EMBRYOLOGY - INTRODUCTION

Ms. Manochitra
Guest Lecturer
Department of Biomedical science,
Bharathidasan University, Trichy

INTRODUCTION

EMBRYOLOGY

*The study of the development of the embryo.

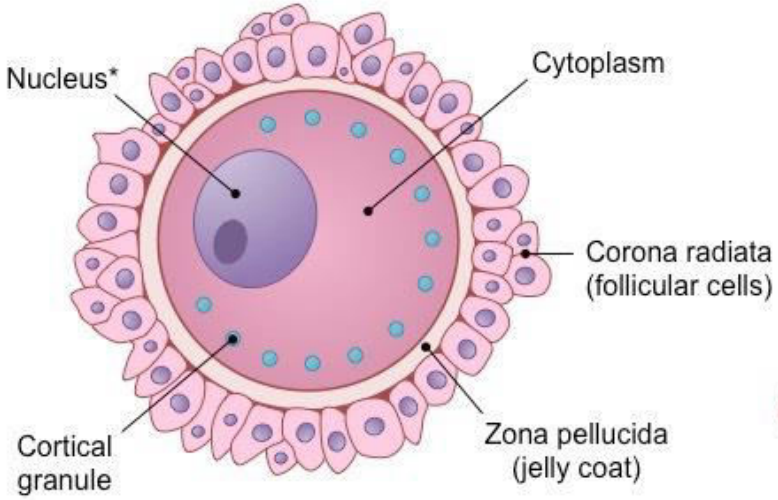
*The term applied to the various changes which take place during the growth of an animal from the egg to the adult condition.

EMBRYO

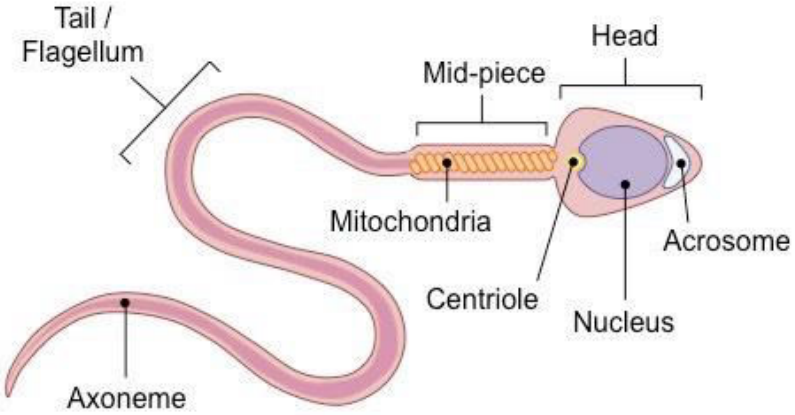
*After gastrulation, at which time the cells that will give rise to the future human being can be distinguished from those that form extra embryonic tissues.

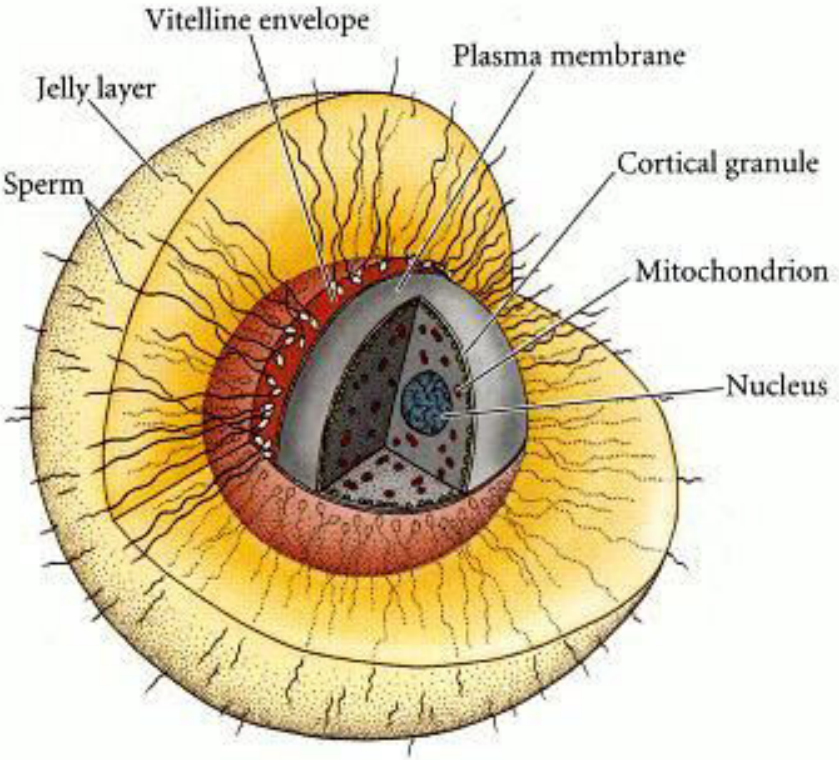
* The product of fertilization of an oocyte.

