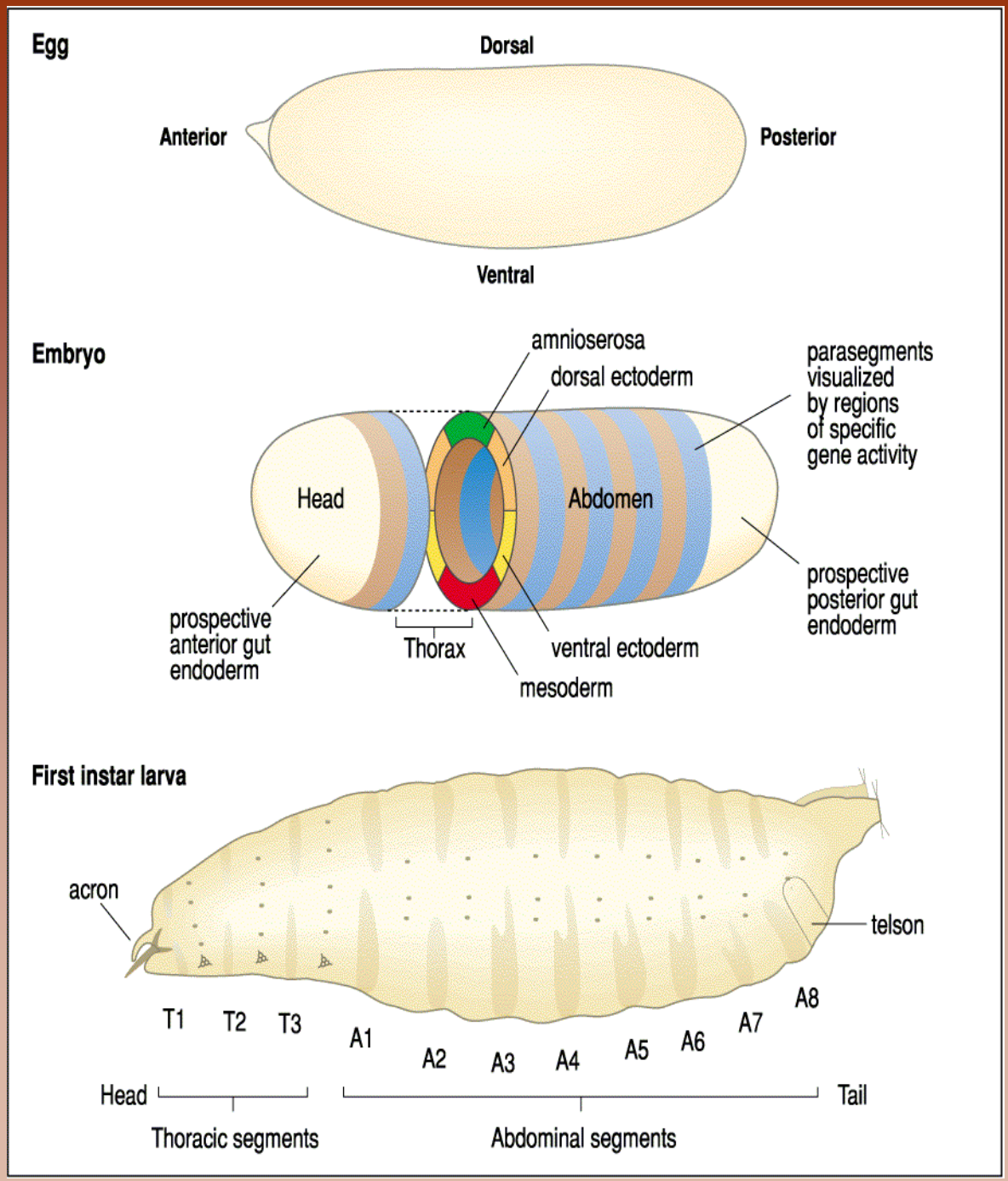
Pattern Formation in Development
Lecture 2

