VIEVKANANDA COLLEGE
THAKURPUKUR
KOLKATA-700063

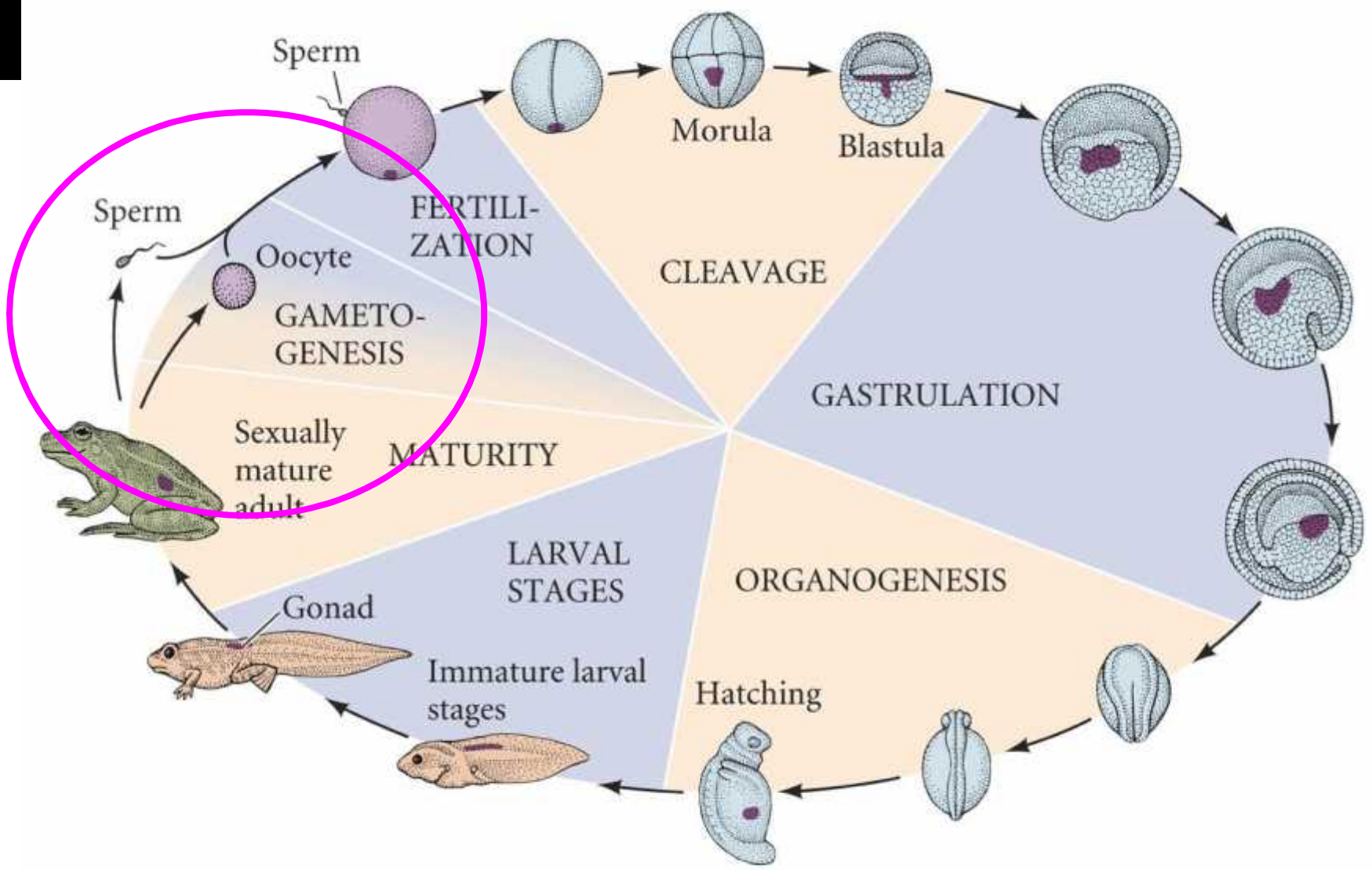
NAAC ACCREDITED A GRADE

- TOPIC :- Early embryonic development
- COURSE TITLE:- cc-2 Comparative….Dev.
- PAPER :-ZOOG- CC2 -2TH
- SEMESTER :-cc2 GE-2
- UNIT:- 6
- NAME OF THE TEACHER:- DR. TRIJIT NANDA
- NAME OF THE DEPARTMENT:- ZOOLOGY

Gametogenesis
(Germ cell specification and maturation)

- Germ line specification (g.l. stem cells first)
- Germ line migration to the gonads
- Meiosis
- Gamete maturation

Figure 2.1 *Developmental History of the Leopard Frog,* Rana pipiens



DEVELOPMENTAL BIOLOGY, Seventh Edition, Figure 2.1 Sinauer Associates, Inc.
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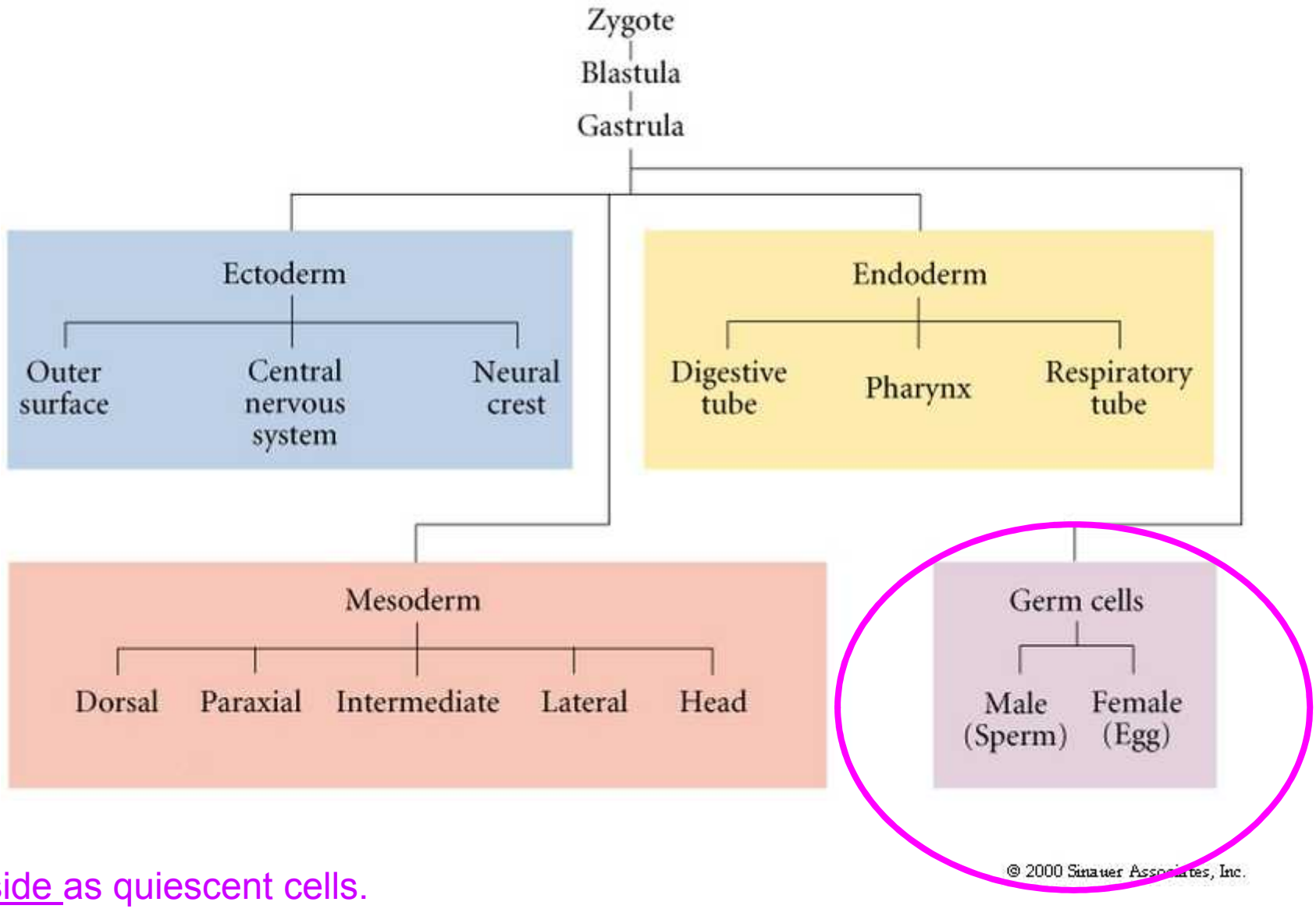
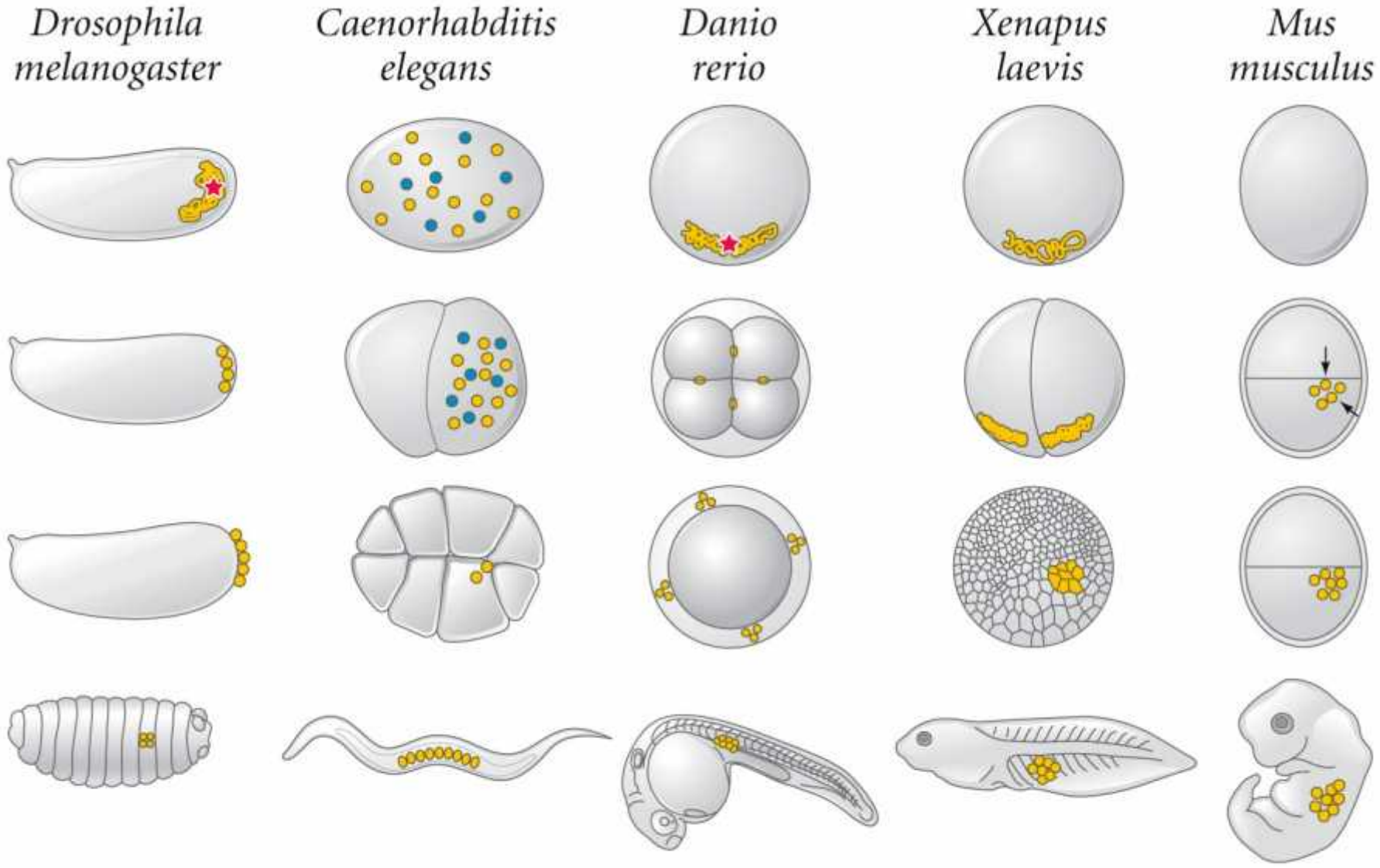
For All Bilaterians *(here, ecto-meso-endo specifics for tetrapods)*



Set aside as quiescent cells.

"Pole cells", with "pole plasm" Transcription & Diff. to Ecto Meso Endo blocked

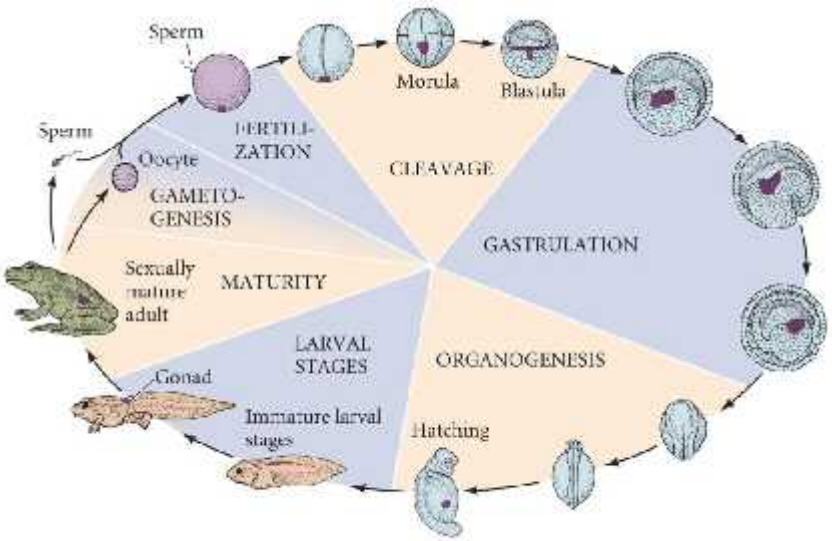
For All Bilaterians:



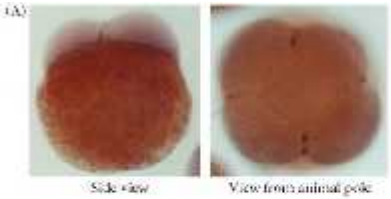
DEVELOPMENTAL BIOLOGY 10e, Figure 17.1

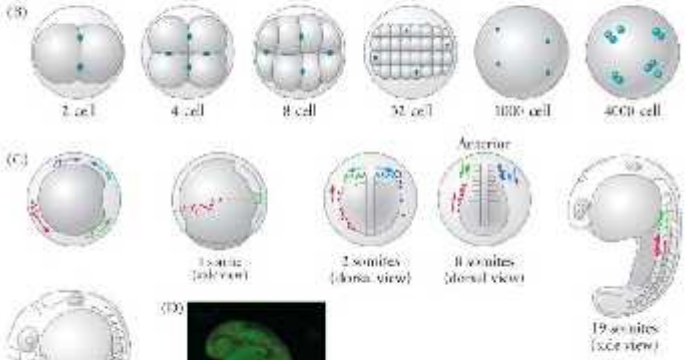
Set aside as quiescent cells. These express Vasa in all bilaterians & Nanos, Piwi . . .