Human Egg (Ovum)



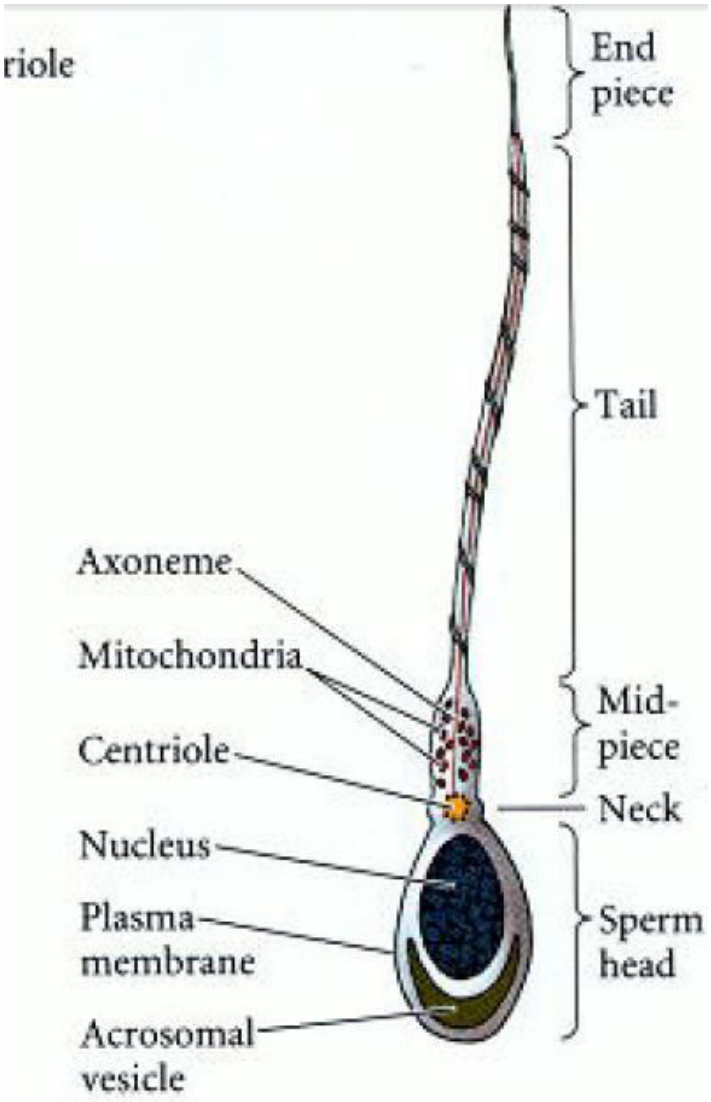
Human Sperm (Spermatozoa)




Vitelline envelope
Plasma membrane
Jelly layer
Cortical granule
Sperm
Mitochondrion
Nucleus

Egg

Sperm


riole
End piece
Tail
Axoneme
Mitochondria
Mid-piece
Centriole
Neck
Nucleus
Plasma membrane
Sperm head
Acrosomal vesicle

Meiosis

-- occurs during gametogenesis

2n (diploid)

↓

4n (diploid

↓

2n (haploid)

↓

1n (haploid)