L S Shashidhara

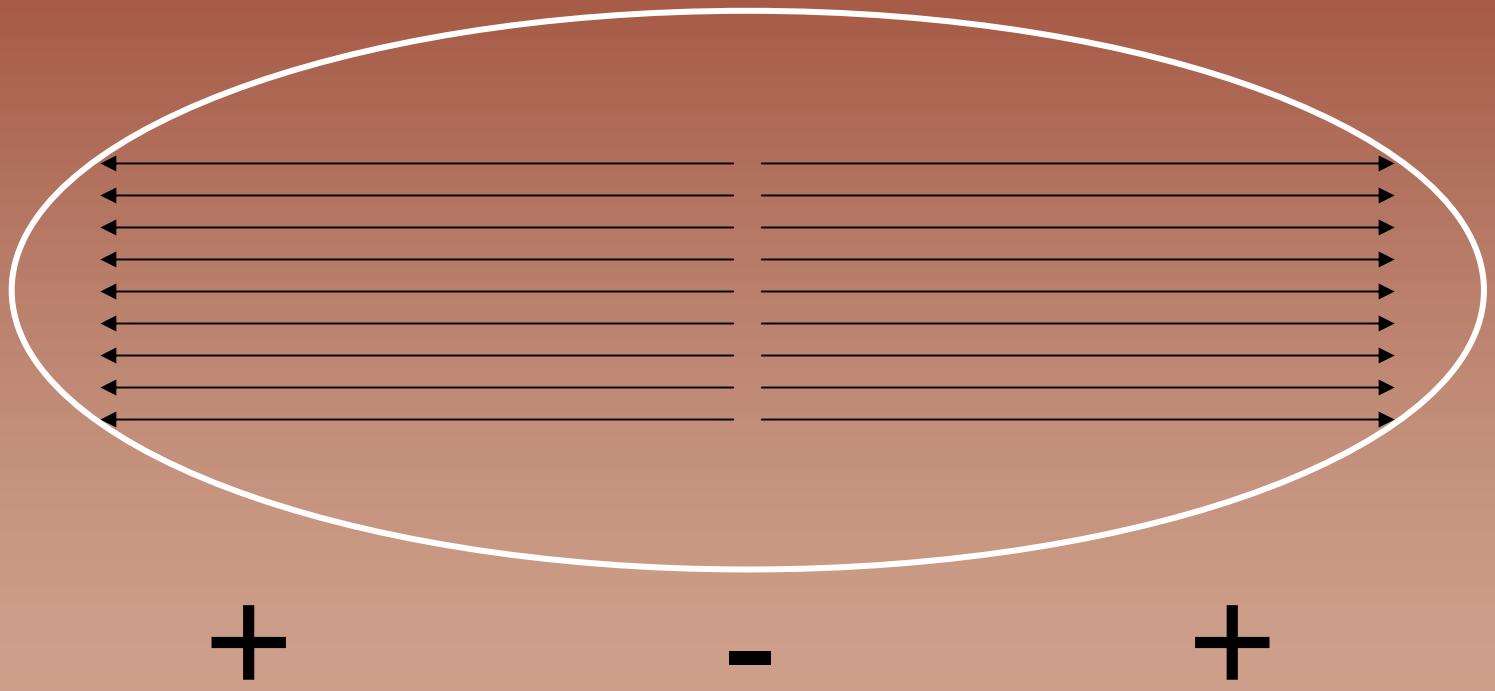
IISER Pune

The life cycle of *Drosophila melanogaster*

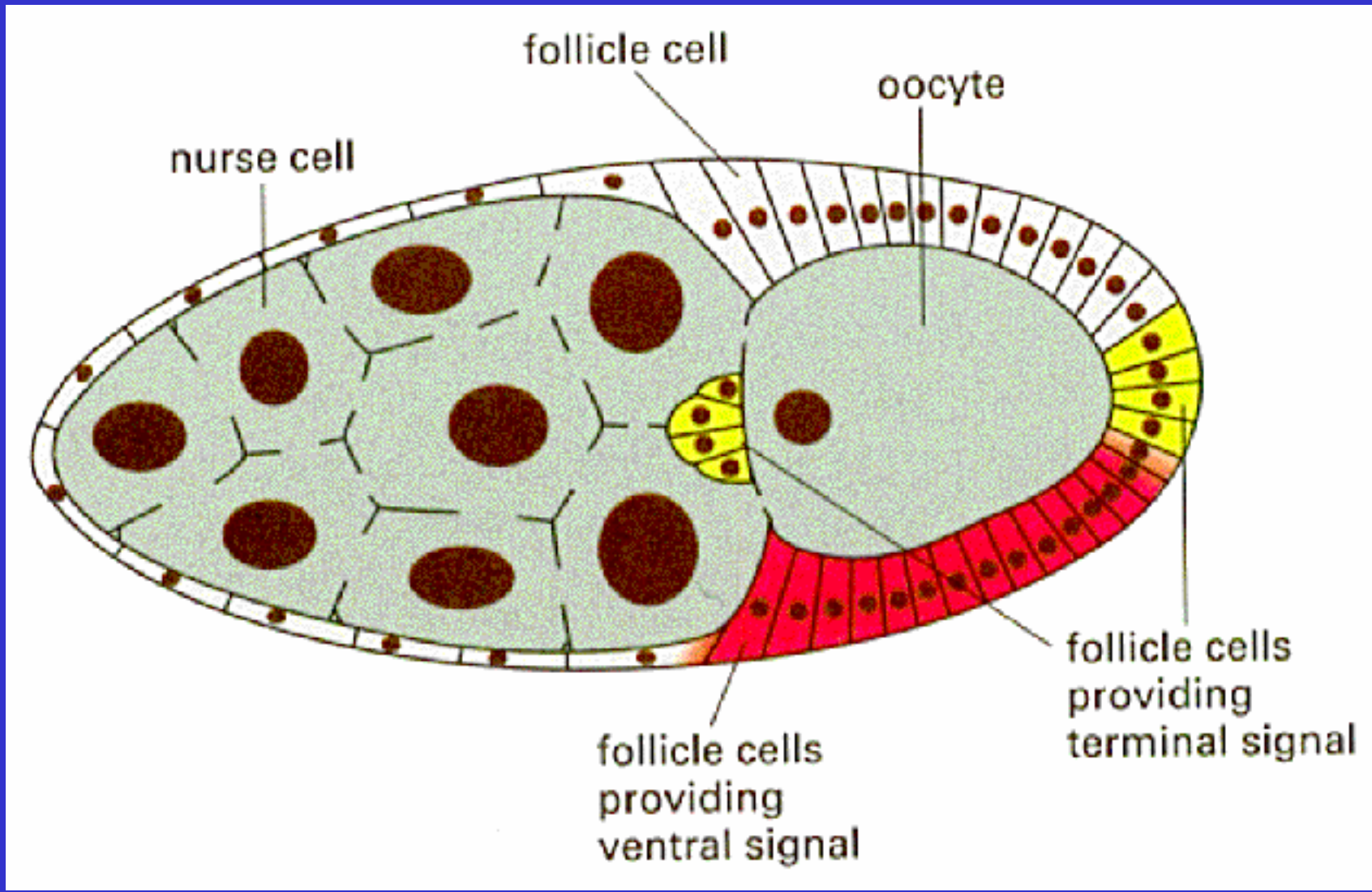



Egg
Dorsal
Anterior
Posterior
Ventral
Embryo
amnioserosa
dorsal ectoderm
parasegments visualized by regions of specific gene activity
Head
Abdomen
prospective anterior gut endoderm
Thorax
ventral ectoderm
mesoderm
prospective posterior gut endoderm
First instar larva
acron
telson
T1
T2
T3
A1
A2
A3
A4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

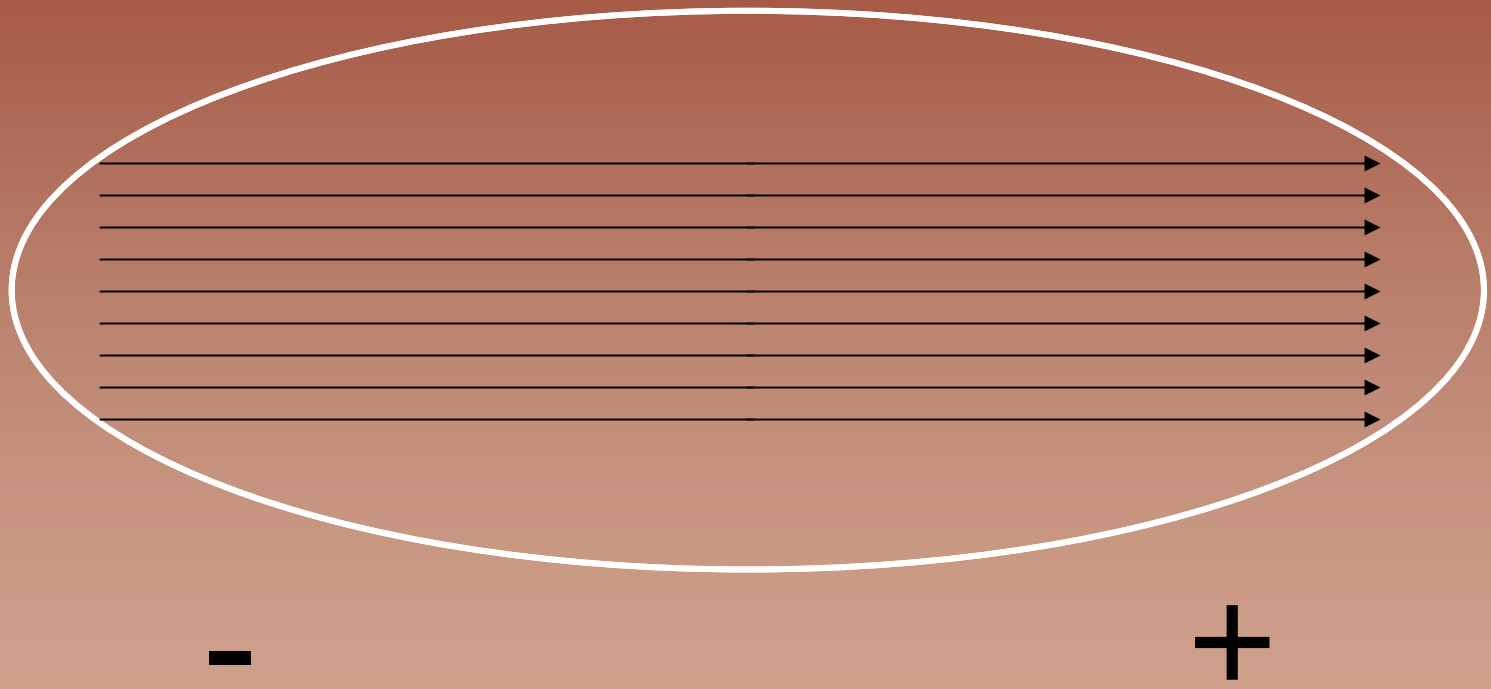
Microtubule organization – prior to oocyte maturation

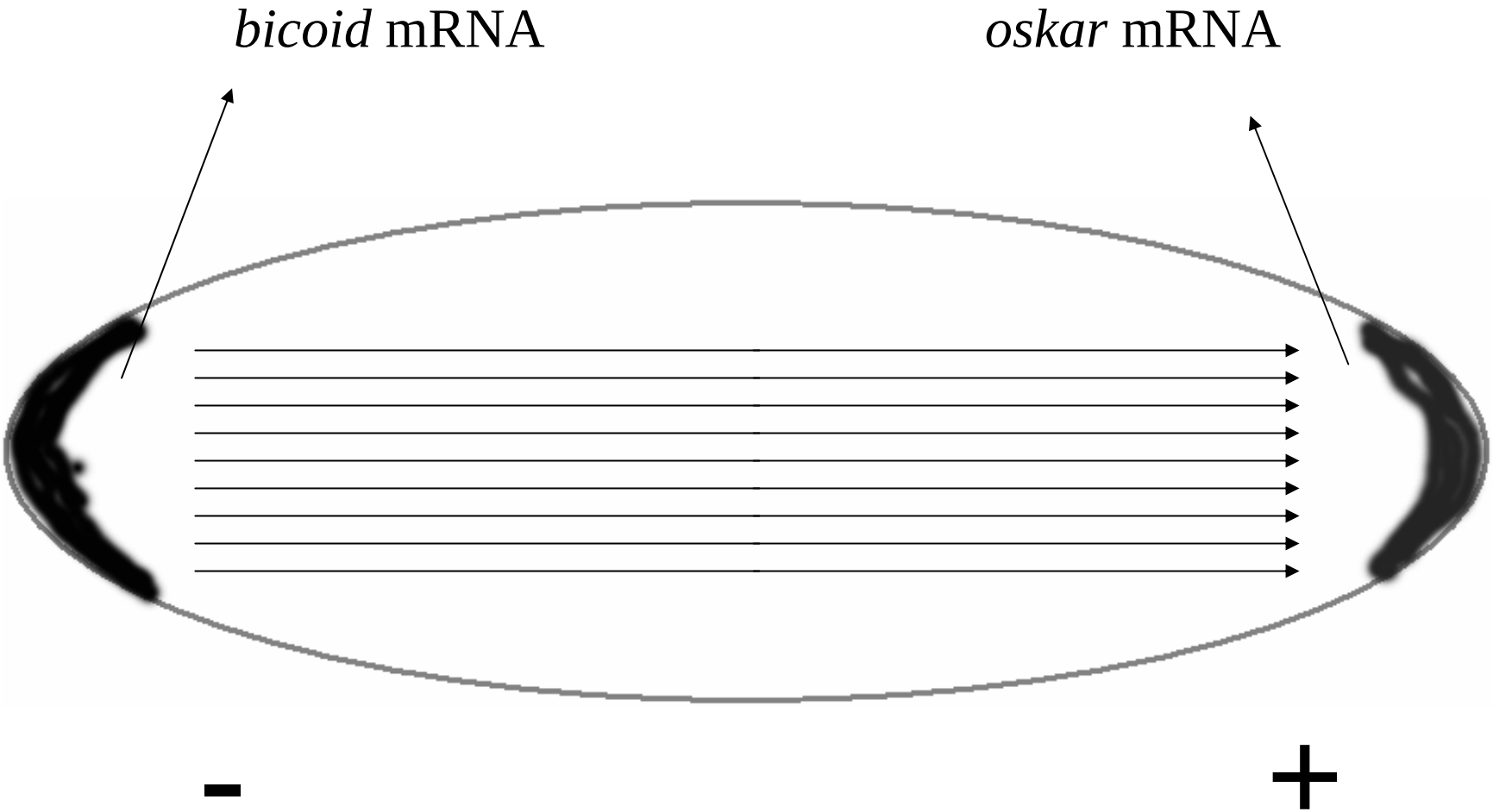


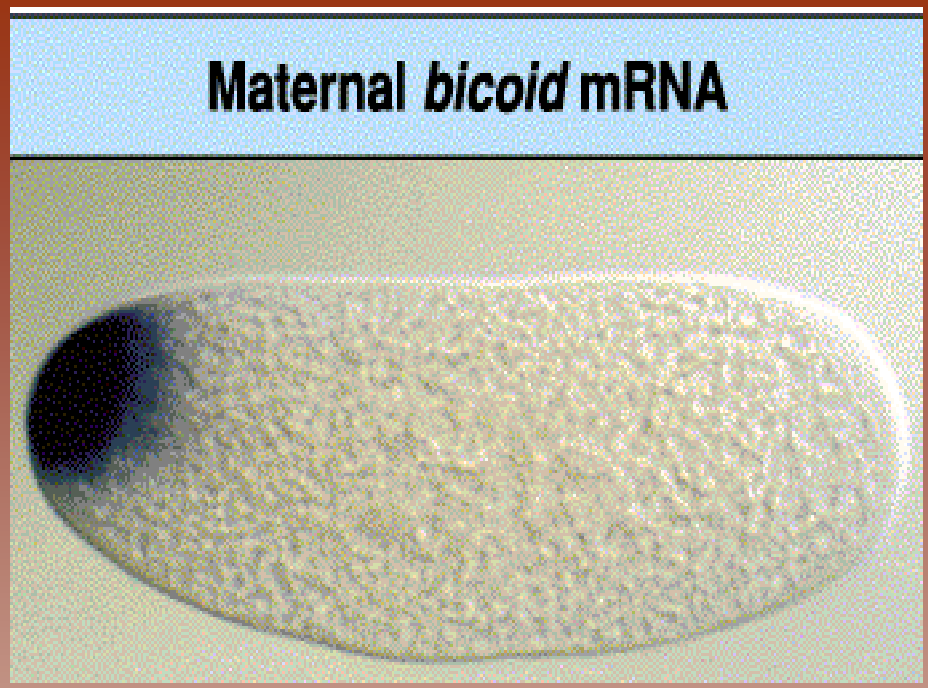
Nurse and Follicle Cells of the Egg Chamber are Instrumental in Patterning the Early Embryo