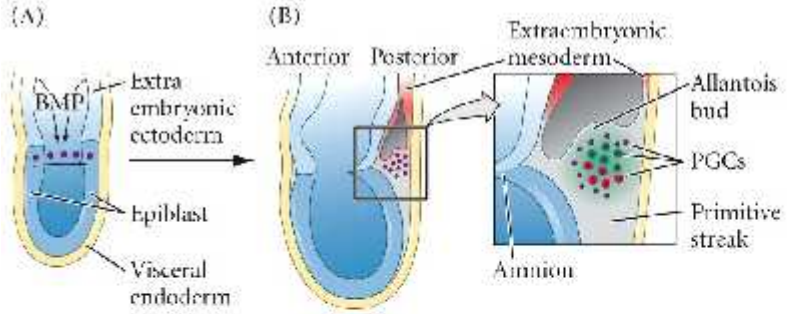
For All Bilaterians:

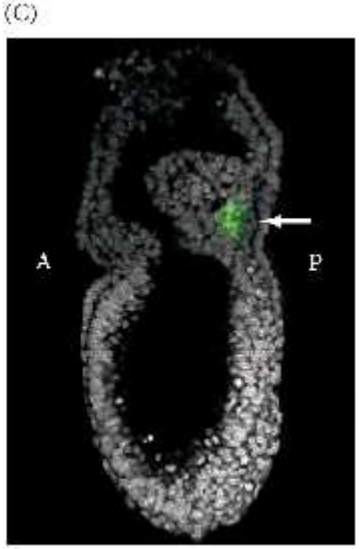


DEVELOPMENTAL BIOLOGY 10e, Figure 17.6

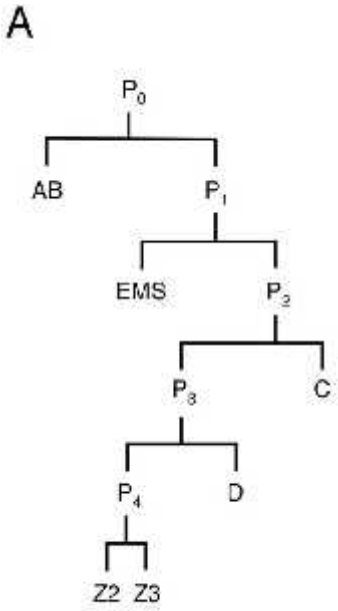


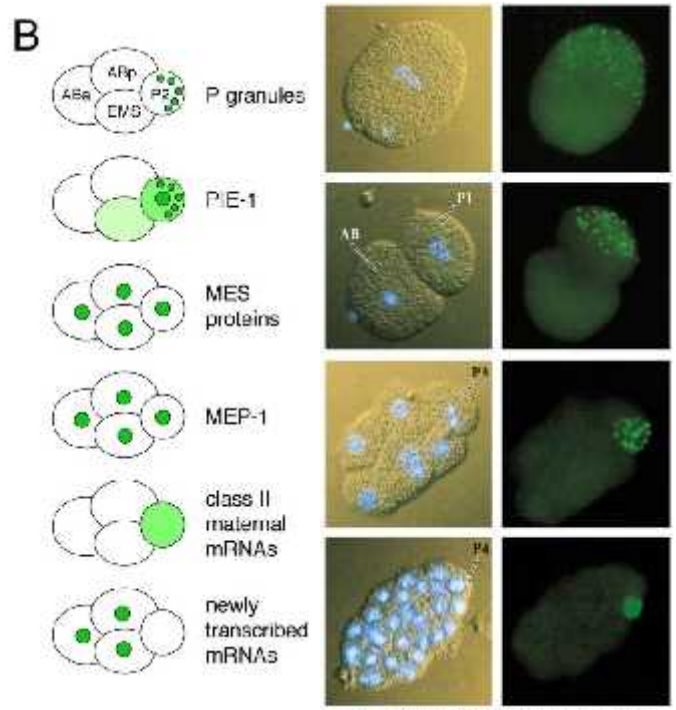


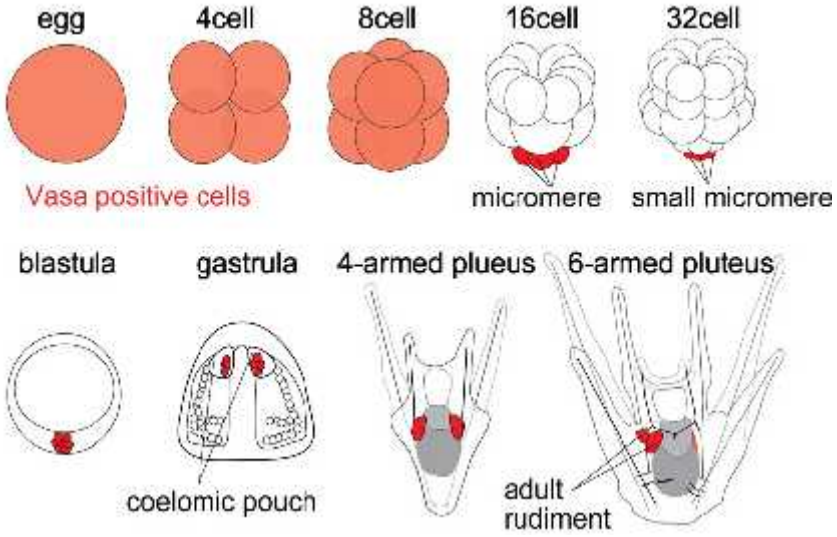


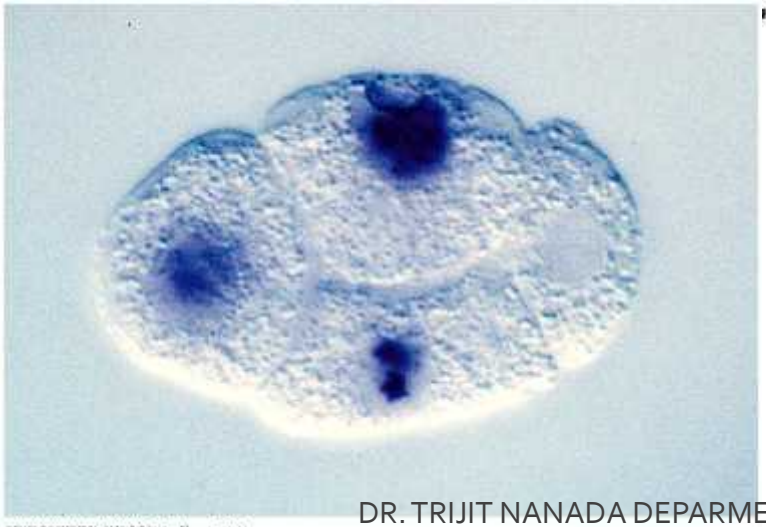


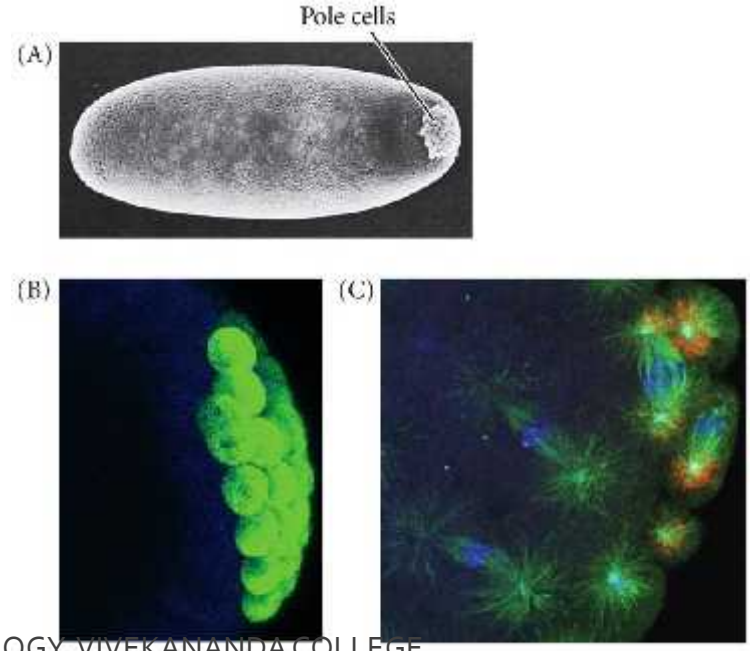
For All Bilaterians:







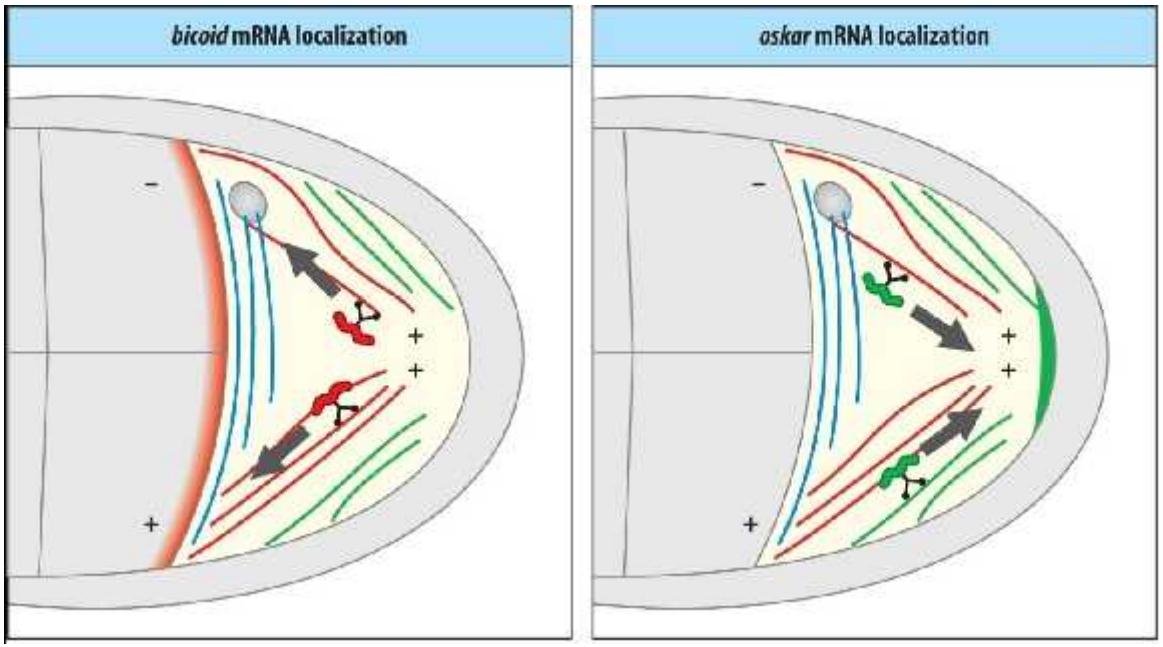




For All Bilaterians:

In addition ‘placement’ in the proper positions - -

These molecules are transported on microtubules (made of *Tubulin*) as *cargo* on molecular motors:



Dynenin: to -

Kinesin: to +

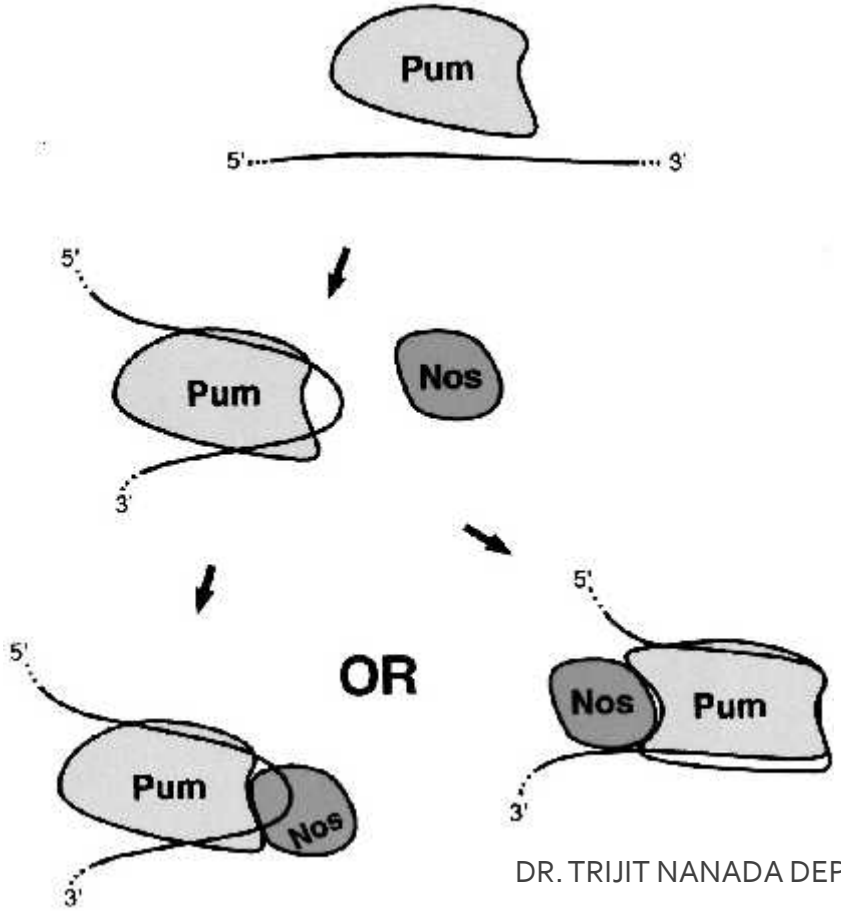
see Movies: Kinesin_Transport_Protein.MOV

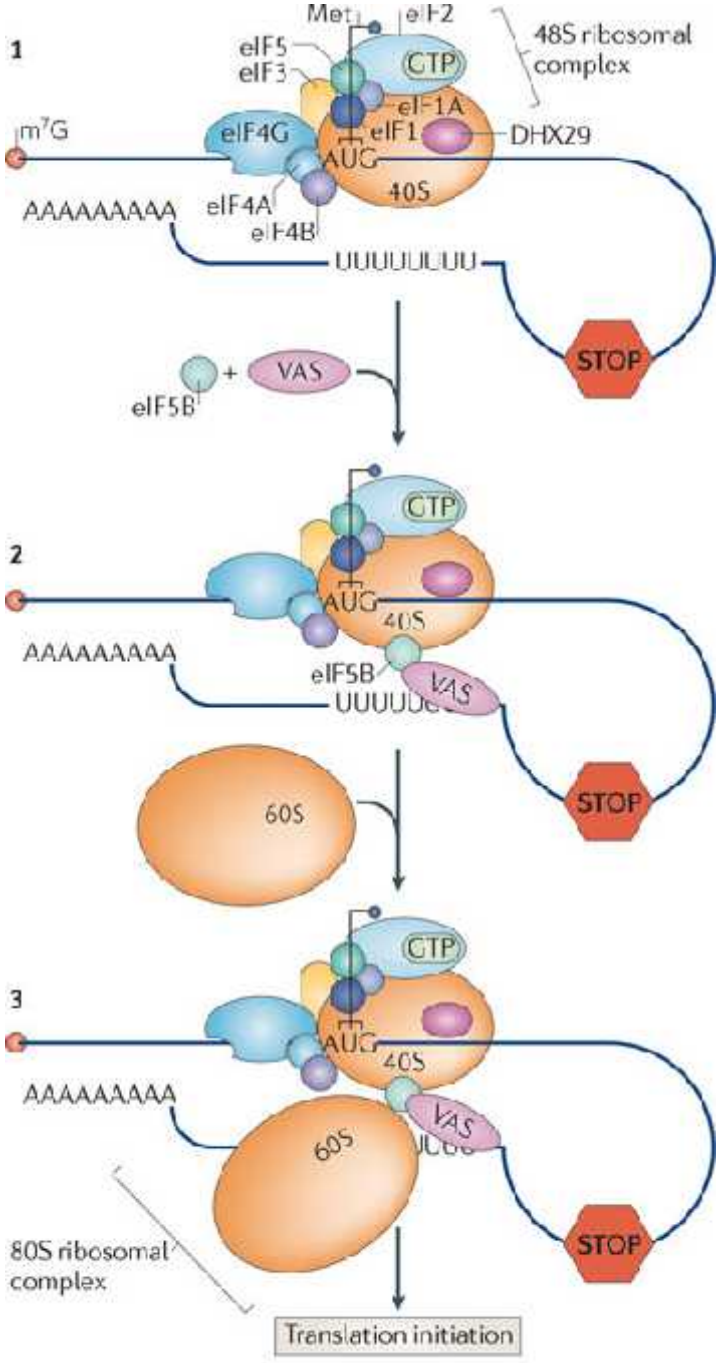
For All Bilaterians:

Vasa and Nanos-

RNA binding proteins

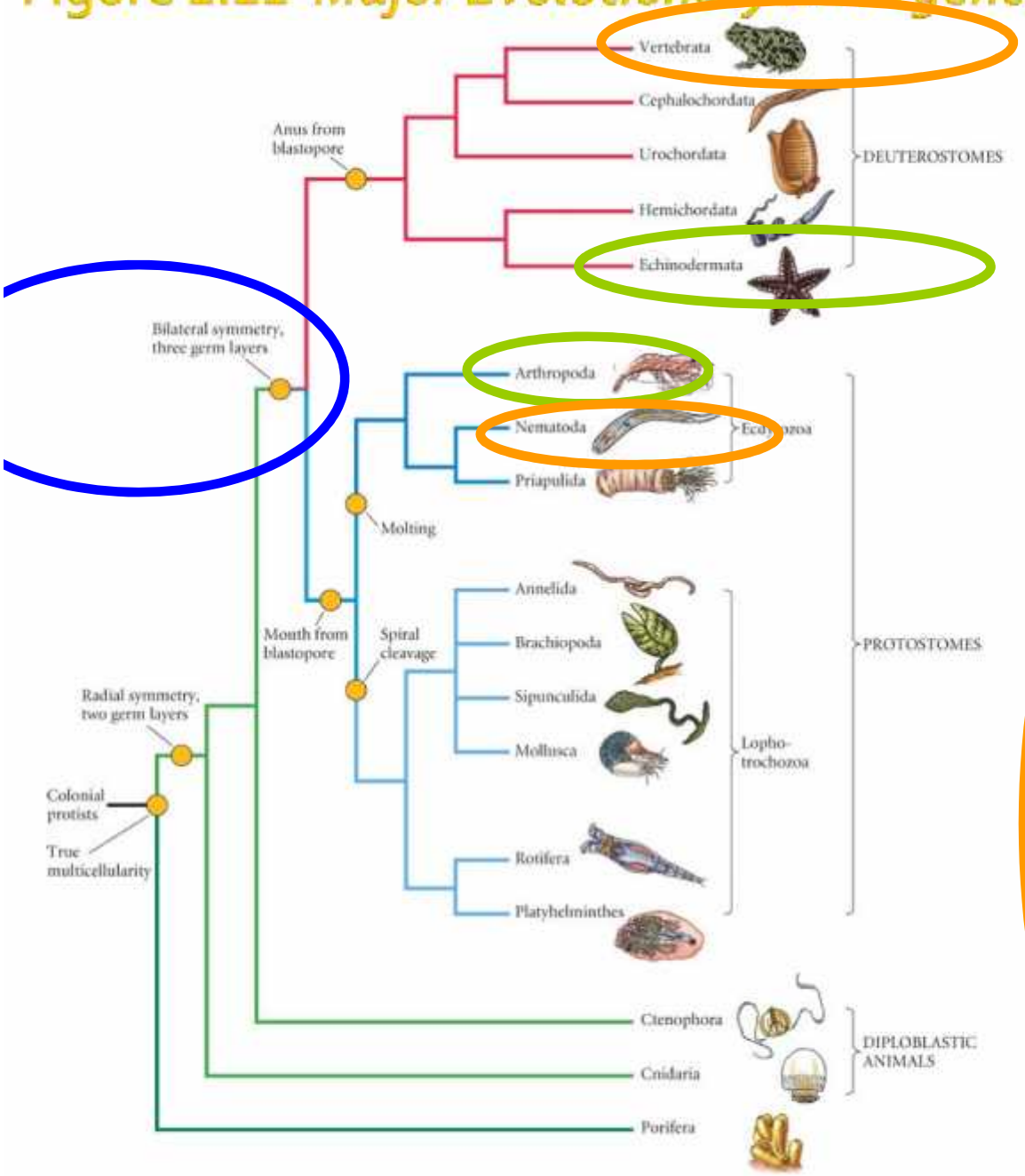
In flies and many others:

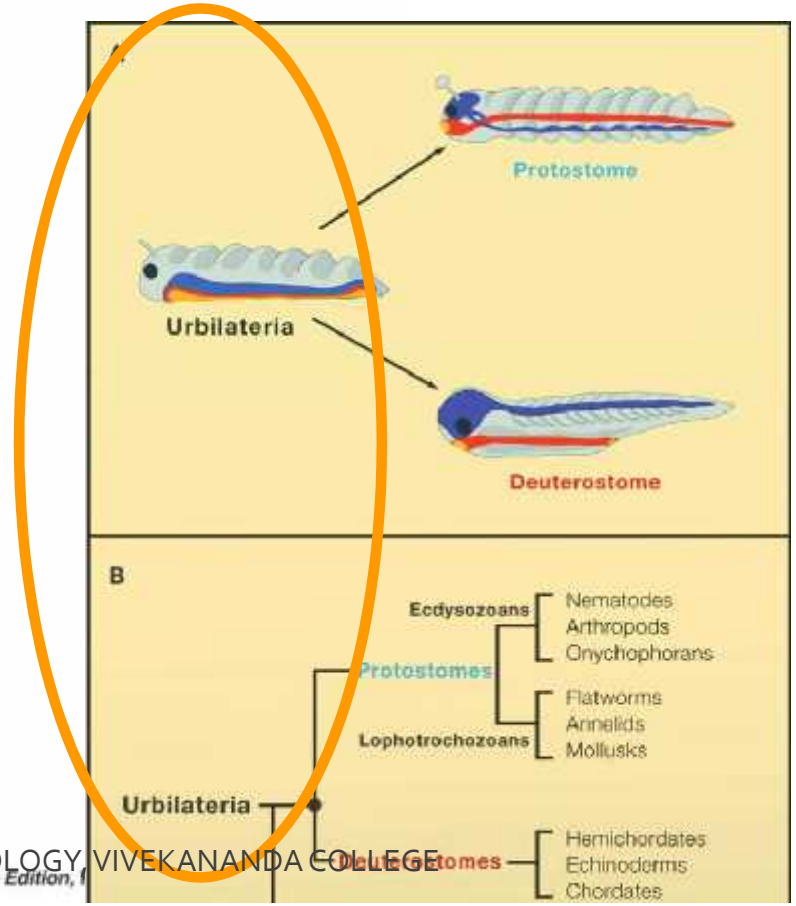




Nature Reviews | Molecular Cell Biology

Figure 2.21 Major Evolutionary Divergences in Extant Animals





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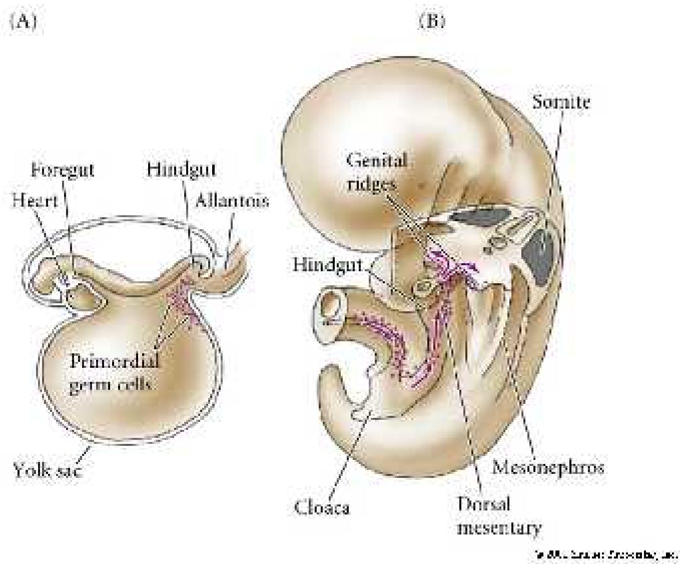
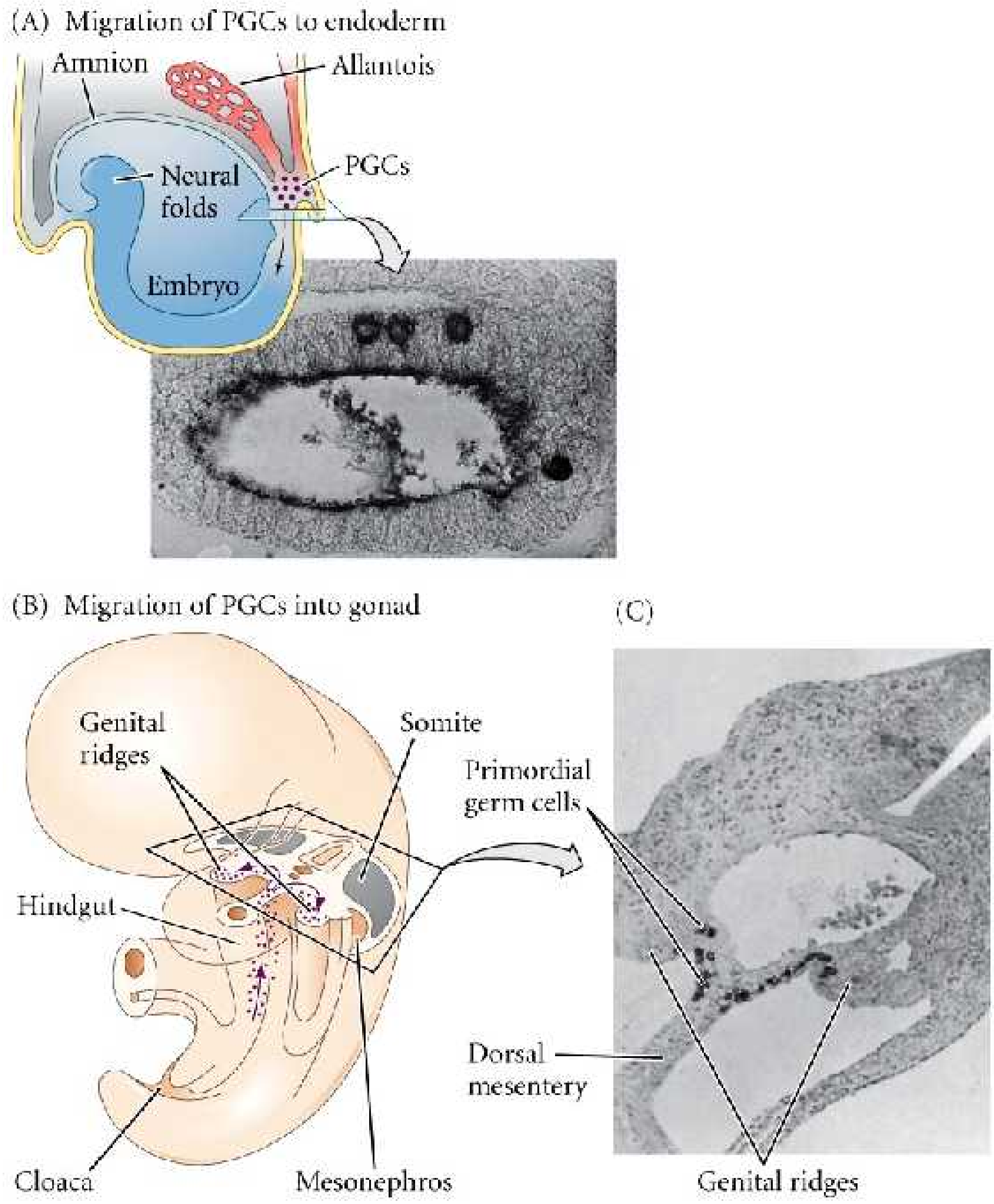
Gametogenesis
(Germ cell specification and maturation)

- Germ line specification (g.l. stem cells first)
- Germ line migration to the gonads
- Meiosis
- Gamete maturation