Ploidy = # of each unique chromosome set

n = number of copies of each unique DNA set

46 Chromosomes –

22 pairs – autosomes

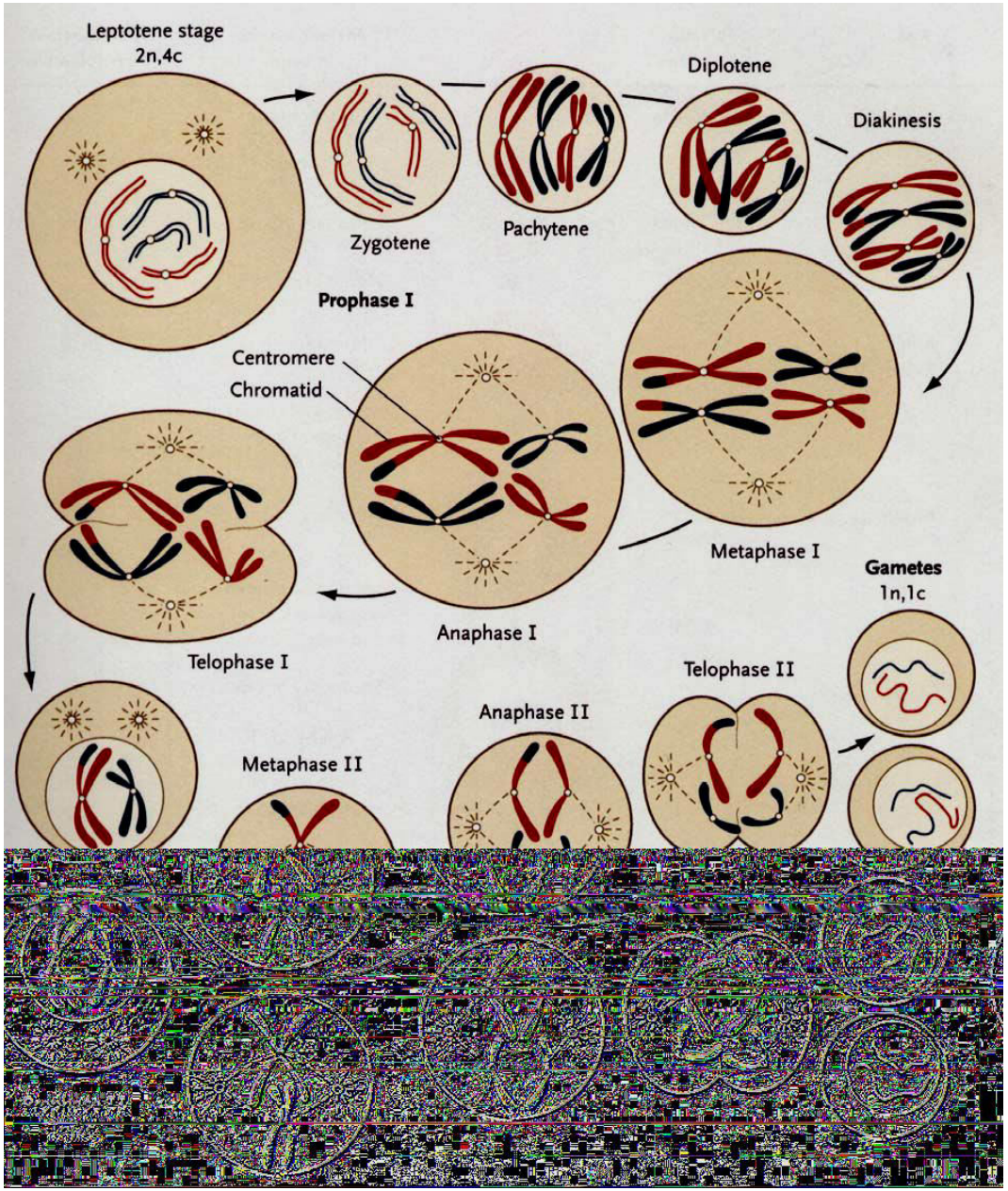
2 sex chromosomes

female is XX

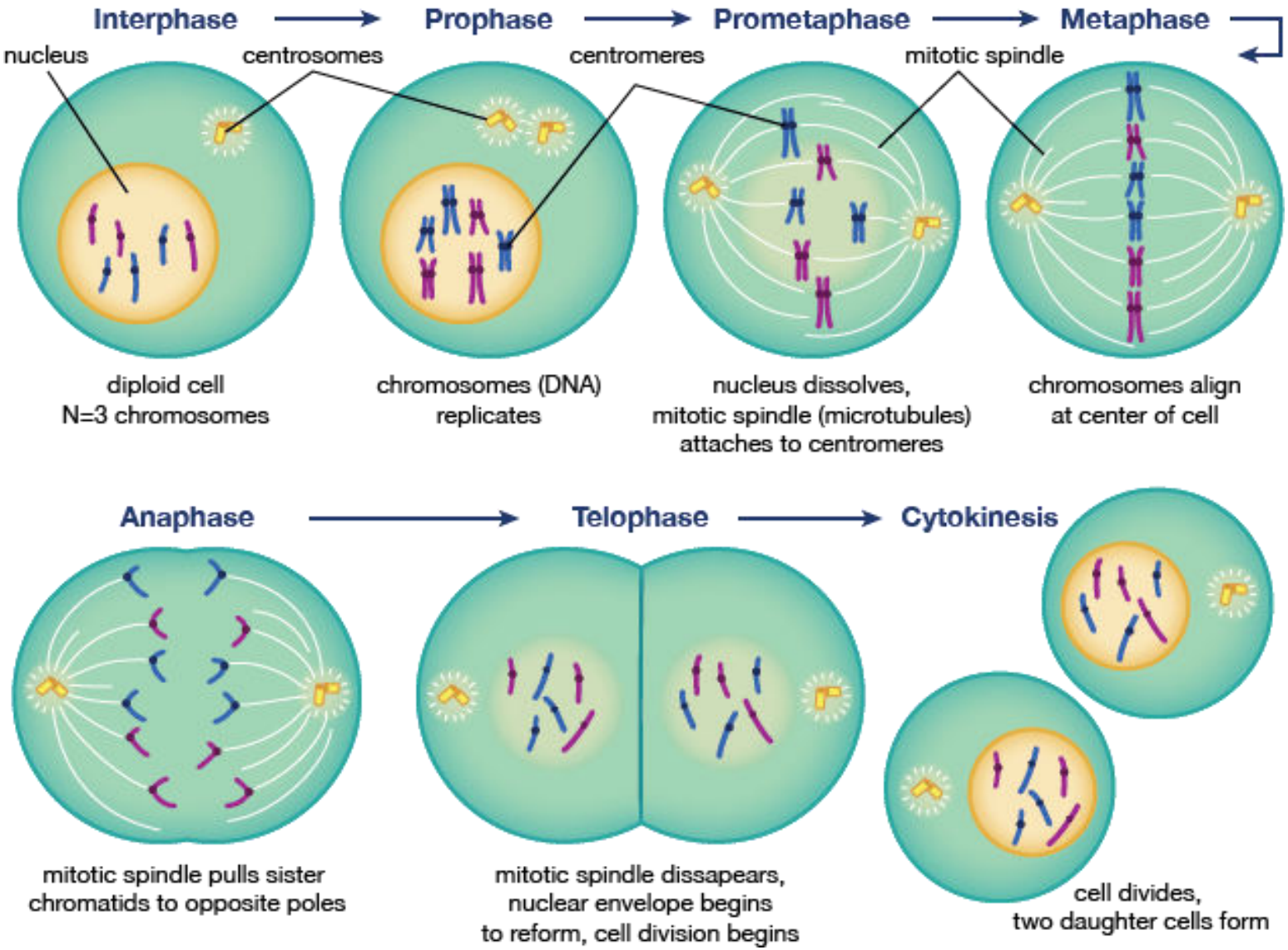
male is XY

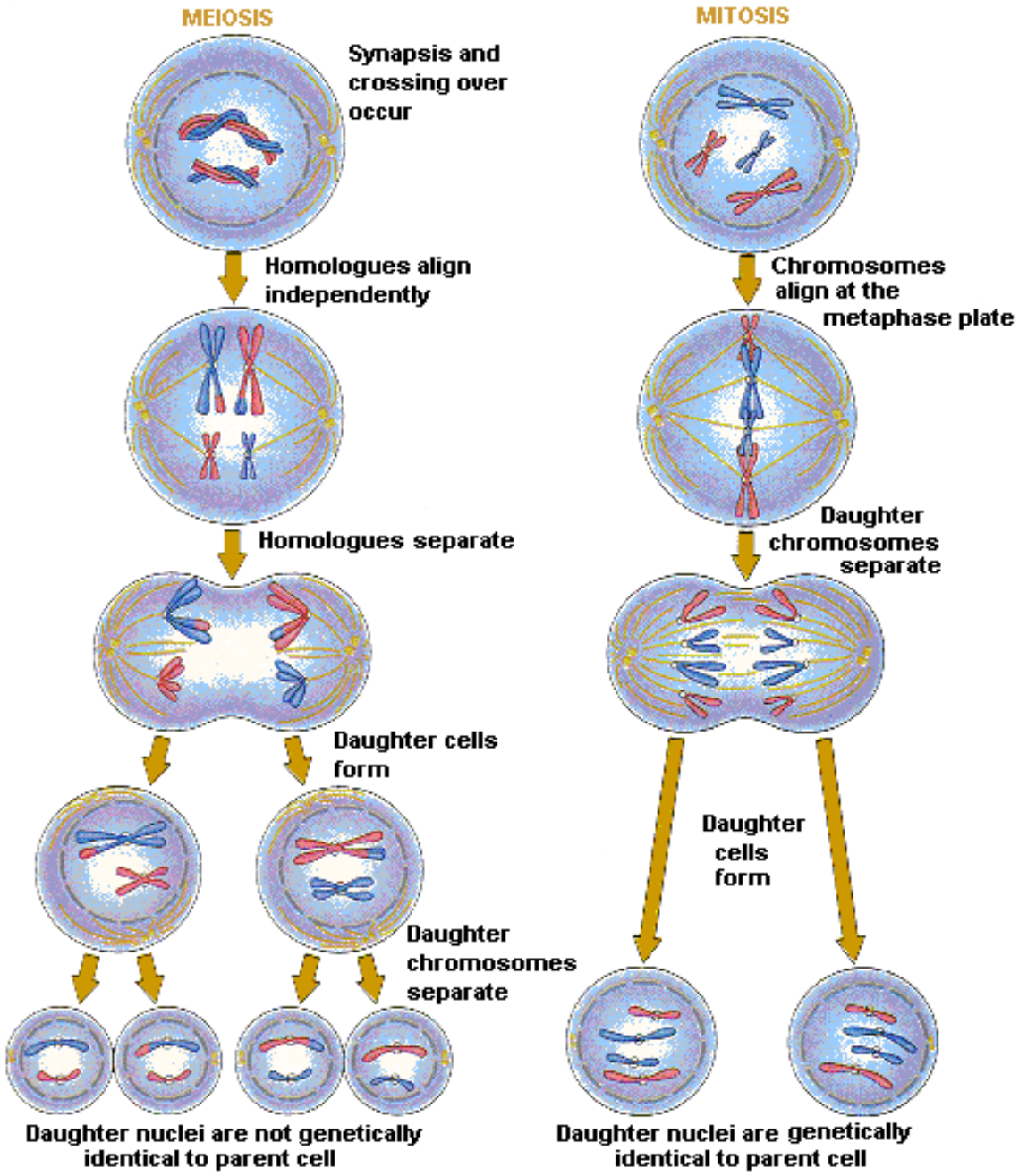
Nomenclature: 46,XX or 46,XY