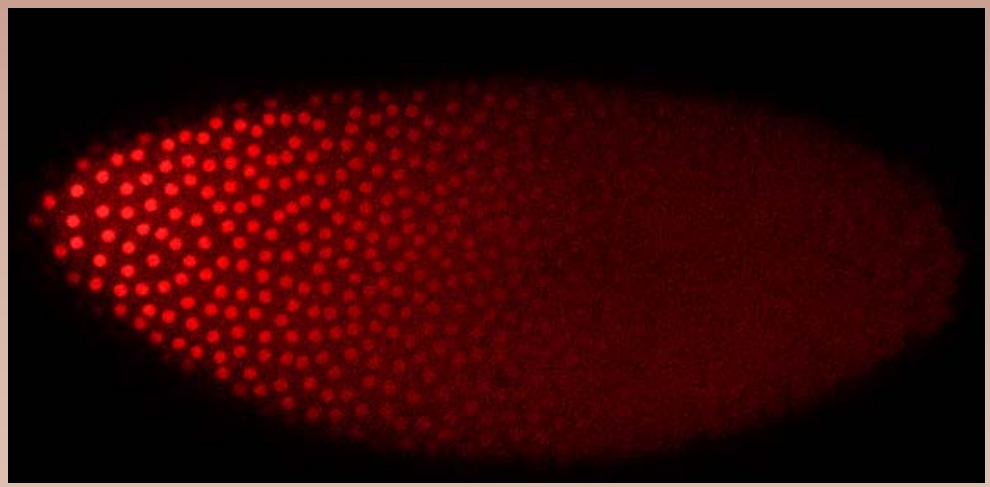
Microtubule organization – in a mature oocyte