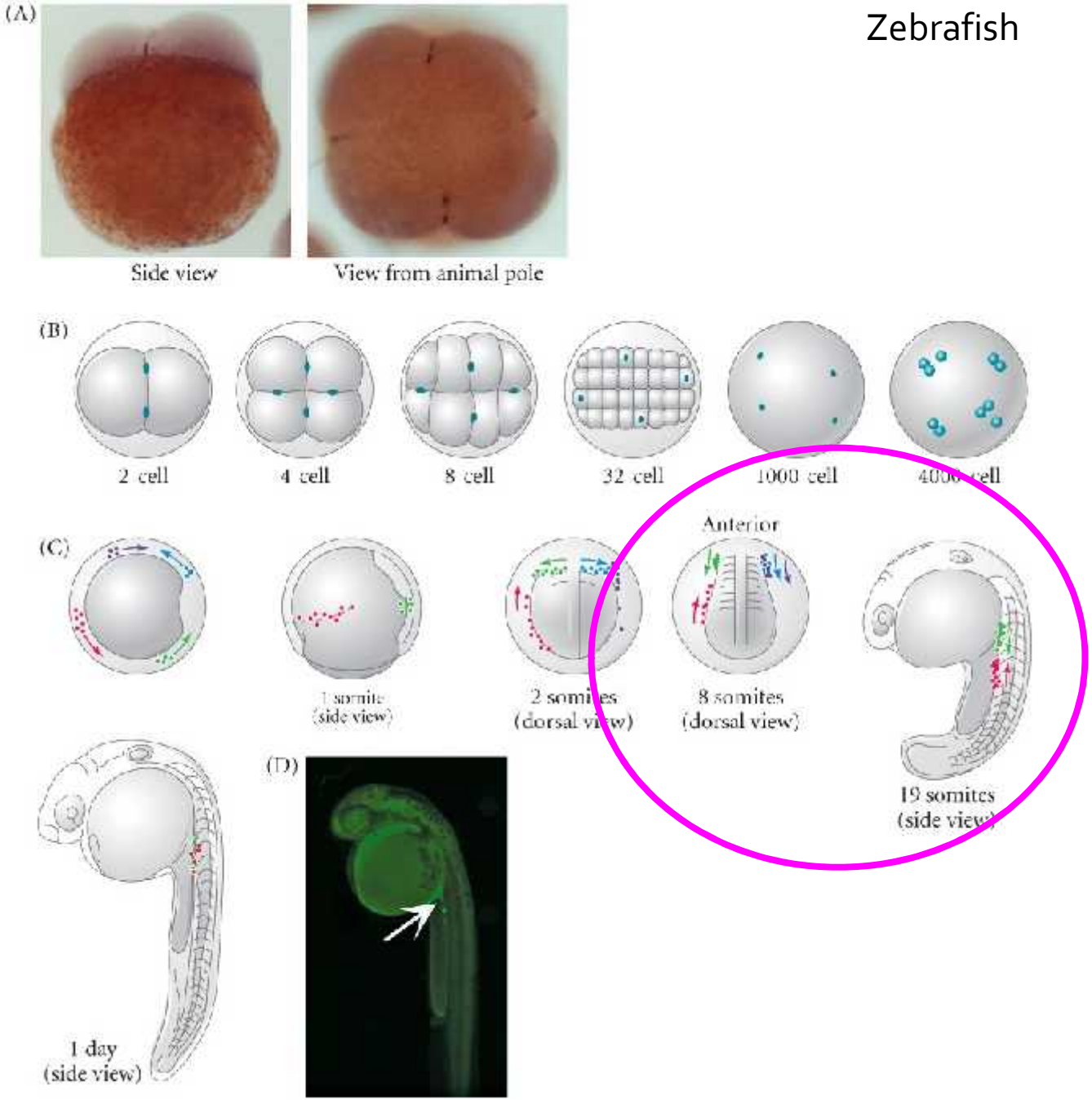
Mammalian





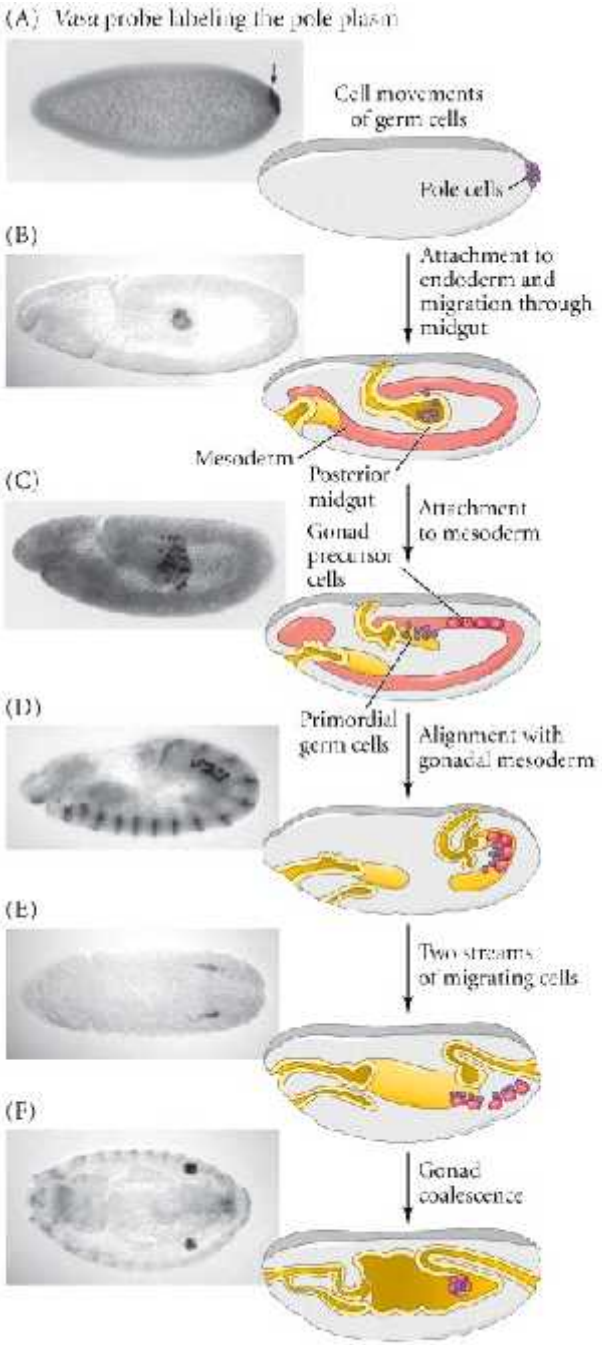
DEVELOPMENTAL BIOLOGY 10e, Figure 17.15

Zebrafish



DEVELOPMENTAL BIOLOGY 10e, Figure 17-13

Fruitfly *Drosophila melanogaster*



DEVELOPMENTAL BIOLOGY 10e, Figure 17.12

Gametogenesis (Germ cell specification and maturation)

- Germ line specification (g.l. stem cells first)
- Germ line migration to the gonads
- Meiosis

TABLE 17.2 Sexual dimorphism in mammalian meioses

Female oogenesis	Male spermatogenesis
Meiosis initiated once in a finite population of cells	Meiosis initiated continuously in a mitotically dividing stem cell population
One gamete produced per meiosis	Four gametes produced per meiosis
Completion of meiosis delayed for months or years	Meiosis completed in days or weeks
Meiosis arrested at first meiotic prophase and reinitiated in a smaller population of cells	Meiosis and differentiation proceed continuously without cell cycle arrest
Differentiation of gamete occurs while diploid, in first meiotic prophase	Differentiation of gamete occurs while haploid, after meiosis ends
All chromosomes exhibit equivalent transcription and recombination during meiotic prophase	Sex chromosomes excluded from recombination and transcription during first meiotic prophase

Source: After Handel and Eppig 1998.

***DEVELOPMENTAL BIOLOGY 10e*, Table 17.2**

Gametogenesis

oogenesis

spermatogenesis

After fertilization, the zygote will essentially be an activated egg

Frog oocyte

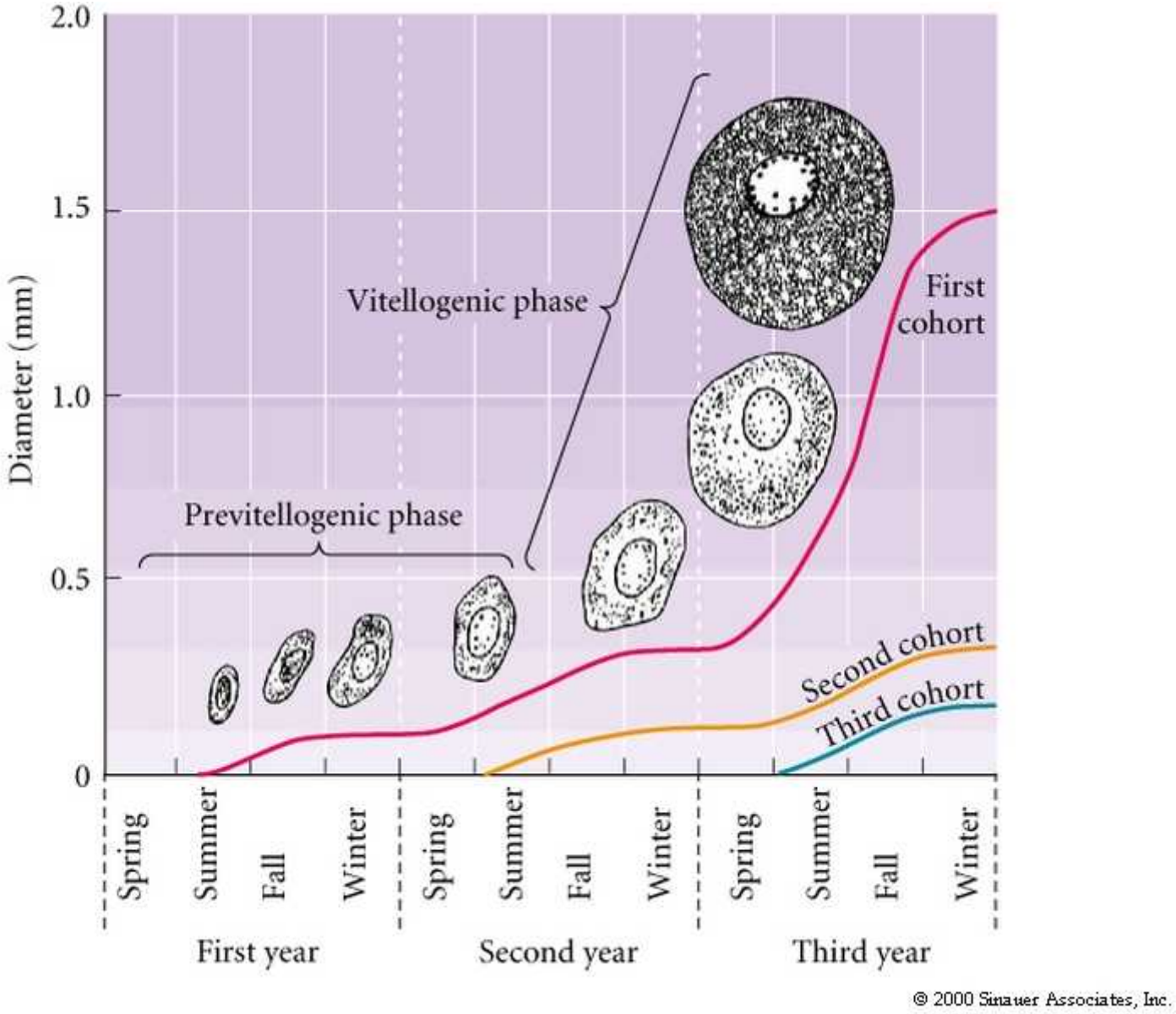

2.0
1.5
1.0
0.5
0
Diameter (mm)
Vitellogenic phase
Previtellogenic phase
First cohort
Second cohort
Third cohort
Spring
Summer
Fall
Winter
Spring
Summer
Fall
Winter
Spring
Summer
Fall
Winter
First year
Second year
Third year
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Table 19.2 Cellular components stored in the mature oocyte of *Xenopus Laevis*

Component	Approximate excess over amount in larval cells
Mitochondria	100,000
RNA polymerases	60,000- 100,000
DNA polymerases	100,000
Ribosomes	200,000
tRNA	10,000
Histones	15,000
Deoxyribonucleoside triphosphates	2,500

Note Yolk –vitellegenin –from liver

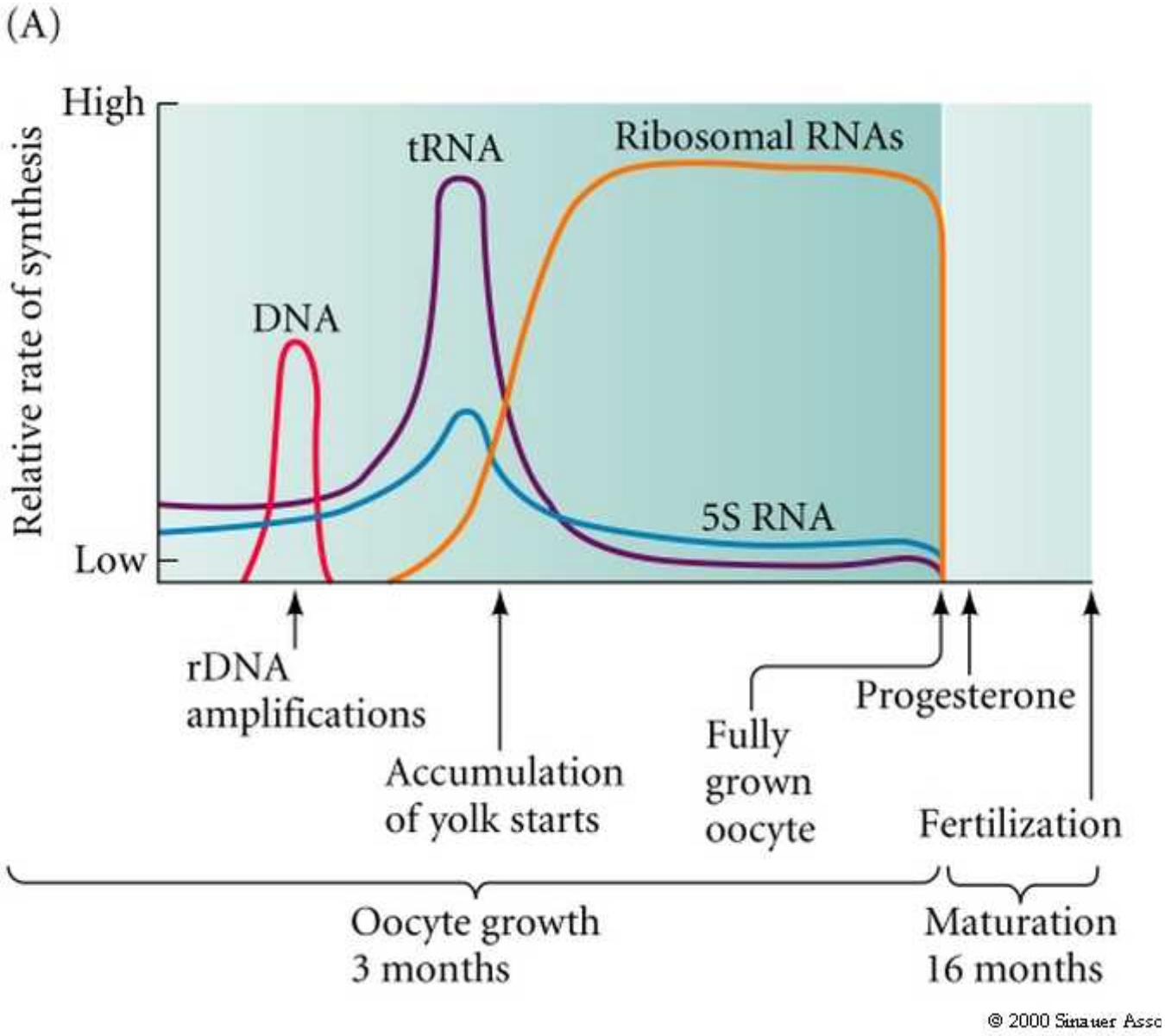
(A)
High
Low
Relative rate of synthesis
DNA
tRNA
Ribosomal RNAs
5S RNA
rDNA amplifications
Accumulation of yolk starts
Fully grown oocyte
Progesterone
Fertilization
Oocyte growth 3 months
Maturation 16 months
© 2000 Sinauer Asso