Recombination occurs during meiosis



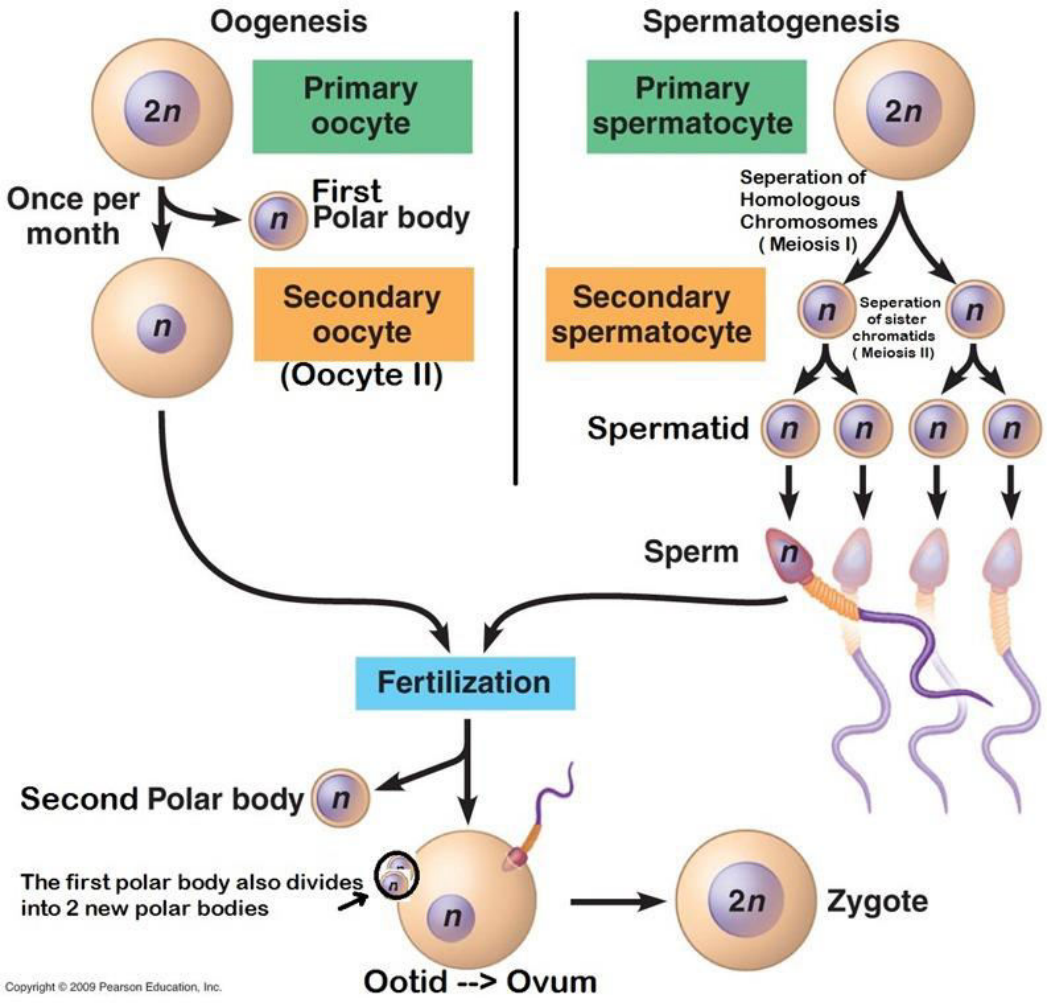
Mitosis

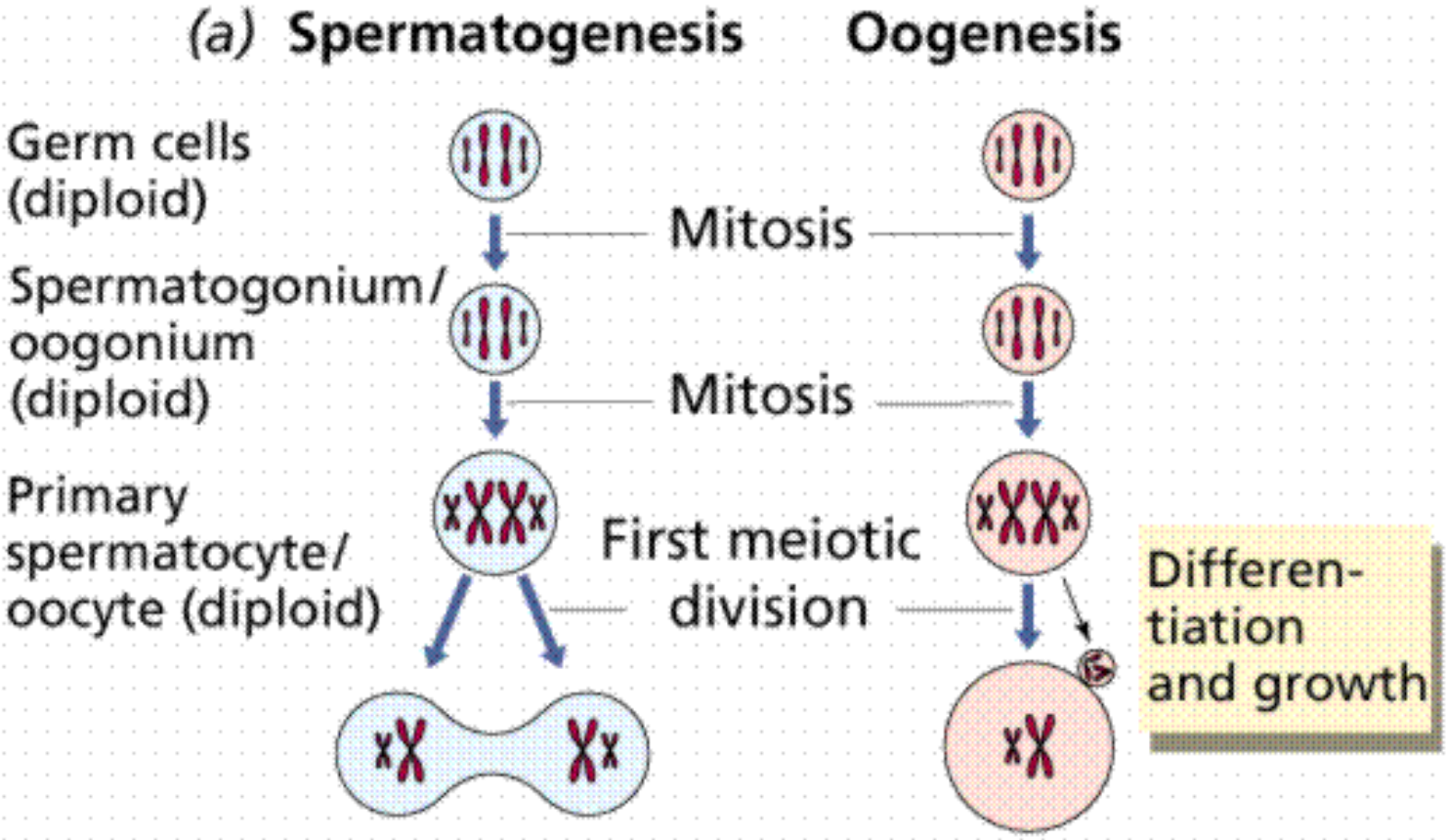

Interphase
Prophase
Prometaphase
Metaphase
nucleus
centrosomes
centromeres
mitotic spindle
diploid cell
N=3 chromosomes
chromosomes (DNA)
replicates
nucleus dissolves,
mitotic spindle (microtubules)