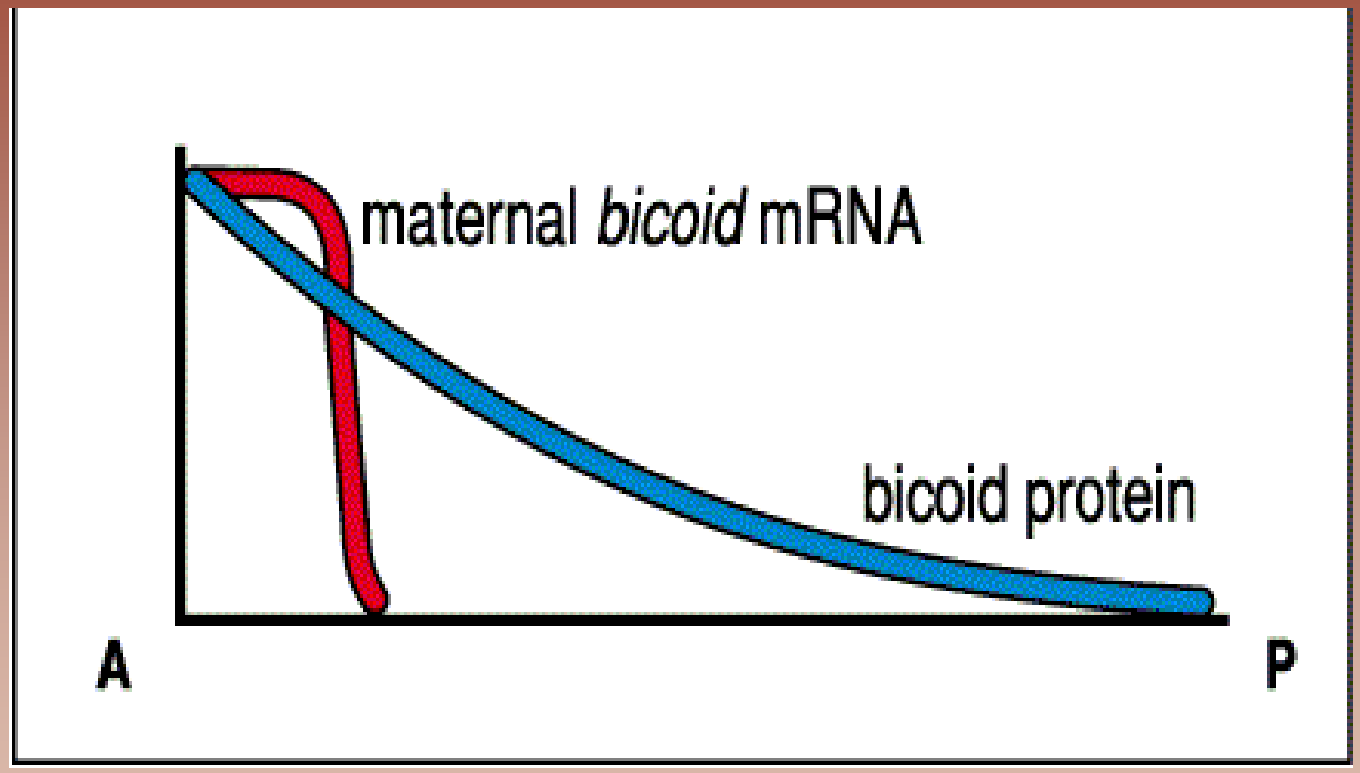


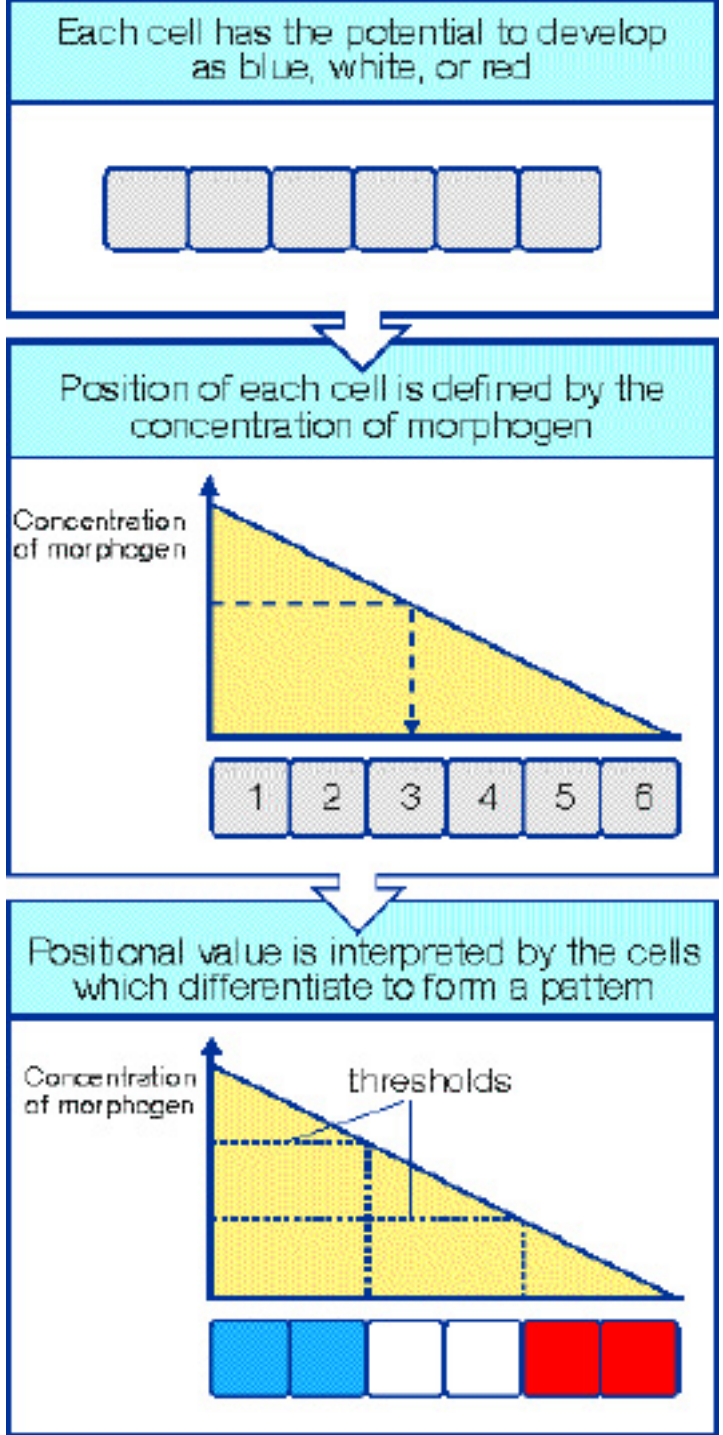

bicoid mRNA
oskar mRNA
-
+

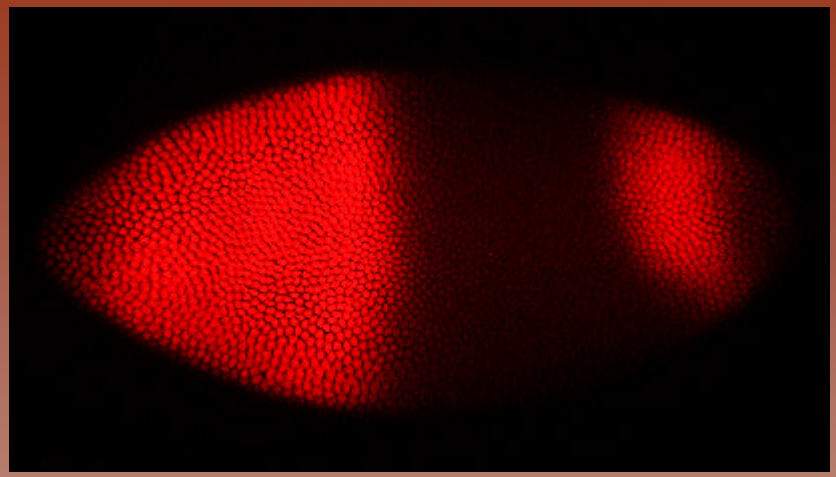


Bicoid Protein

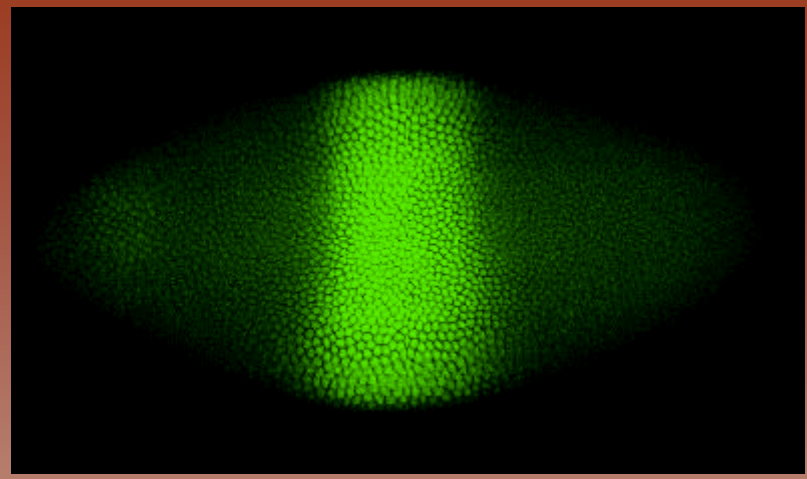



maternal *bicoid* mRNA
bicoid protein
A
P

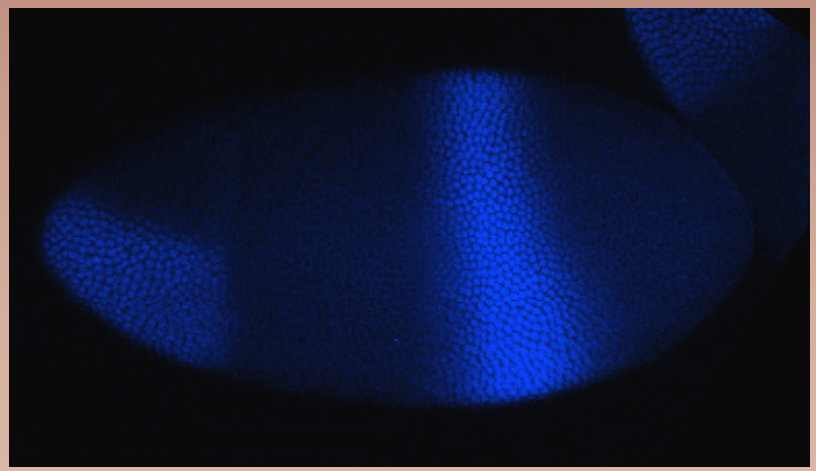

Each cell has the potential to develop as blue, white, or red
Position of each cell is defined by the concentration of morphogen
Concentration of morphogen
1
2
3
4
5
6
Positional value is interpreted by the cells which differentiate to form a pattern
Concentration of morphogen
thresholds



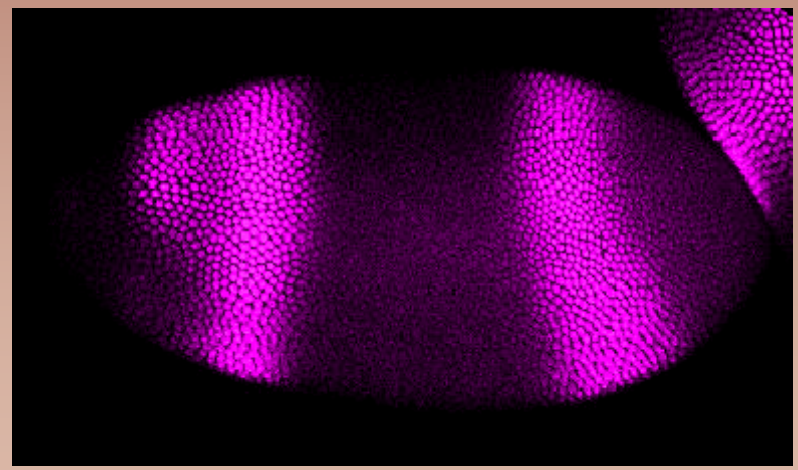
hunchback



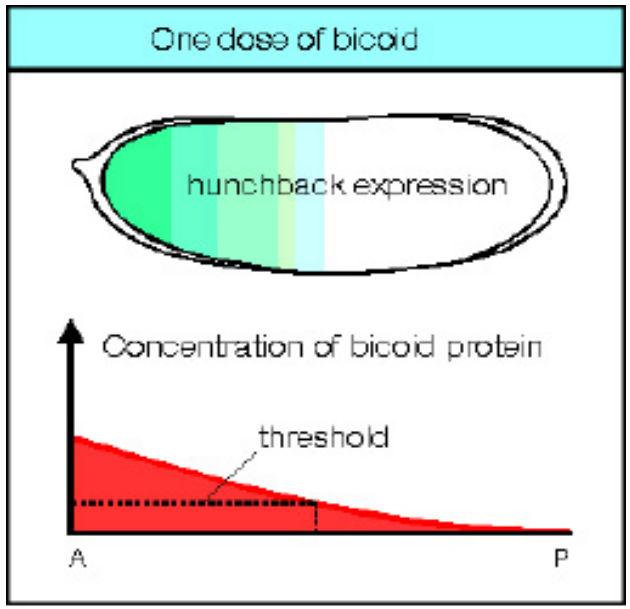
Kruppel

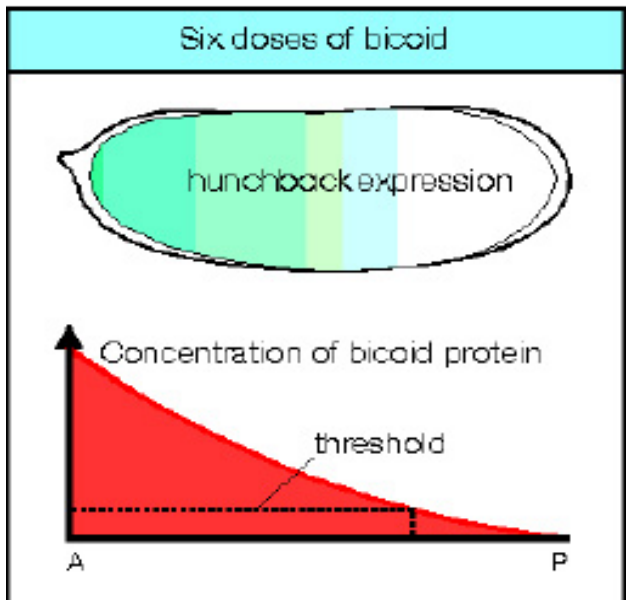


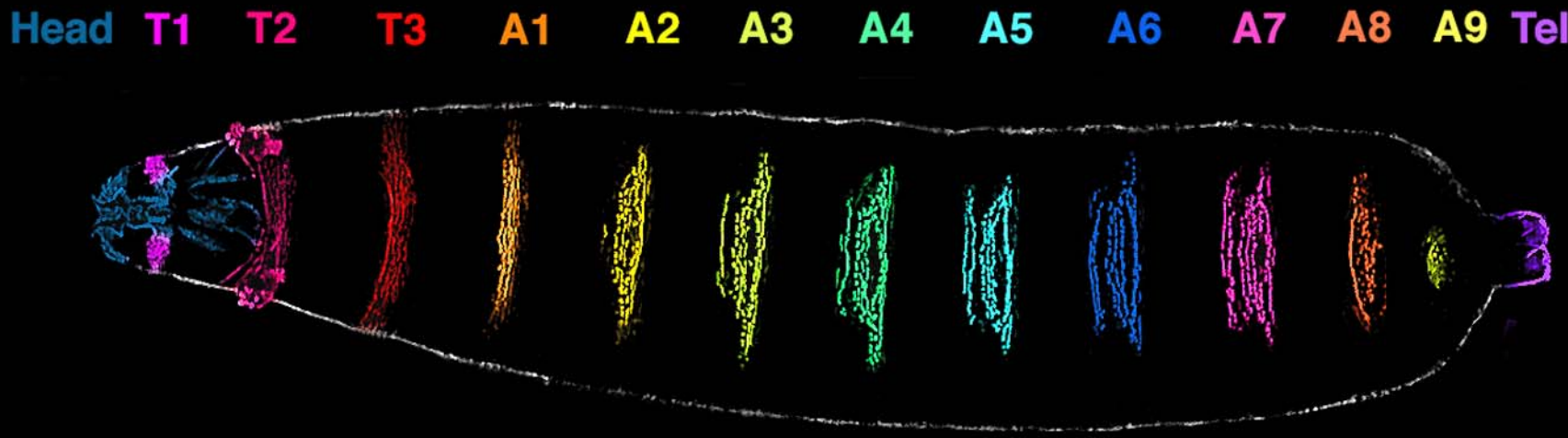
giant



Knirps


One dose of bicoid
hunchback expression
Concentration of bicoid protein
threshold
A
P