Table 19.2 Cellular components stored in the mature oocyte of Xenopus Laevis

Component	Approximate excess over amount in larval cells
Mitochondria	100,000
RNA polymerases	60,000- 100,000
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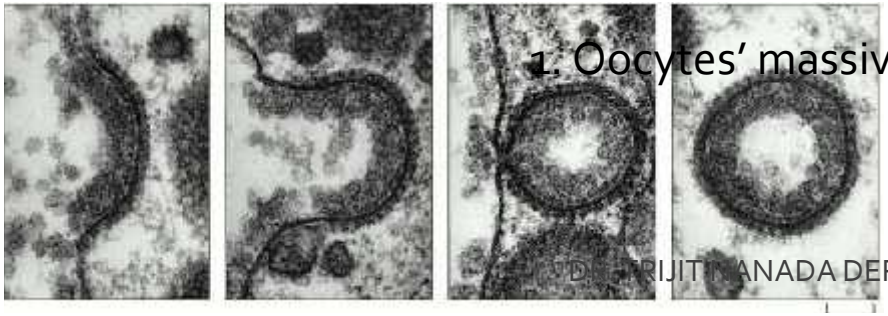
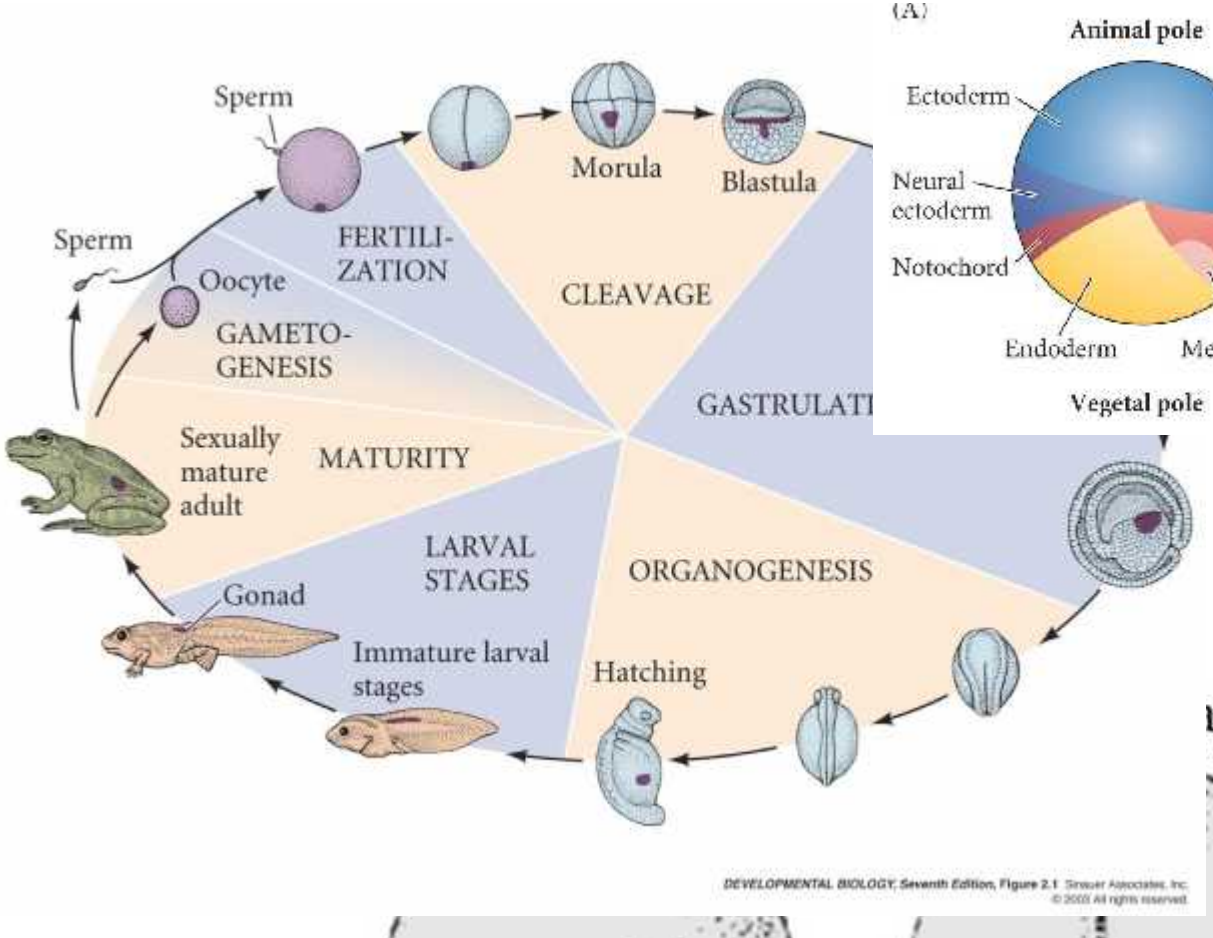
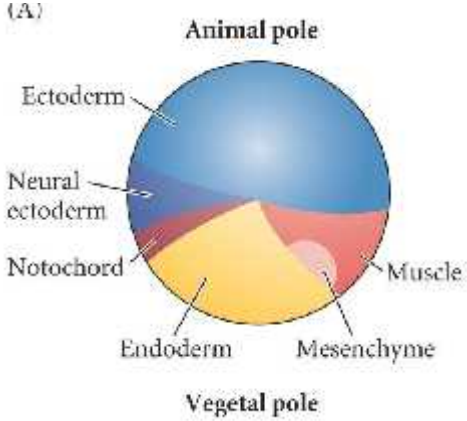
Ribosomes	200,000
tRNA	10,000
Histones	15,000
Deoxyribonucleoside triphosphates	2,500
	Yolk –vitellegenin FROM LIVER

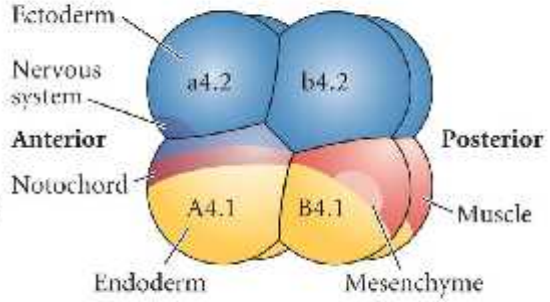


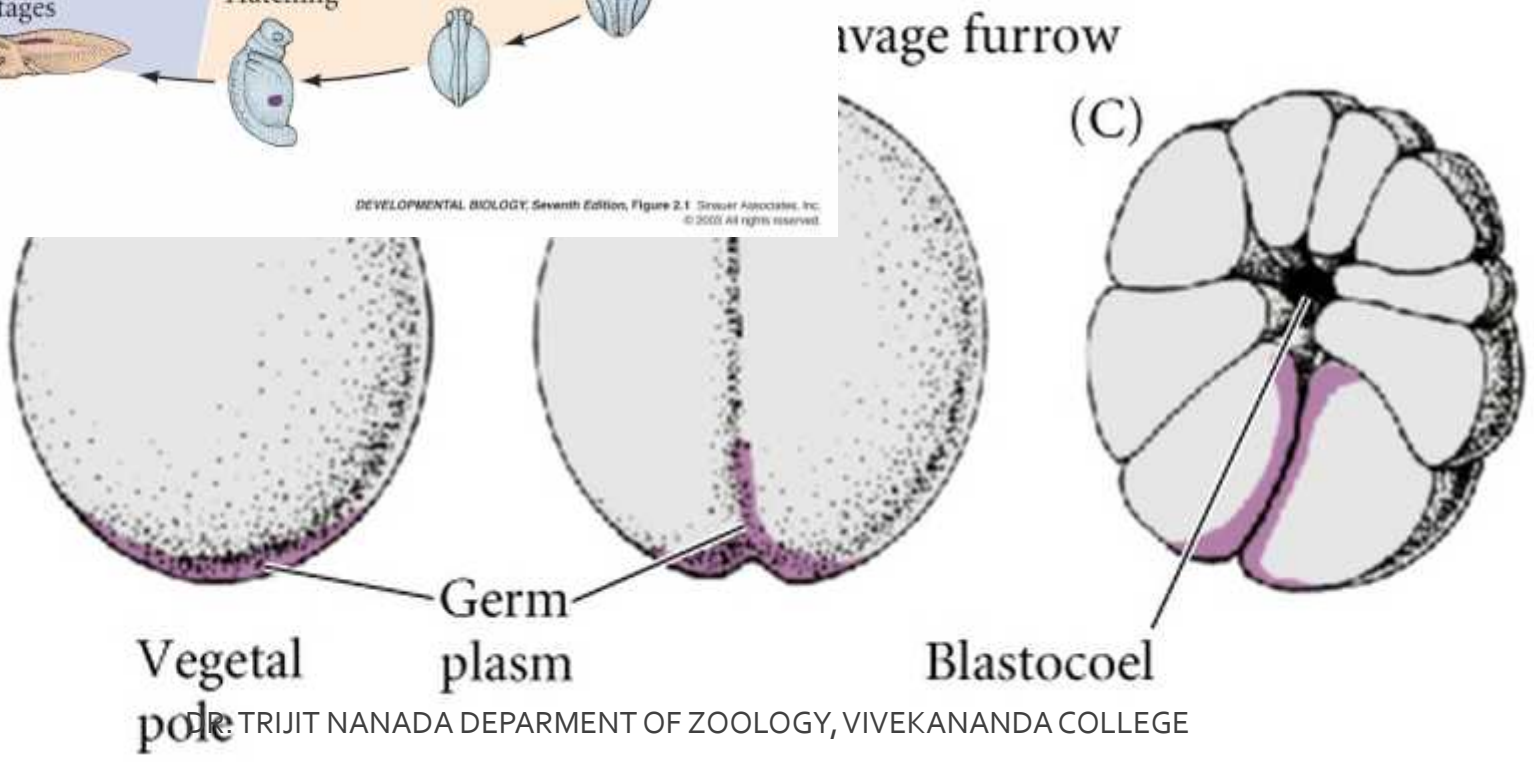
1. Oocytes' massive bio-synthesis of macromolecules

2. Micro-pinocytosis –
vesicle delivery from other cells

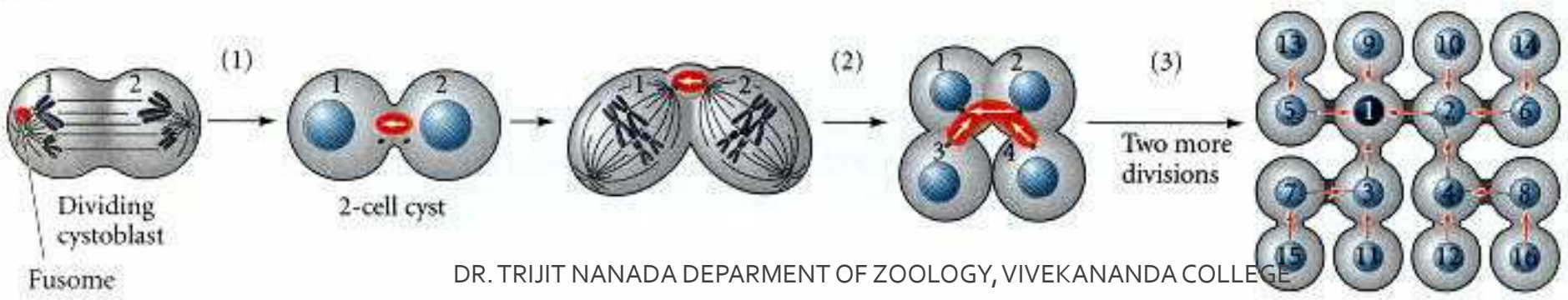

Sperm
Sperm
Oocyte
FERTILI-
ZATION
GAMETO-
GENESIS
Morula
Blastula
CLEAVAGE
GASTRULATI
Sexually
mature
adult
MATURITY
LARVAL
STAGES
ORGANOGENESIS
Gonad
Immature larval
stages
Hatching
DEVELOPMENTAL BIOLOGY, Seventh Edition, Figure 2.1 Sinauer Associates, Inc.


(A)
Animal pole
Ectoderm
Neural
ectoderm
Notochord
Muscle
Endoderm
Mesenchyme
Vegetal pole


Ectoderm
Nervous
system
a4.2
b4.2
Anterior
Posterior
Notochord
A4.1
B4.1
Muscle
Endoderm
Mesenchyme