attaches to centromeres
chromosomes align
at center of cell
Anaphase
Telophase
Cytokinesis
mitotic spindle pulls sister
chromatids to opposite poles
mitotic spindle dissapears,
nuclear envelope begins
to reform, cell division begins
cell divides,
two daughter cells form

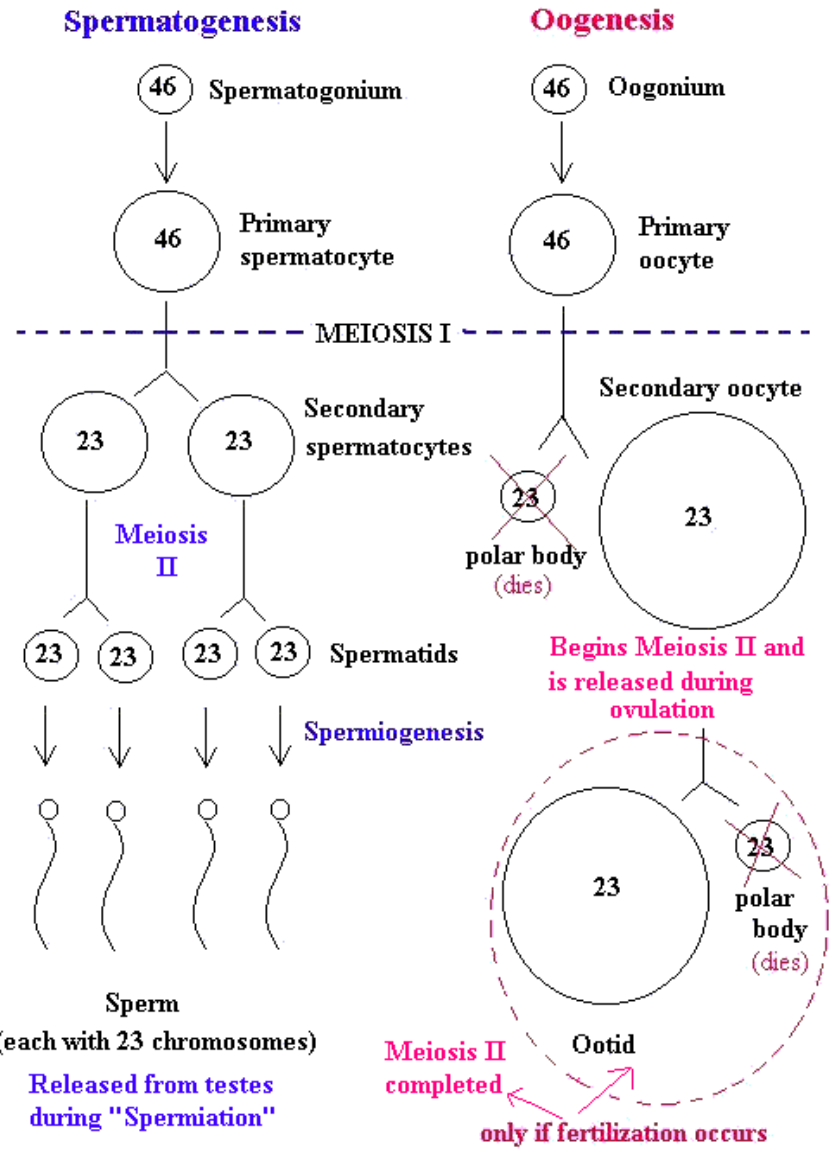

MEIOSIS
Synapsis and crossing over occur
Homologues align independently
Homologues separate
Daughter cells form
Daughter chromosomes separate
Daughter nuclei are not genetically identical to parent cell
MITOSIS
Chromosomes align at the metaphase plate
Daughter chromosomes separate
Daughter cells form
Daughter nuclei are genetically identical to parent cell