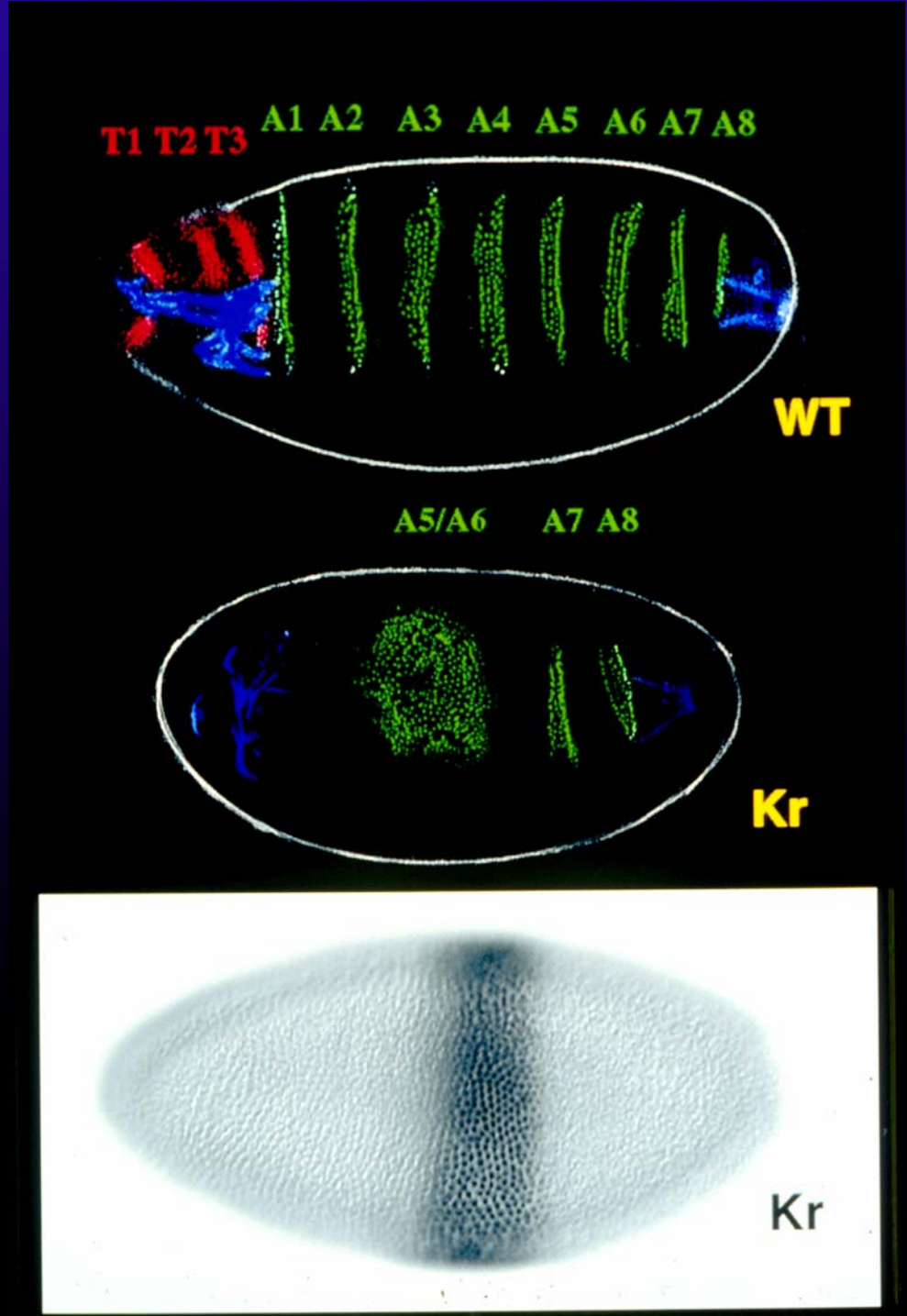

Six doses of bicoid
hunchback expression
Concentration of bicoid protein
threshold
A
P