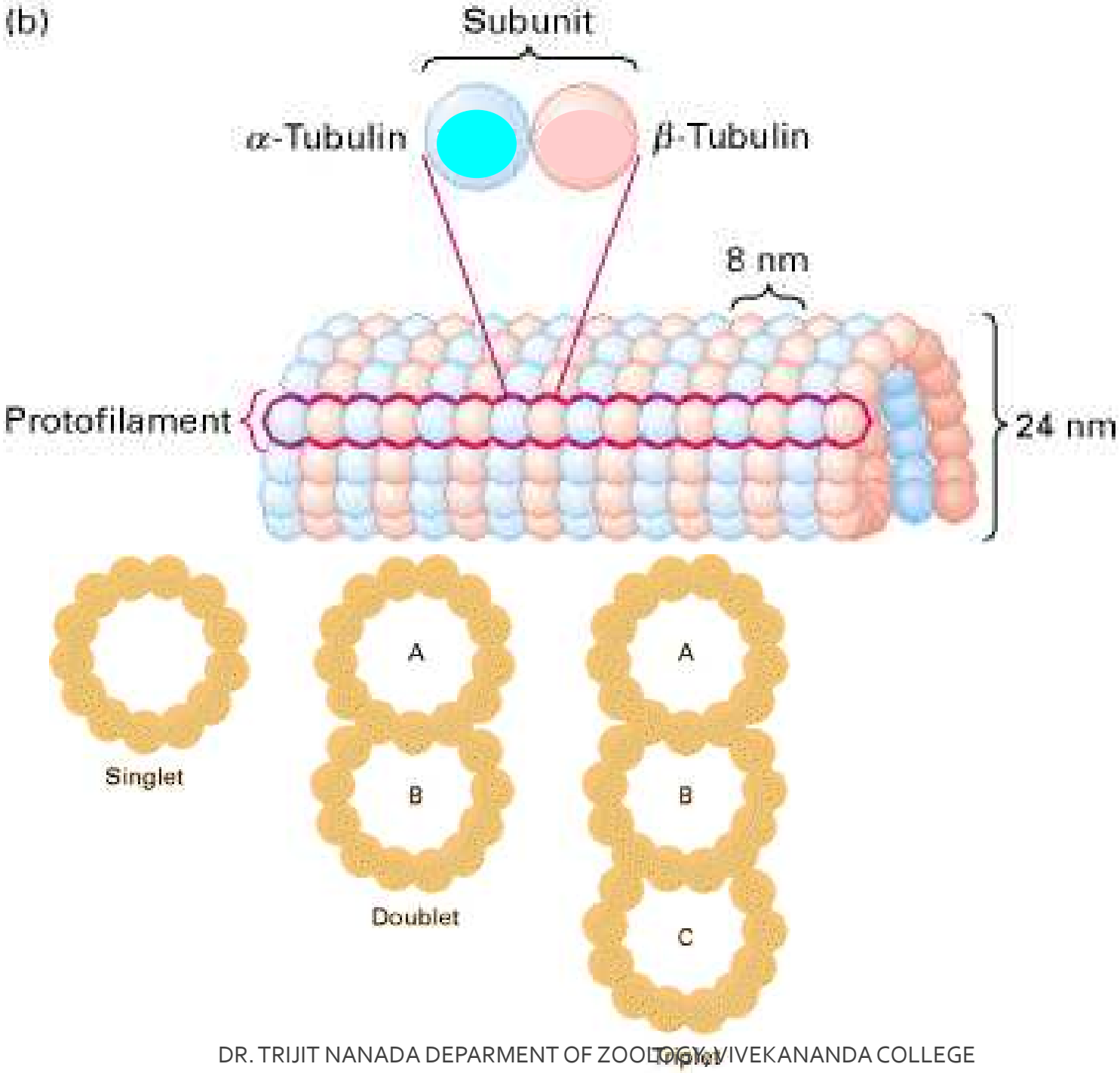

ıvage furrow
(C)
Germ
plasm
Vegetal
pole
Blastocoel

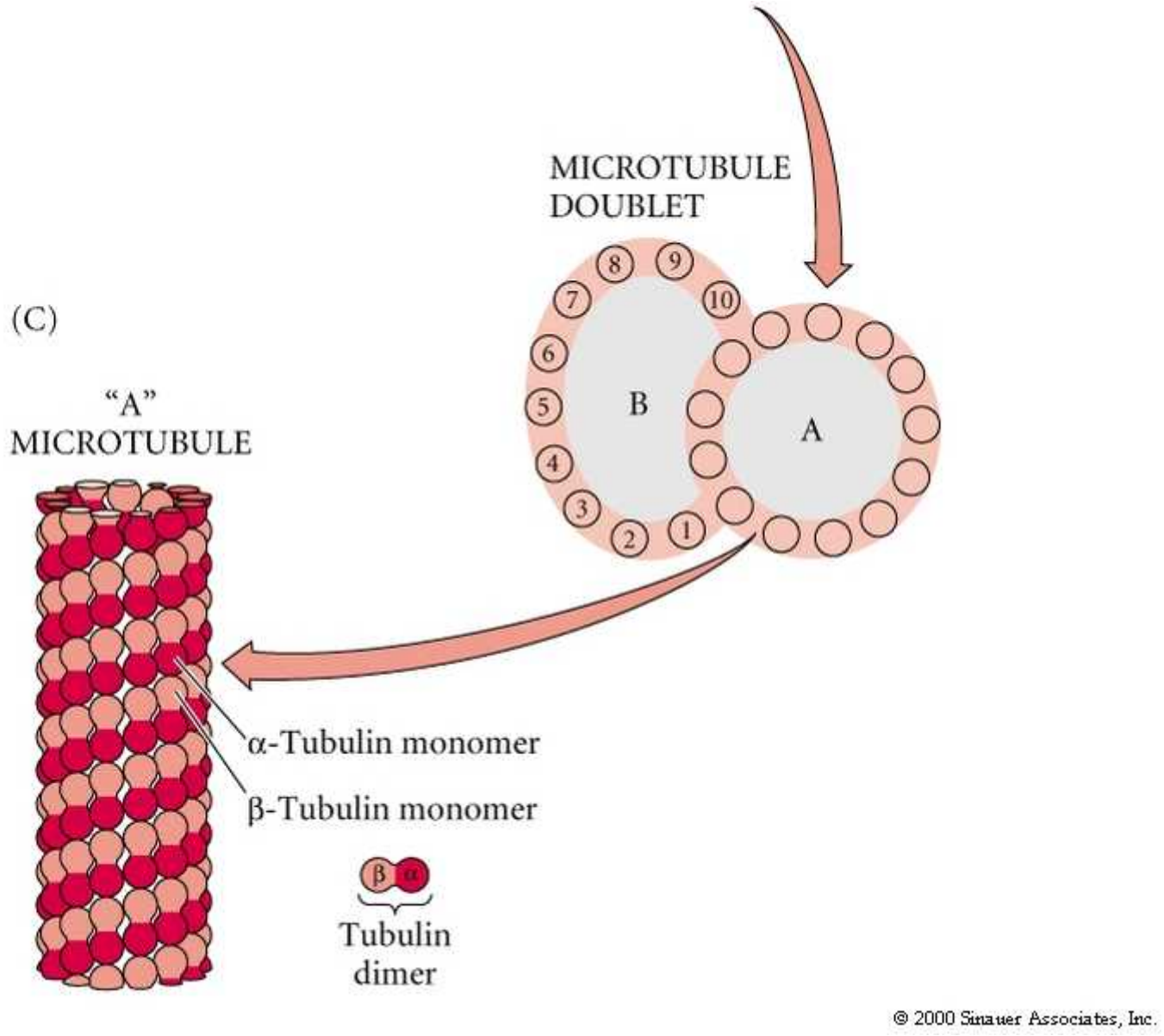
Fruitfly *Drosophila melanogaster*



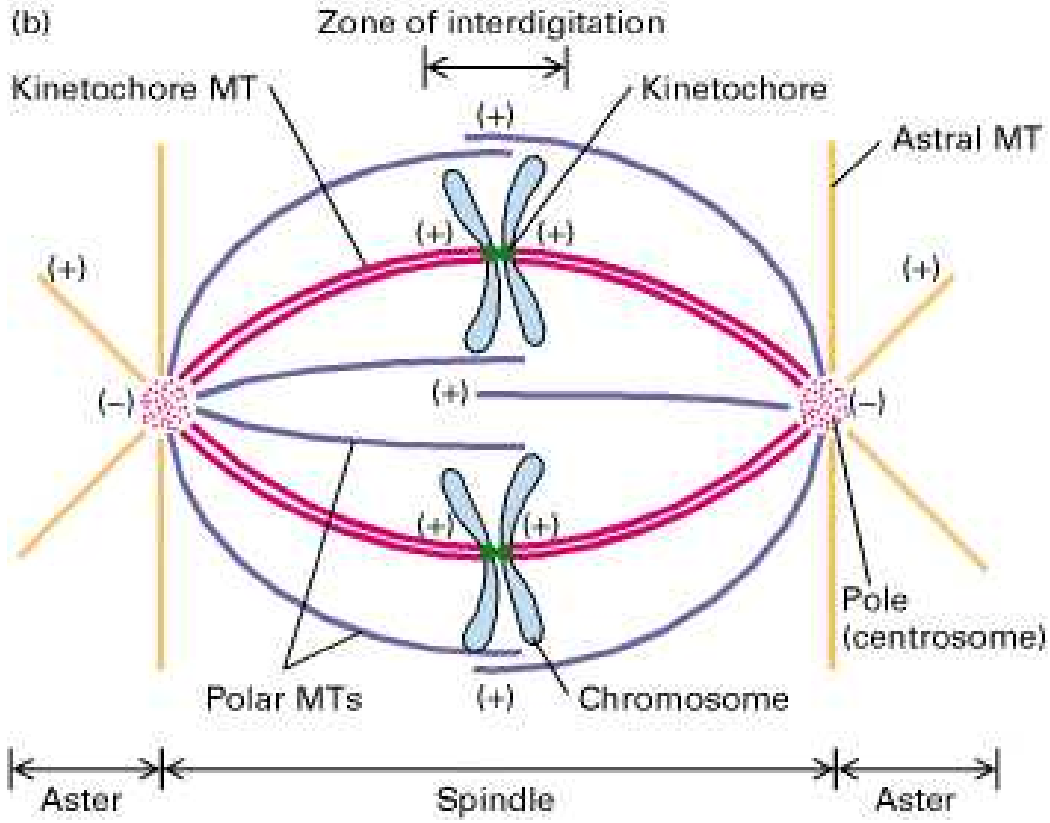
Gametogenesis/Fertilization Unit

OPPORTUNITY TO FOCUS ON MICROTUBULES


(b)
Subunit
α-Tubulin
β-Tubulin
8 nm
Protofilament
24 nm
A
B
Singlet
Doublet
A
B
C
Triplet

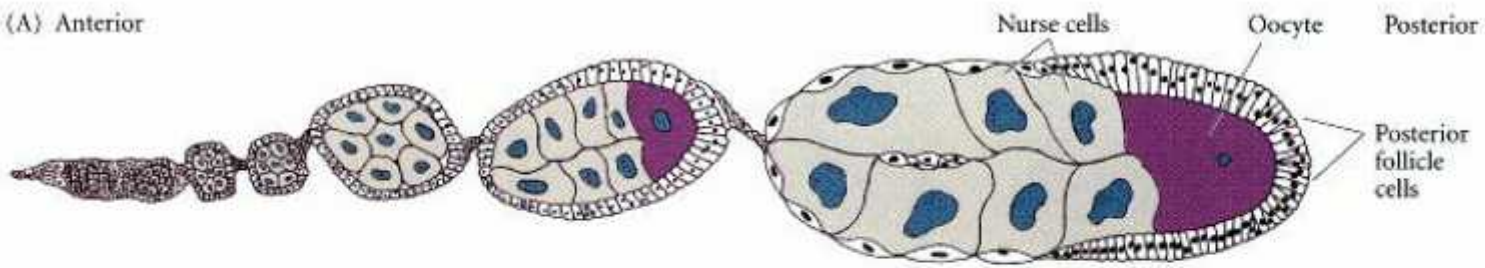

MICROTUBULE
DOUBLET
(C)
"A"
MICROTUBULE
B
A
1
2
3
4
5
6
7
8
9
10
α-Tubulin monomer
β-Tubulin monomer
β
α
Tubulin
dimer
© 2000 Sinauer Associates, Inc.

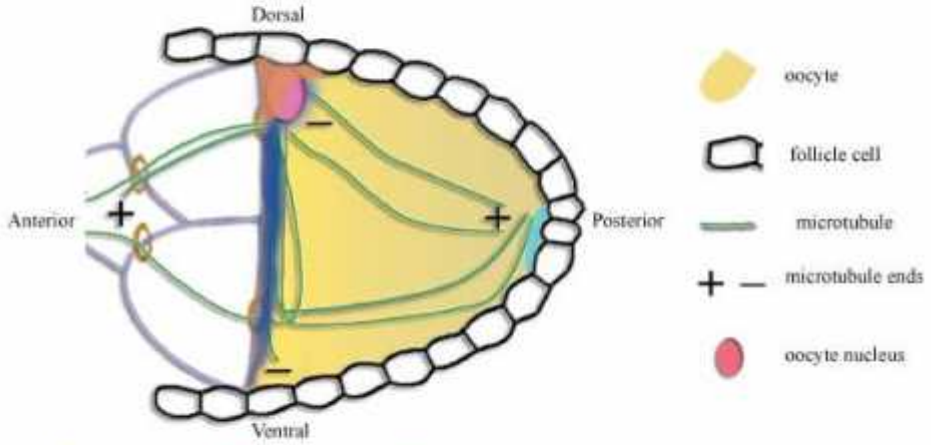
Microtubles in mitosis/meiosis

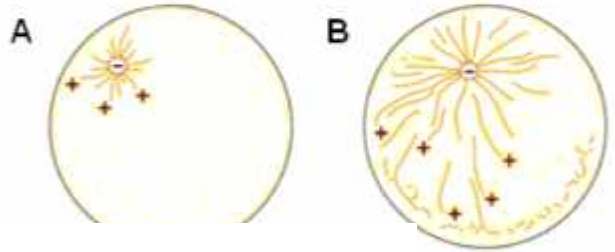


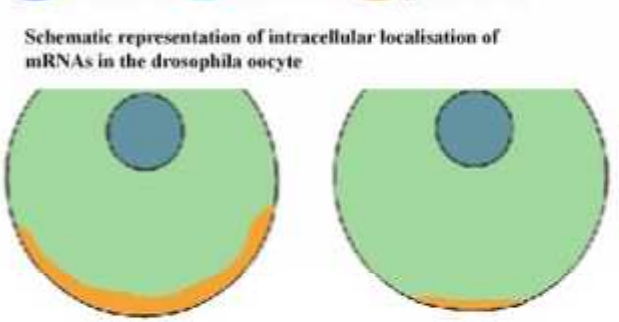
Microtubles in oogenesis, creating assymetry in cytoplasm

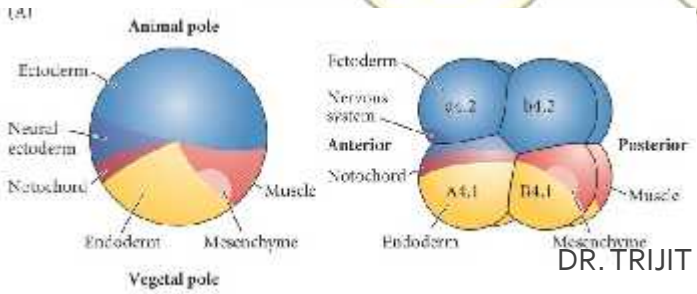
Transport via Microtubules- Assymetric placement of cytoplasmic components (RNA)











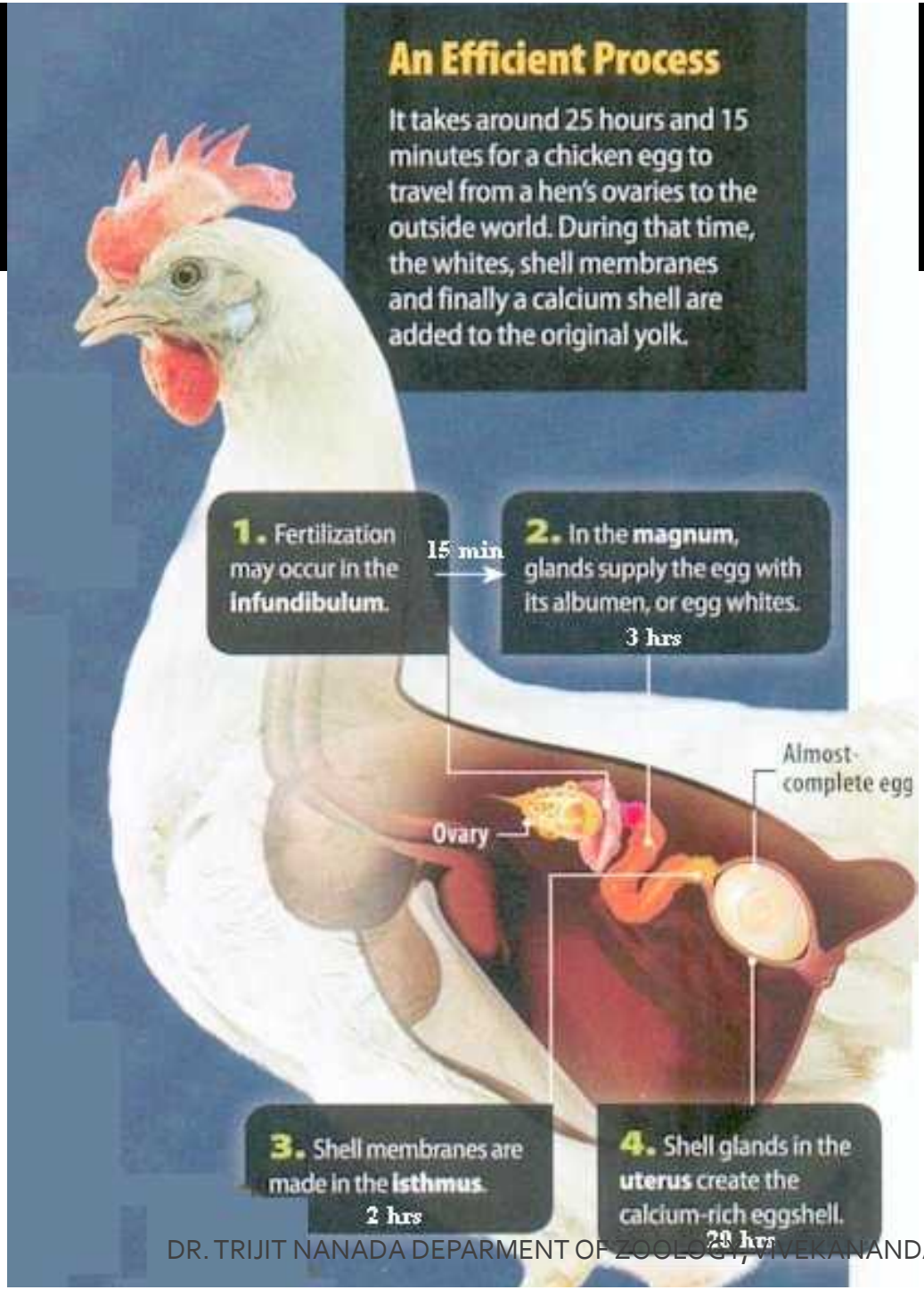
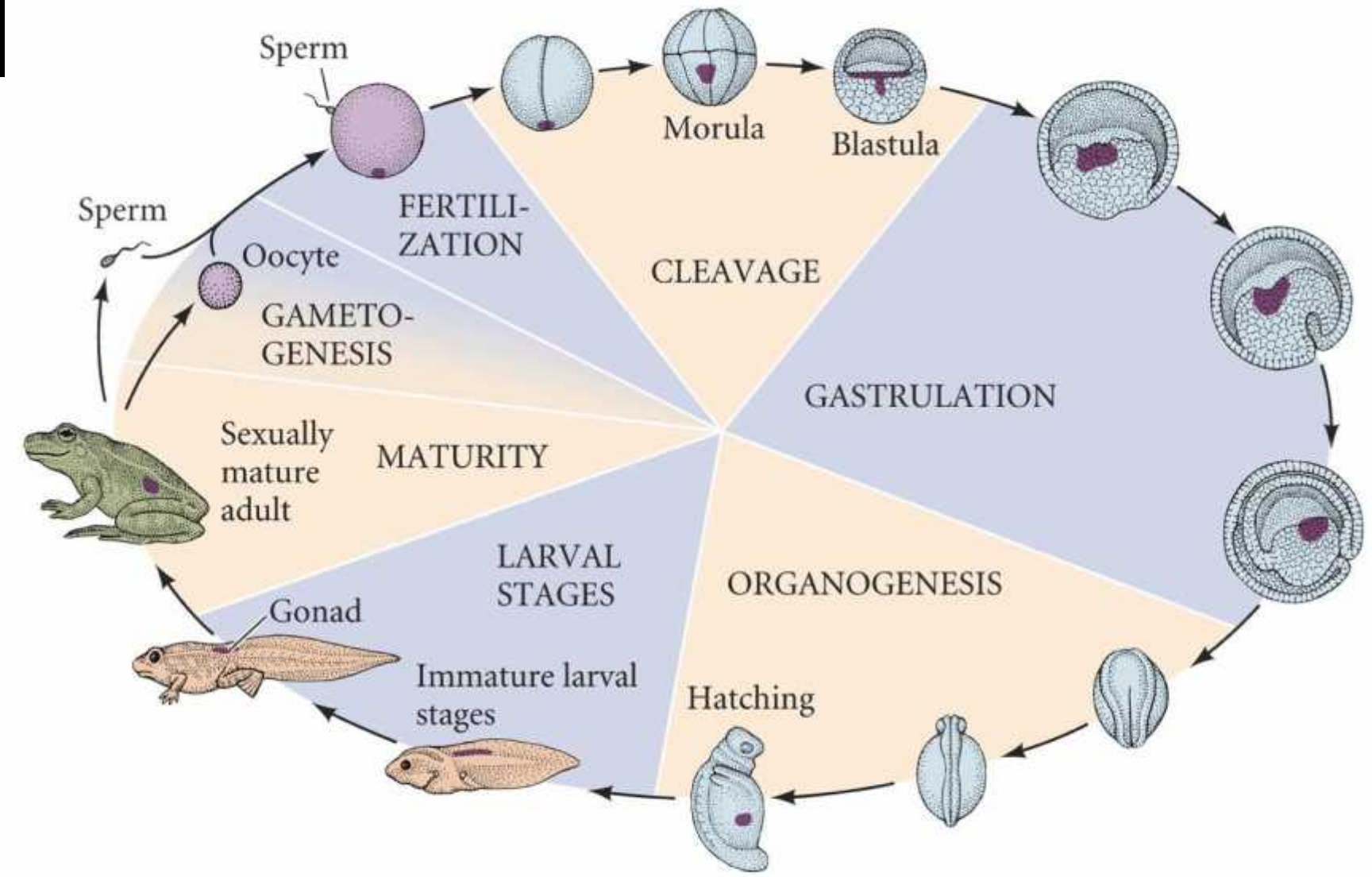