GERM CELLS

GAMETOGENESIS



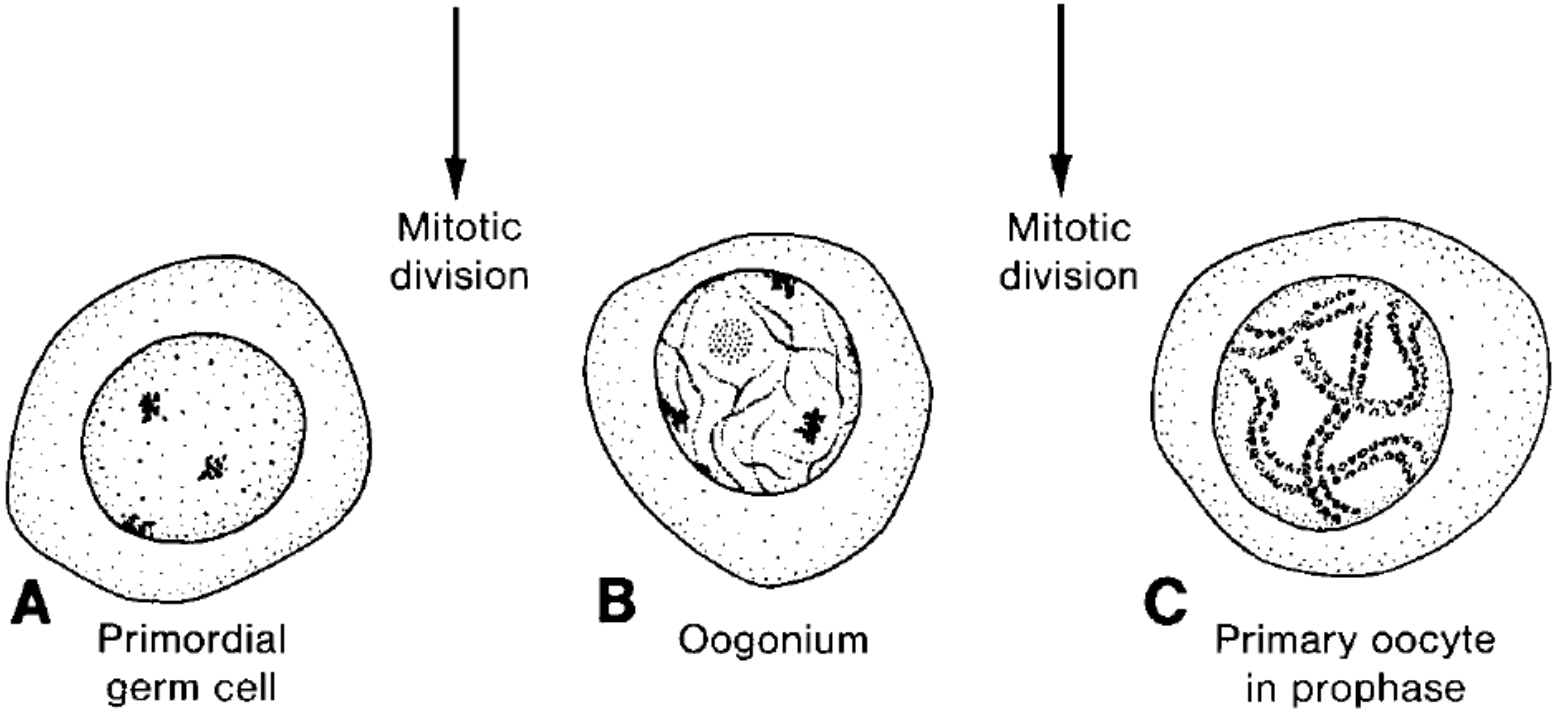

(a) Spermatogenesis
Oogenesis
Germ cells (diploid)
Mitosis
Spermatogonium/ oogonium (diploid)
Mitosis
Primary spermatocyte/ oocyte (diploid)
First meiotic division
Differen-tiation and growth


Spermatogenesis
Oogenesis
46
Spermatogonium
46
Oogonium
46
Primary spermatocyte
46
Primary oocyte
MEIOSIS I
Secondary spermatocytes
Secondary oocyte
23
23
23
23
polar body (dies)
Meiosis II
23
23
23
23
Spermatids
Begins Meiosis II and is released during ovulation
Spermiogenesis
23
23
polar body (dies)
Sperm (each with 23 chromosomes)
Released from testes during "Spermiation"
Ootid
Meiosis II completed
only if fertilization occurs