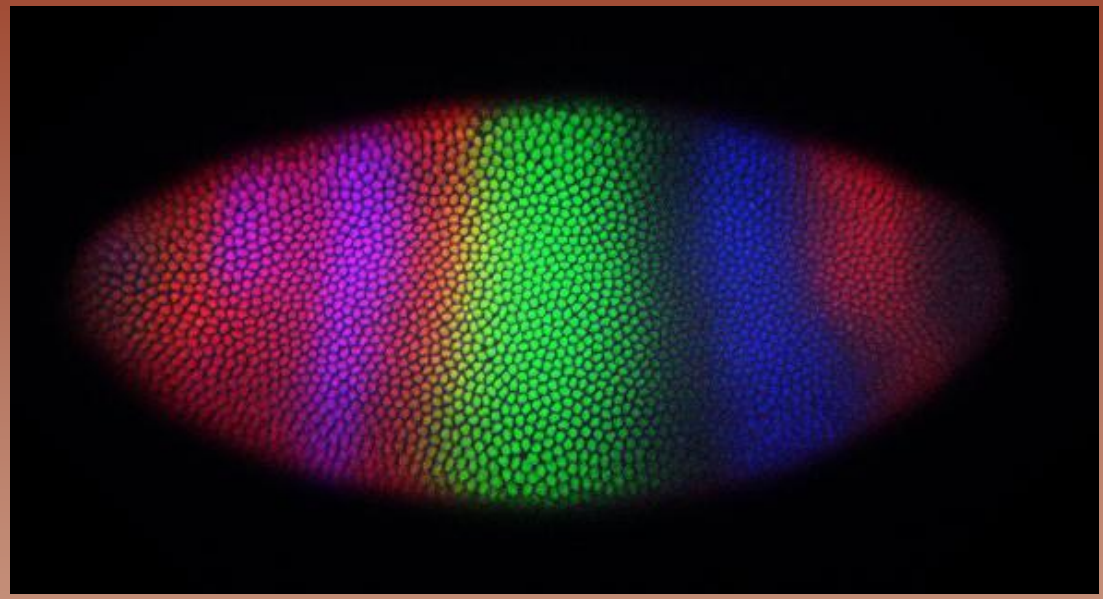

Head
T1
T2
T3
A1
A2
A3
A4
A5
A6
A7
A8
A9
Tel

Gap mutants

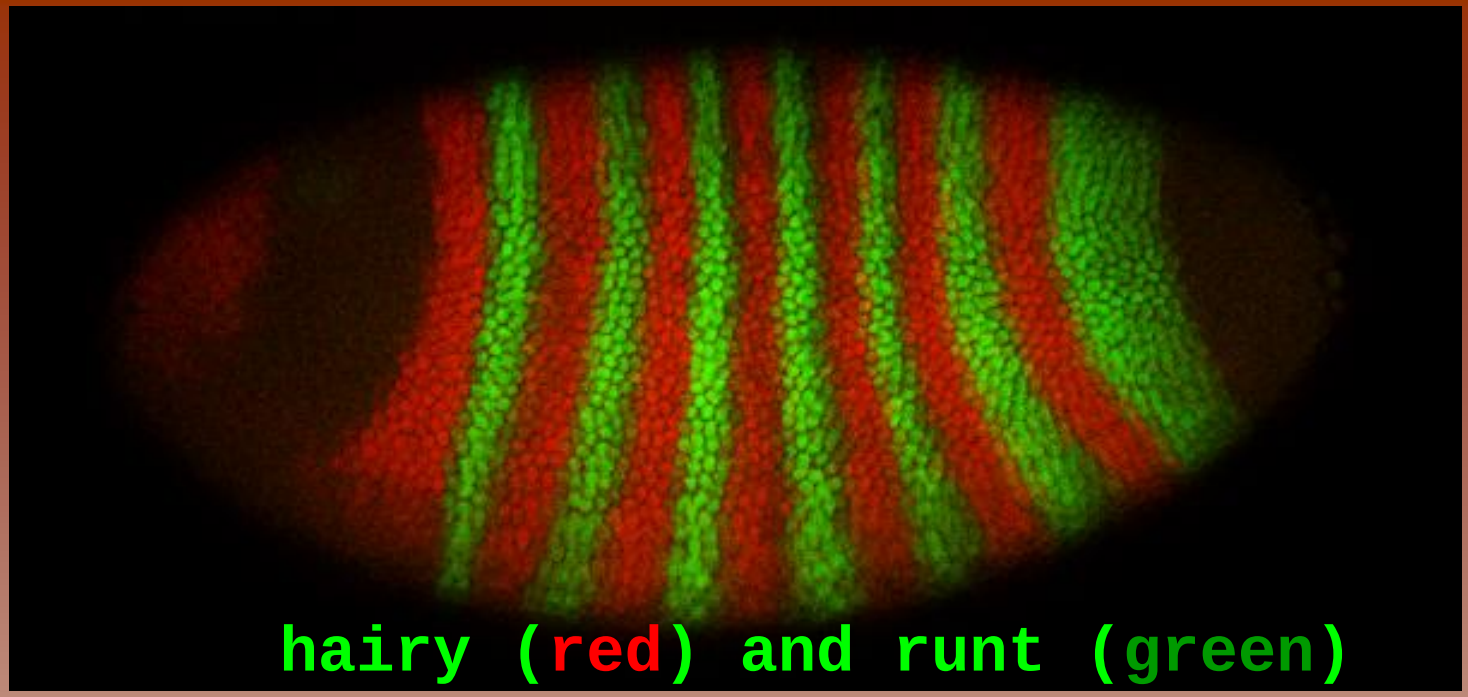
large contiguous deletions

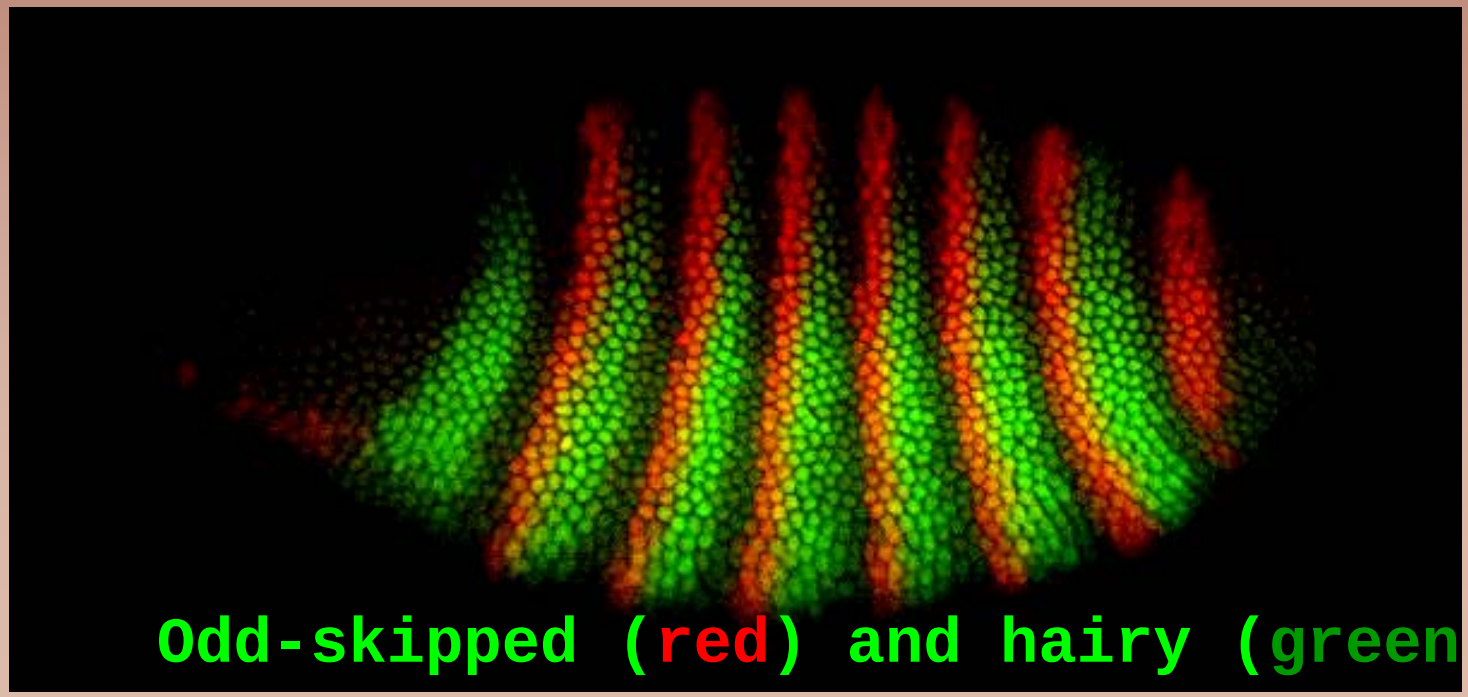
Krüppel
giant
knirps
hunchback





hunchback **(red),** ***Kruppel*** **(green) and** ***giant*** **(b**

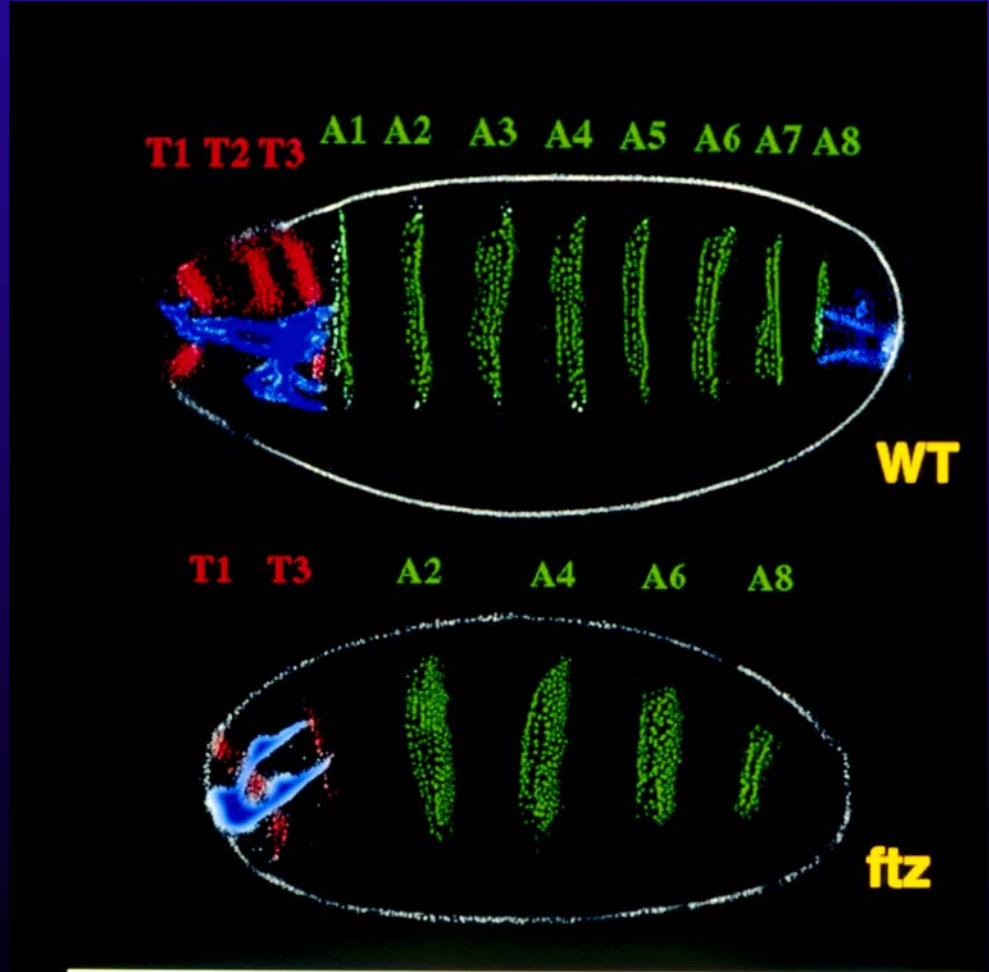

hairy (red) and runt (green)

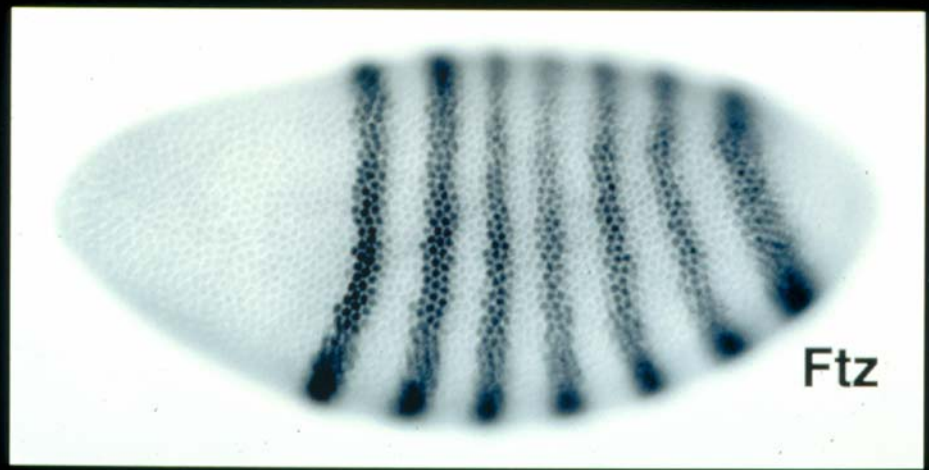

Odd-skipped (red) and hairy (green)