An Efficient Process
It takes around 25 hours and 15 minutes for a chicken egg to travel from a hen's ovaries to the outside world. During that time, the whites, shell membranes and finally a calcium shell are added to the original yolk.
1. Fertilization may occur in the infundibulum.
15 min
2. In the magnum, glands supply the egg with its albumen, or egg whites.
3 hrs
Almost-complete egg
Ovary
3. Shell membranes are made in the isthmus.
2 hrs
4. Shell glands in the uterus create the calcium-rich eggshell.
20 hrs

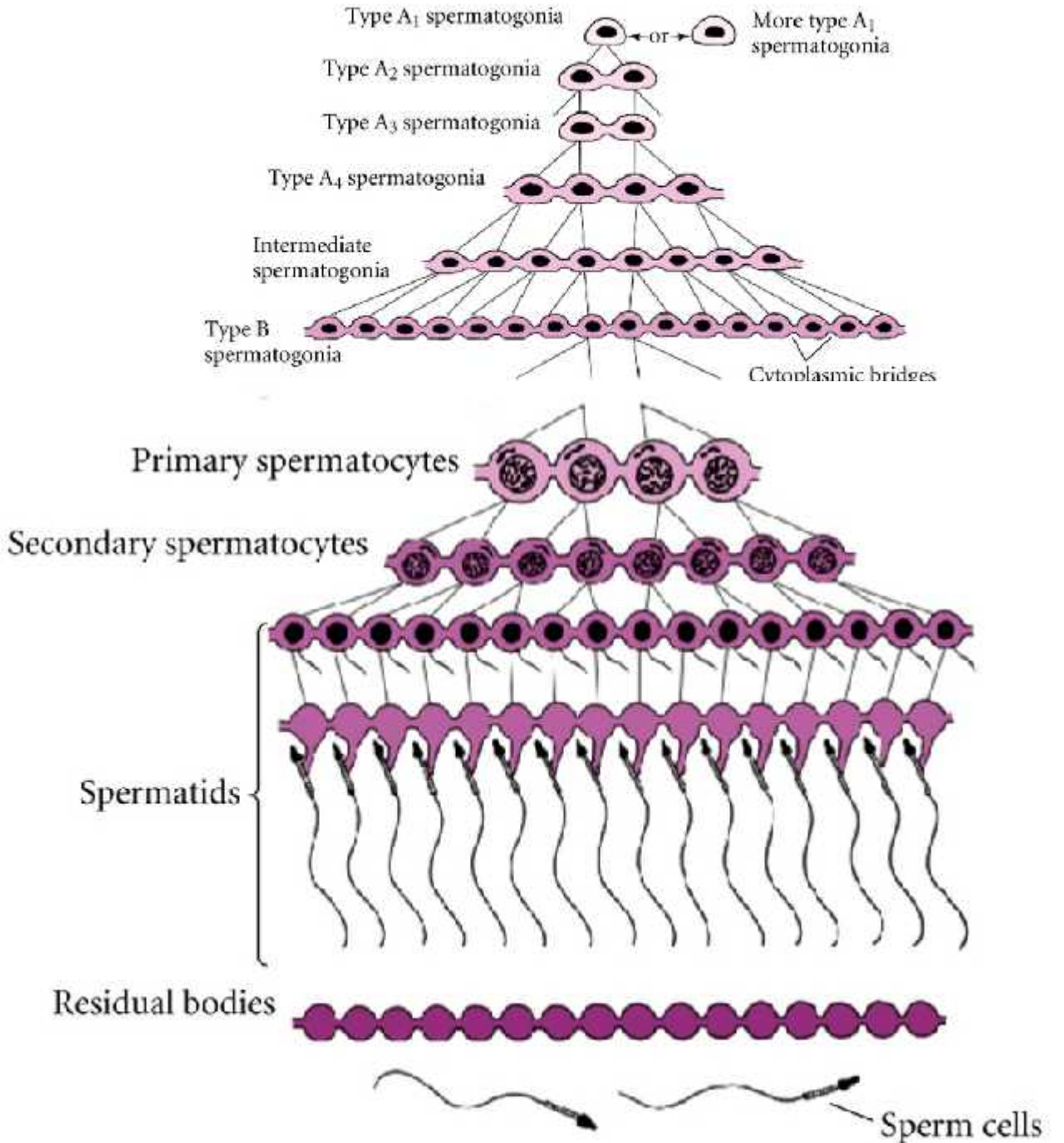
Figure 2.1 *Developmental History of the Leopard Frog,* Rana pipiens