Pair-rule

Two segment periodicity

fushi tarazu
even-skipped
paired
odd-skipped
runt
hairy
odd-paired
sloppy paired



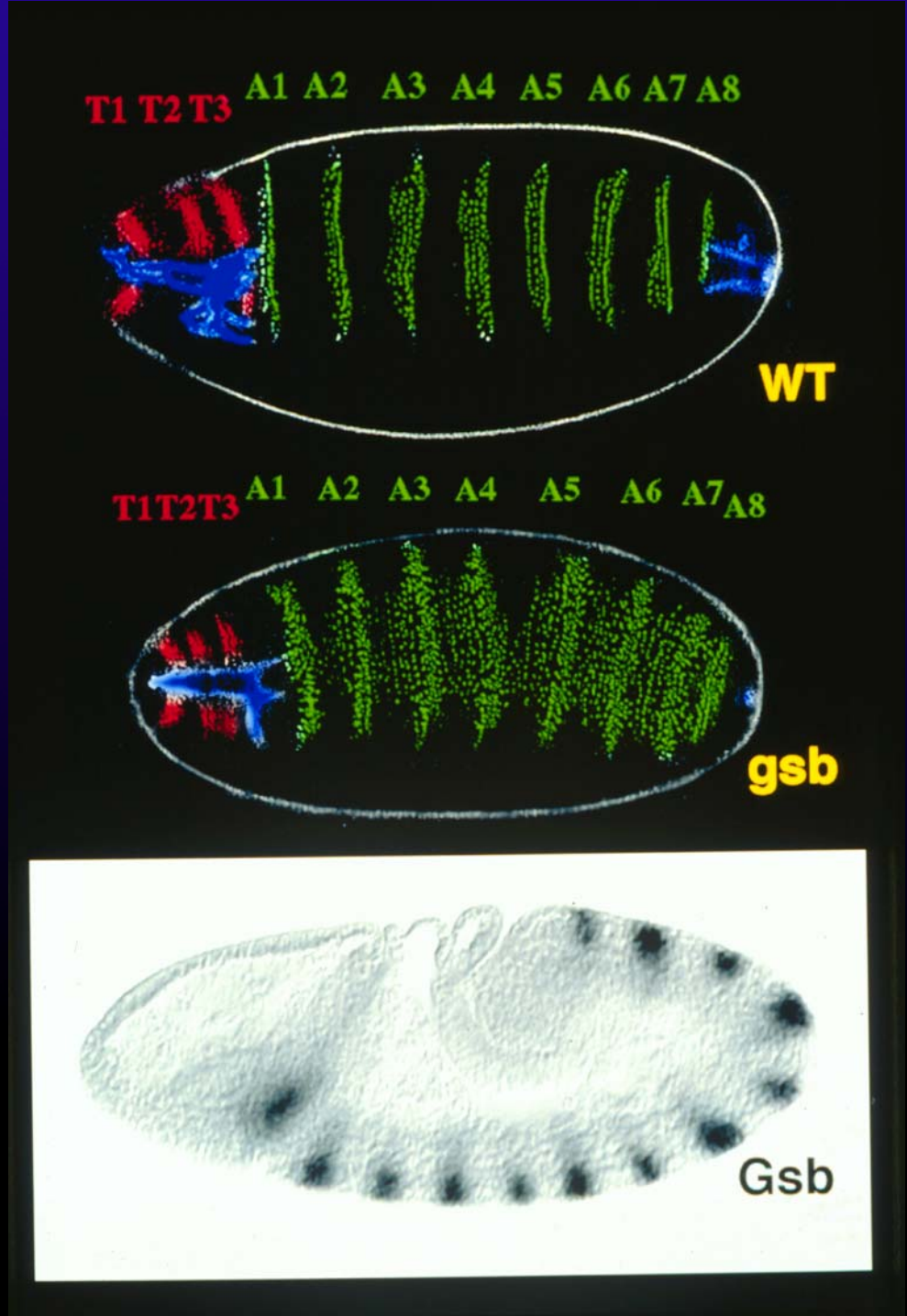


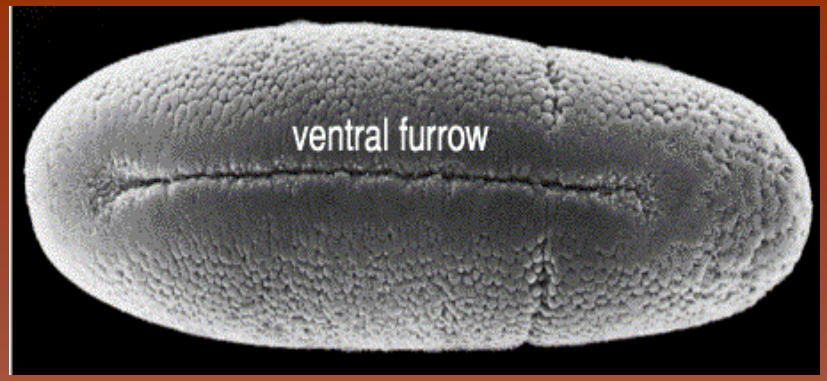
Segment polarity

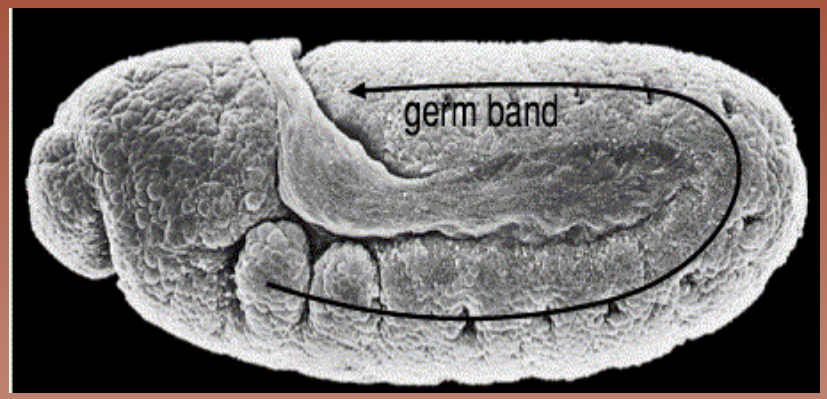
Deletions/duplications in every segment

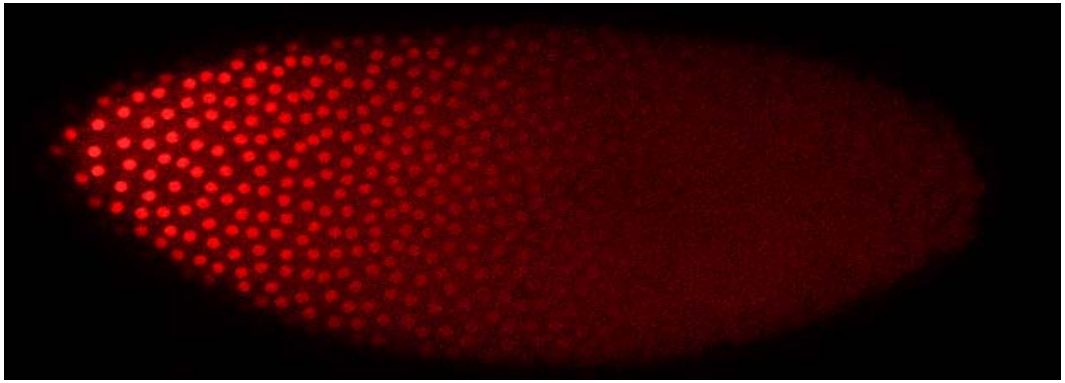
gooseberry
engrailed
hedgehog
wingless
patched
armadillo

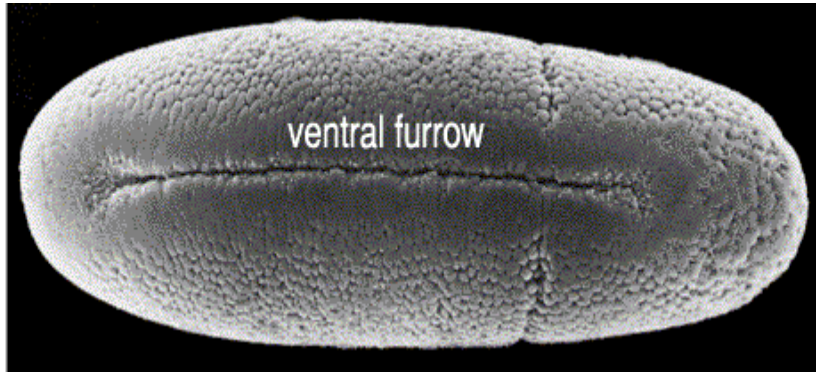
etc.....

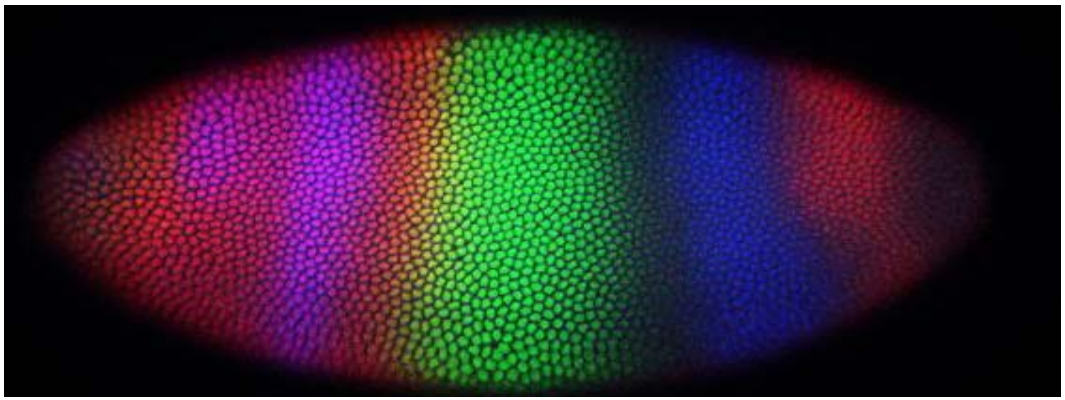


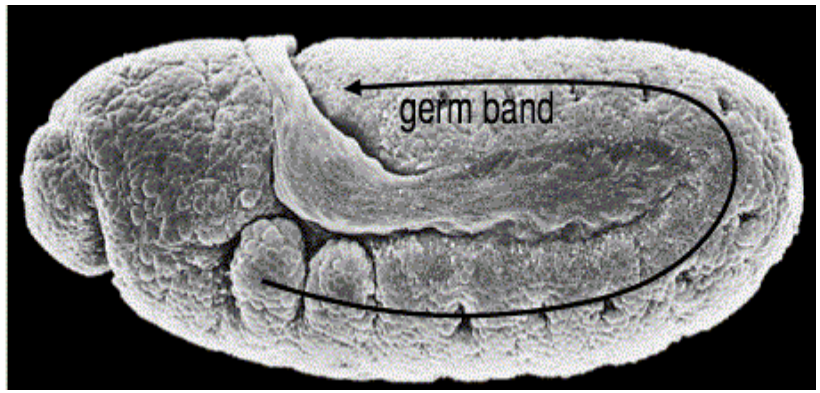

ventral furrow

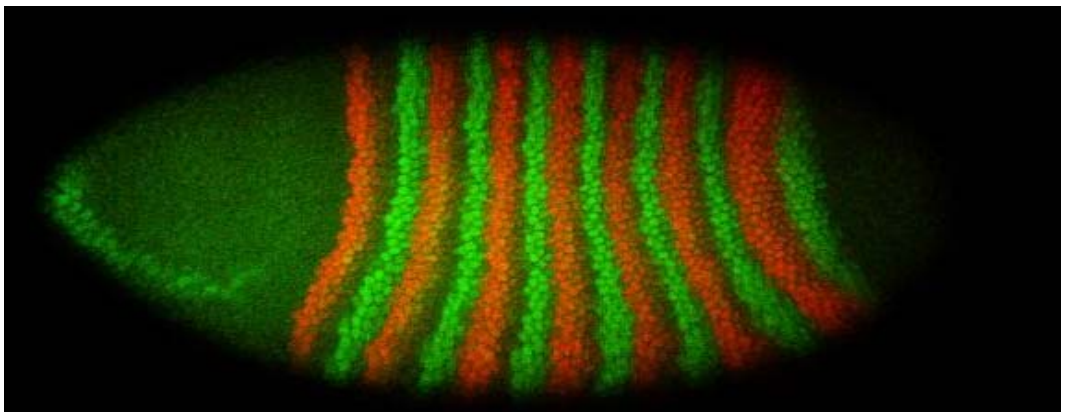

germ band

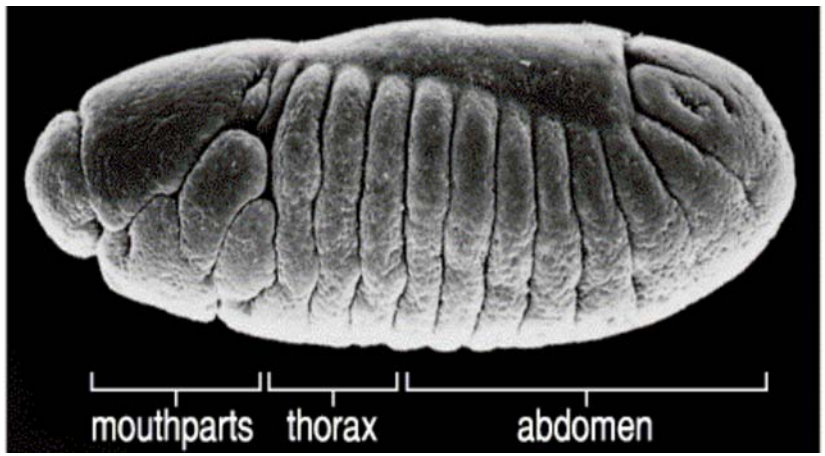




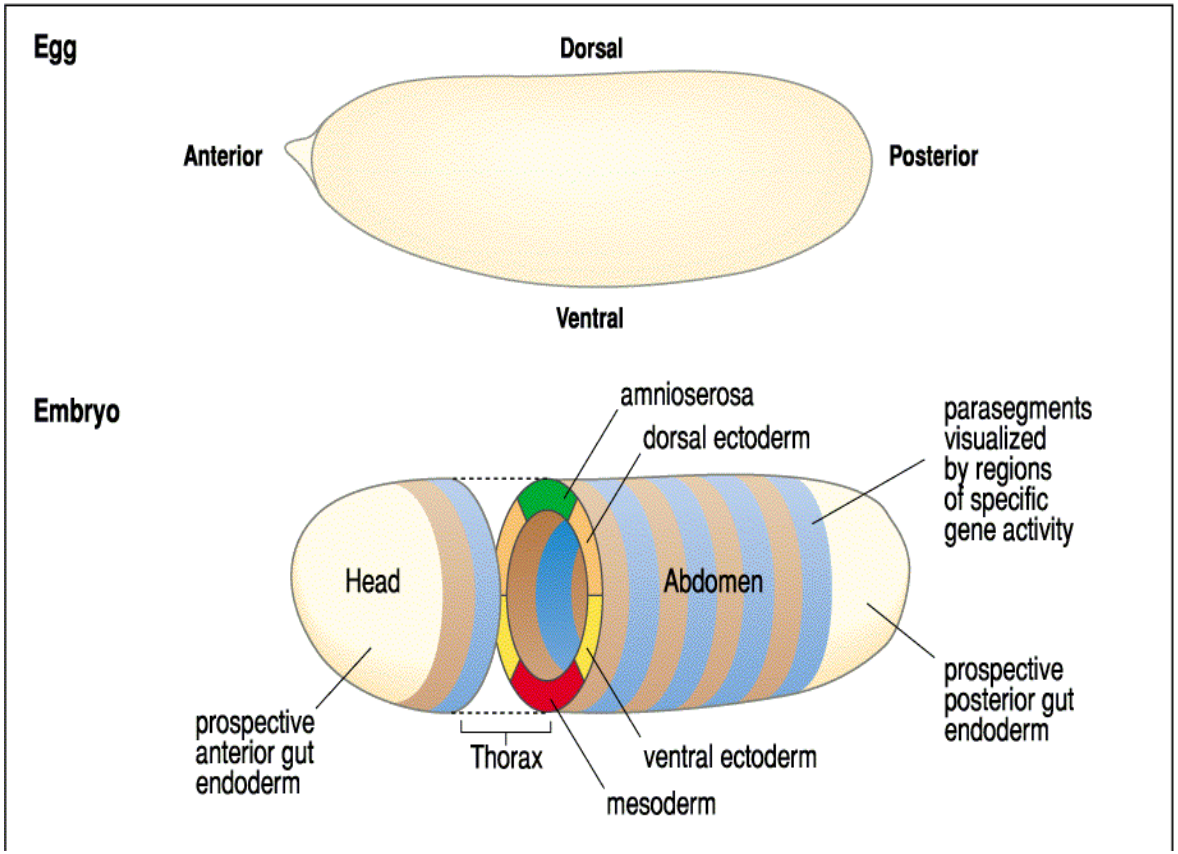








Morphological events are preceded by molecular events


Egg
Dorsal
Anterior
Posterior
Ventral
Embryo
amnioserosa
dorsal ectoderm
parasegments visualized by regions of specific gene activity
Head
Abdomen
prospective anterior gut endoderm
Thorax
ventral ectoderm
prospective posterior gut endoderm
mesoderm

The Dorsal Nuclear Gradient

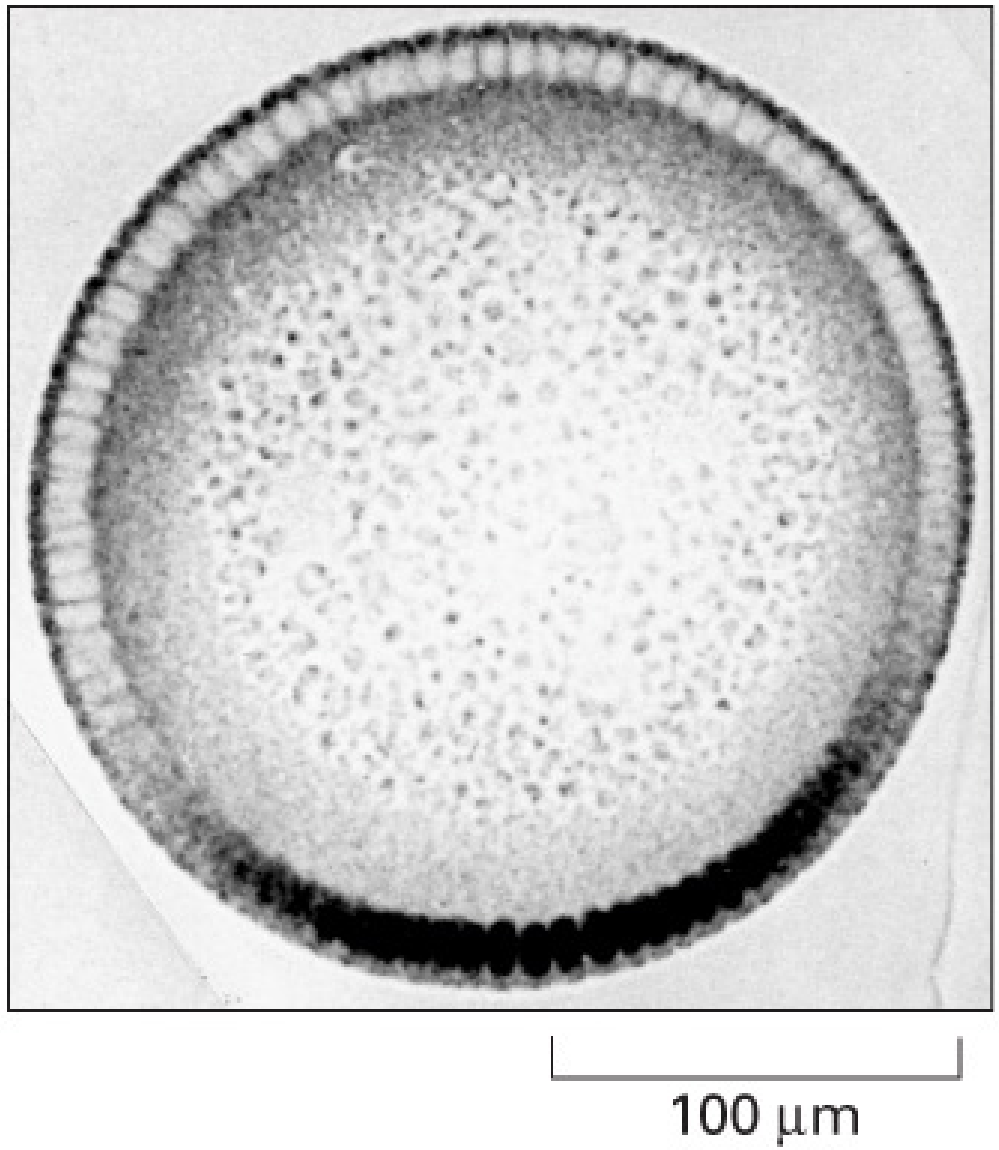


Figure 21–32. Molecular Biology of the Cell, 4th Edition.

Problems with diffusion:

Pathway and diffusion constant - tortuous path makes diffusion constant some 5 times less

Reliability

Precision - robustness but…..

Making a gradient