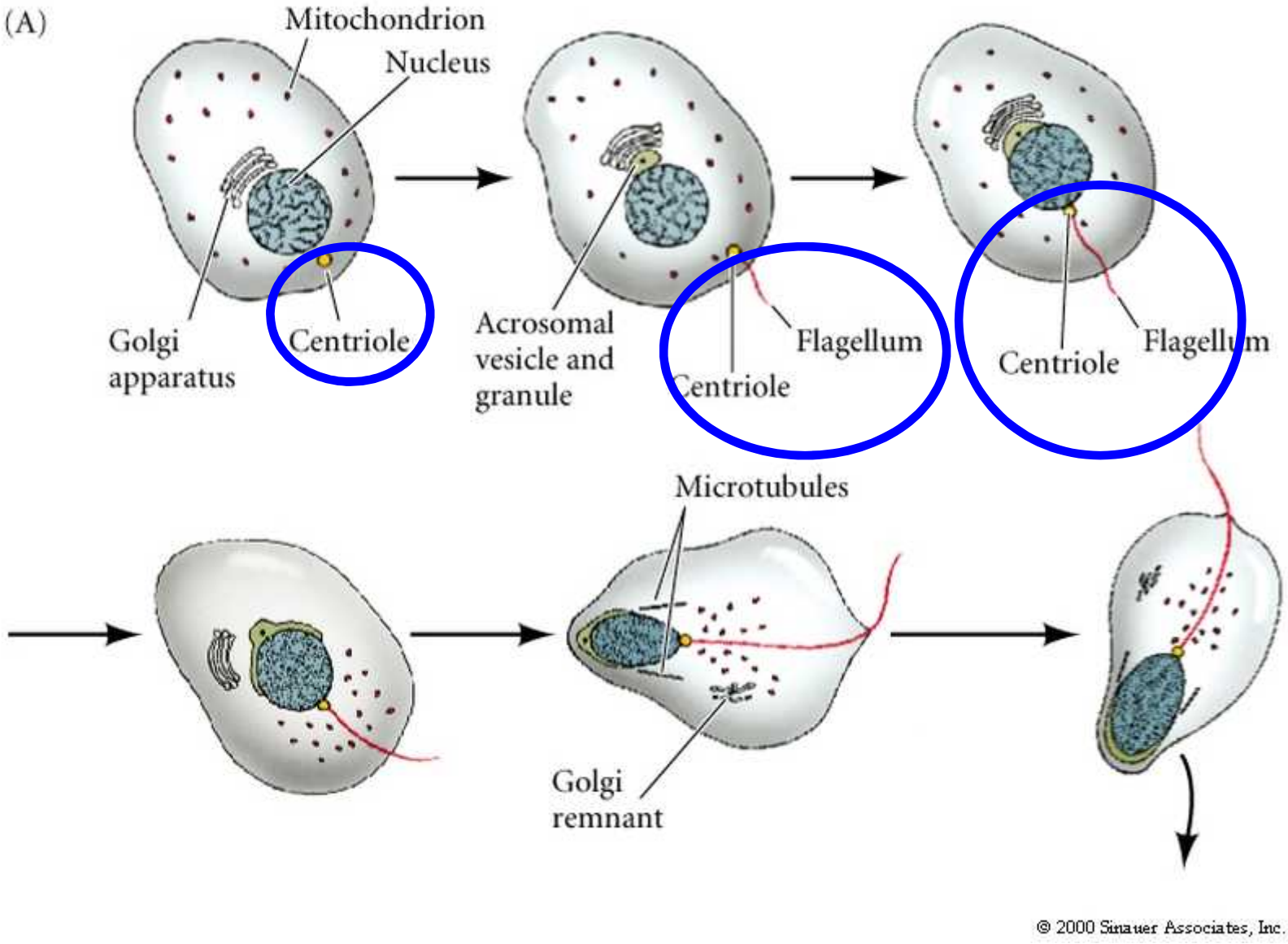
Gametogenesis

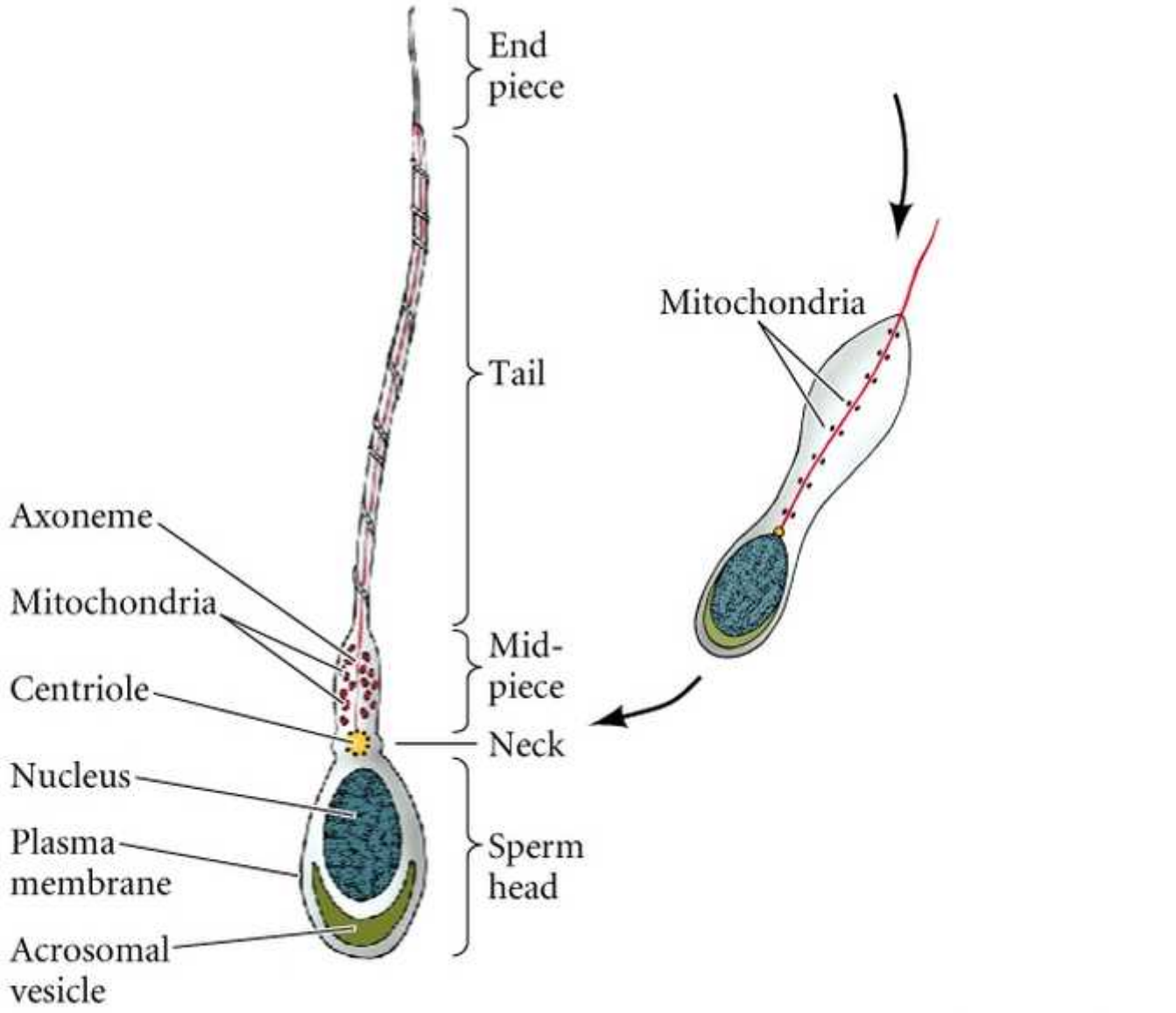
spermatogenesis

oogenesis

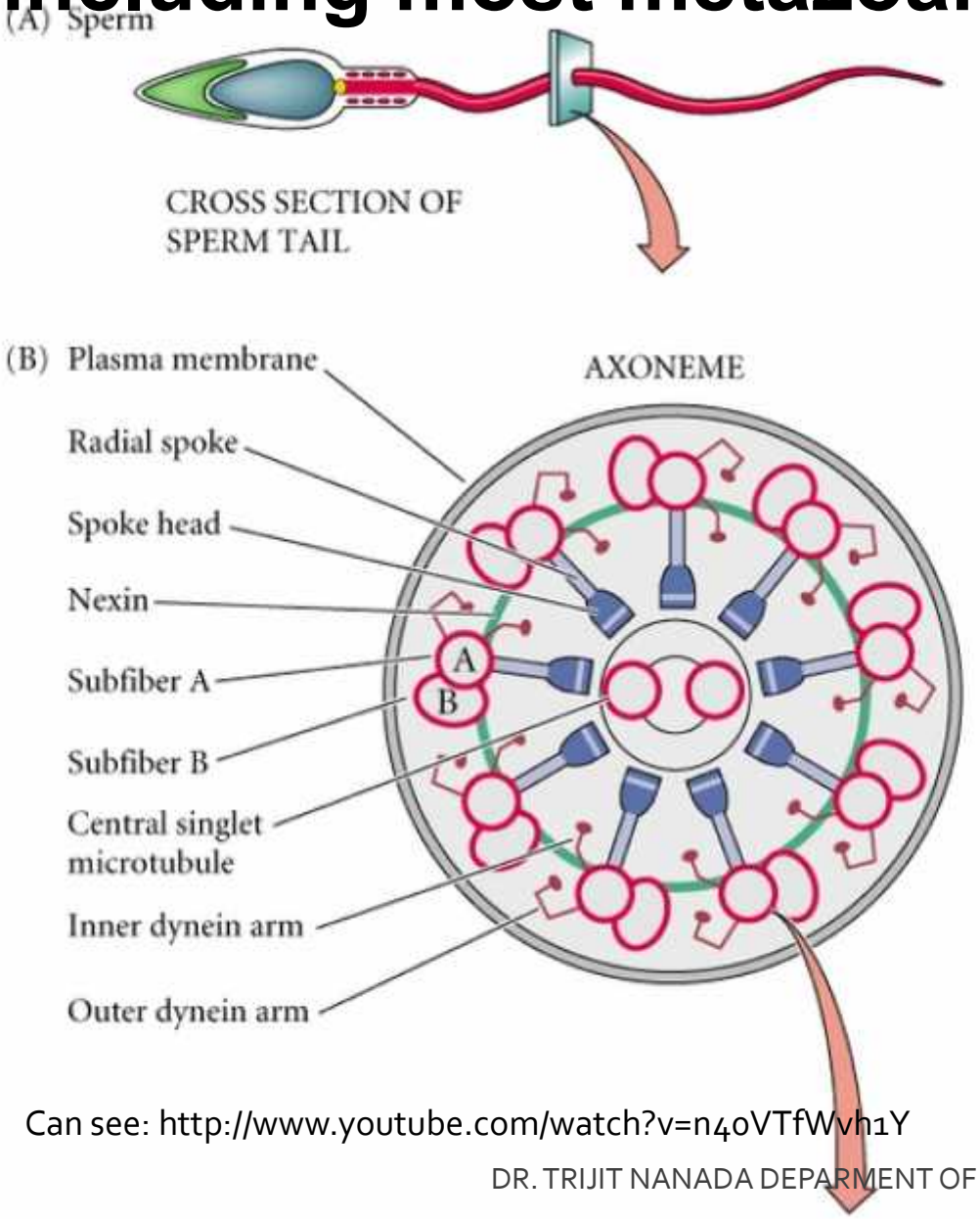


First: Microtubles and the flagellum




End piece
Tail
Mid-piece
Neck
Sperm head
Mitochondria
Axoneme
Mitochondria
Centriole
Nucleus
Plasma membrane
Acrosomal vesicle
© 2000 Sinauer Associates, Inc.

9+2 micorotuble arrangement - in motile cilia - including most metazoans' sperm flagella



9 dimer microtubules + 2 monomer microtubules

-primary cilia in eukaryotic cells: 9: stationary

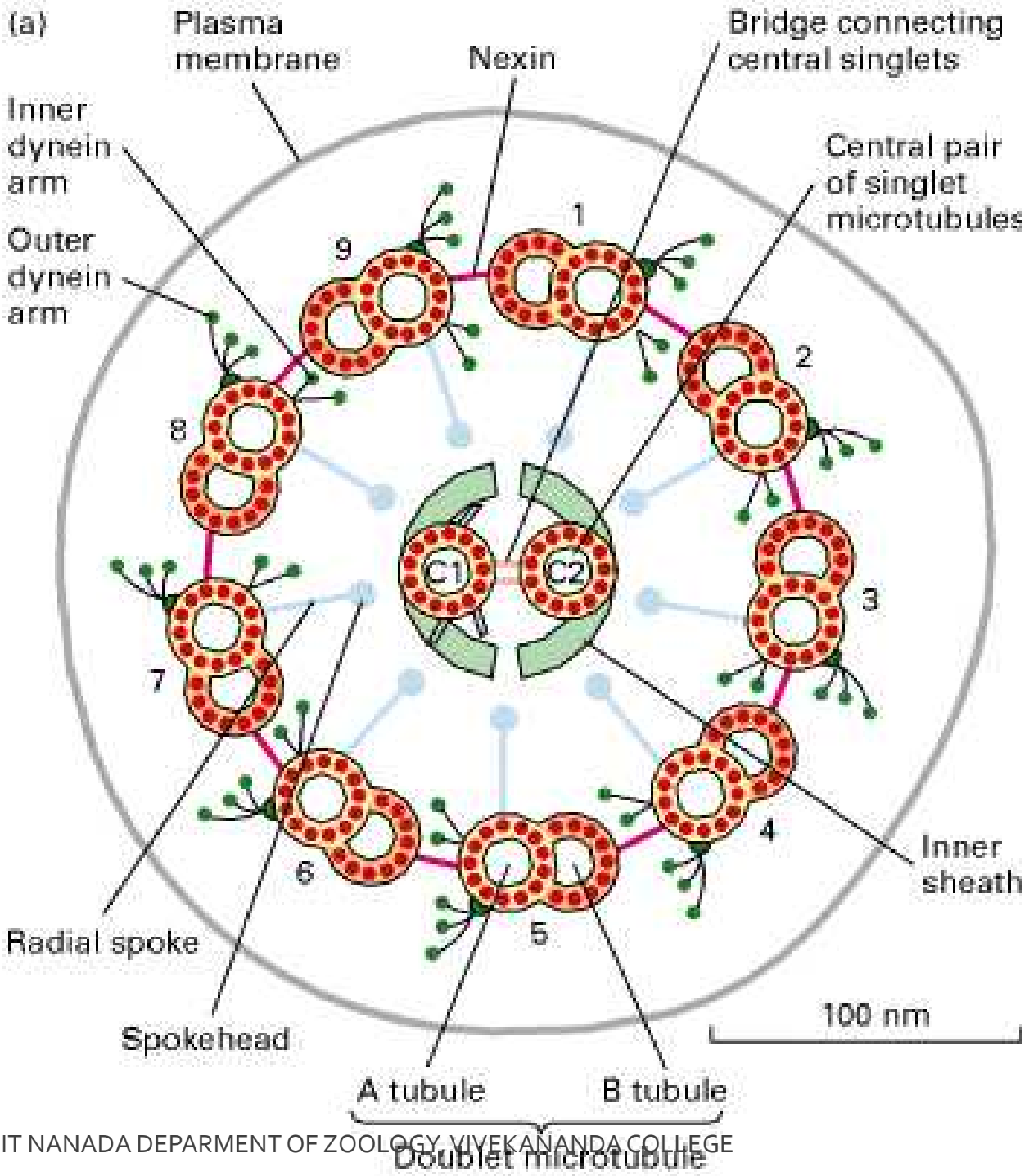
-secondary cilia, including flagella: 9+2: movement

Can see: http://www.youtube.com/watch?v=n4oVTfWvh1Y

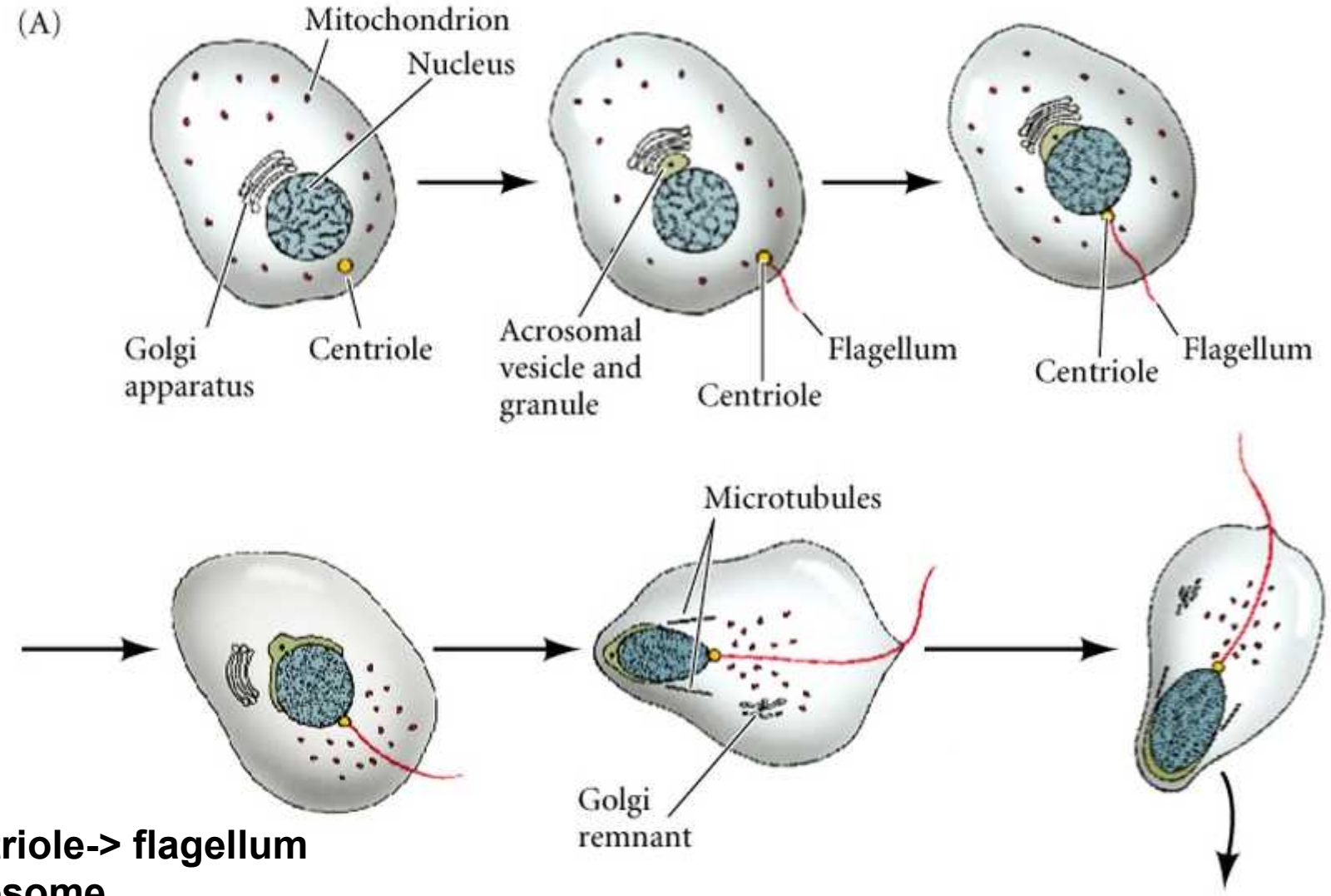
http://www.youtube.com/watch?v=vQ3CdSiVzUk

cilia

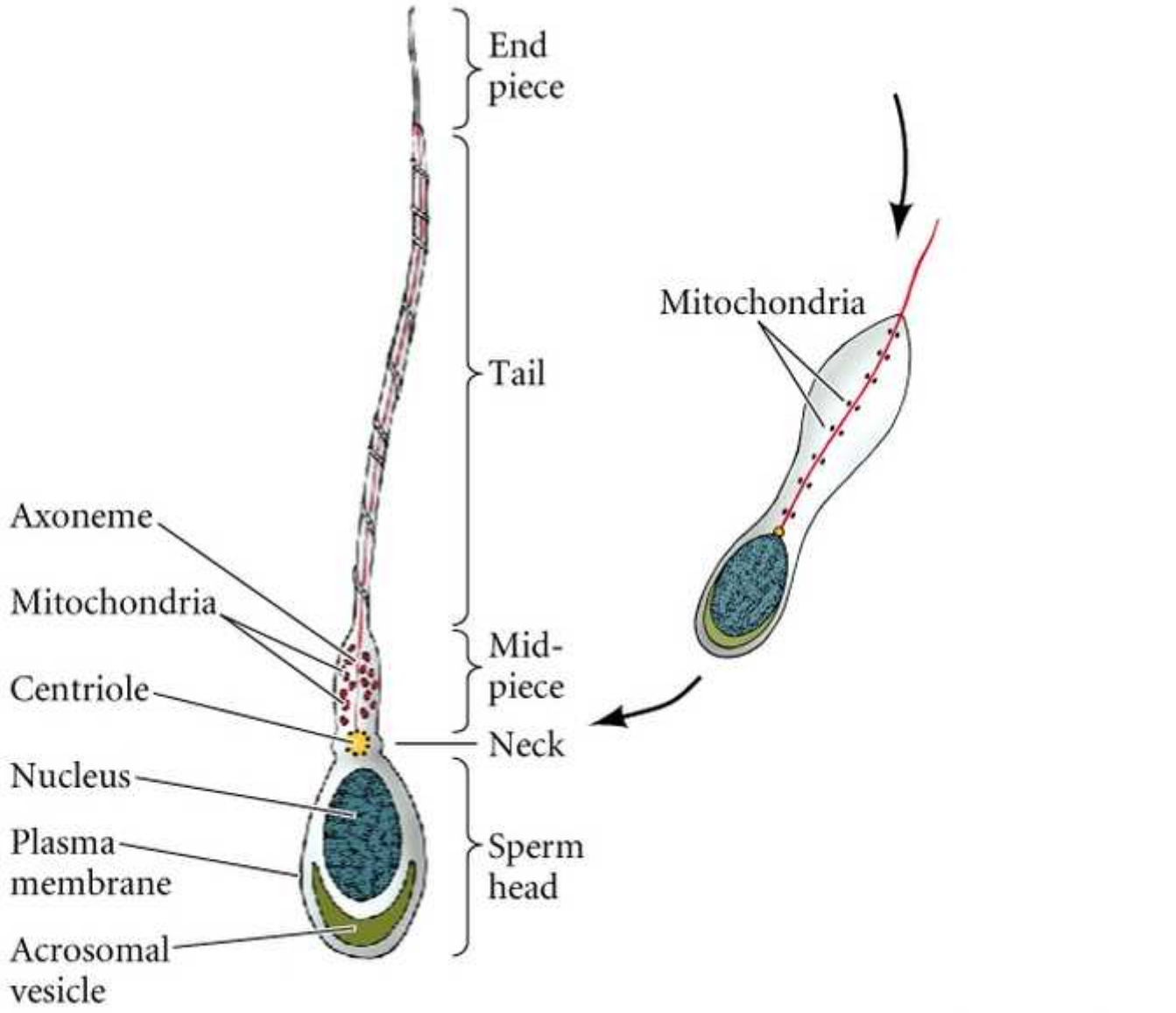
Flagellum structure:
Sperm and most eukaryotic flagella



http://www.youtube.com/watch?v=5rqbmLiSkpk



Centriole-> flagellum
Acrosome
Mitochondria to axoneme
Cytoplasm


End piece
Tail
Mid-piece
Neck
Sperm head
Mitochondria
Axoneme
Mitochondria
Centriole
Nucleus
Plasma membrane
Acrosomal vesicle
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By-the-way: Flagella in *Eubacteria*, (and in *Archea*), are Analogous, NOT homologous