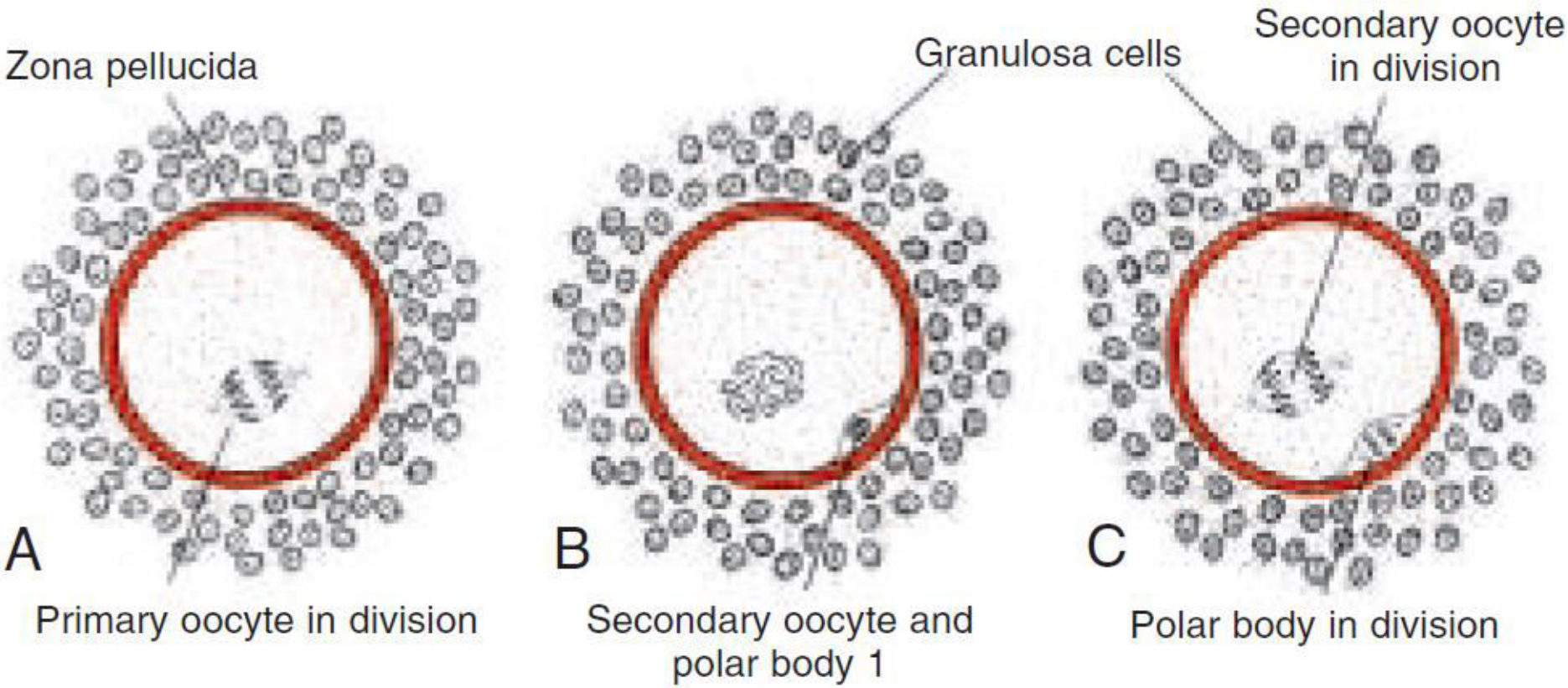
	Spermatogenesis	Oogenesis
Process		
Location	Occurs *entirely* in testes	Occurs *mostly* in ovaries
Meiotic divisions	Equal division of cells	Unequal division of cytoplasm
Germ line epithelium	Is involved in gamete production	Is not involved in gamete production
Gametes		
Number produced	Four	One (plus 2 – 3 polar bodies)
Size of gametes	Sperm smaller than spermatocytes	Ova larger than oocytes
Timing		
Duration	Uninterrupted process	In arrested stages
Onset	Begins at puberty	Begins in foetus (pre-natal)
Release	Continuous	Monthly from puberty (menstrual cycle)
End	Lifelong (but reduces with age)	Terminates with menopause

Developmental processes

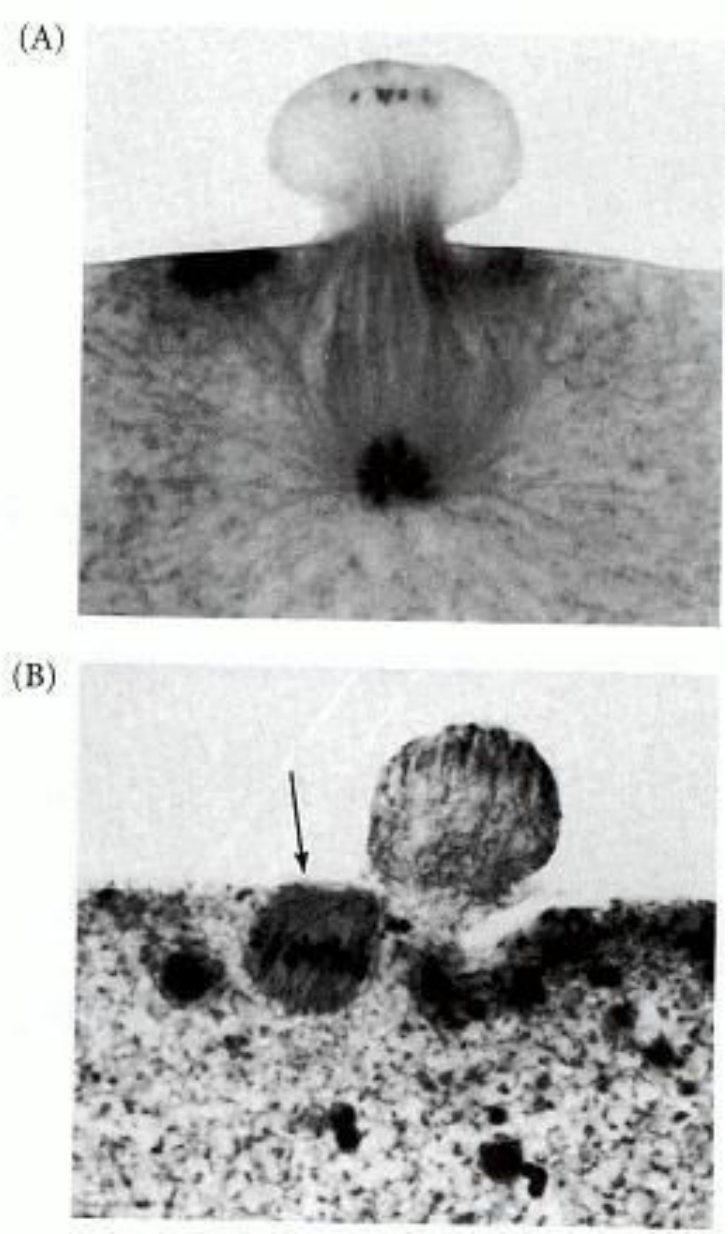
Differentiation of germ cells – female gamete



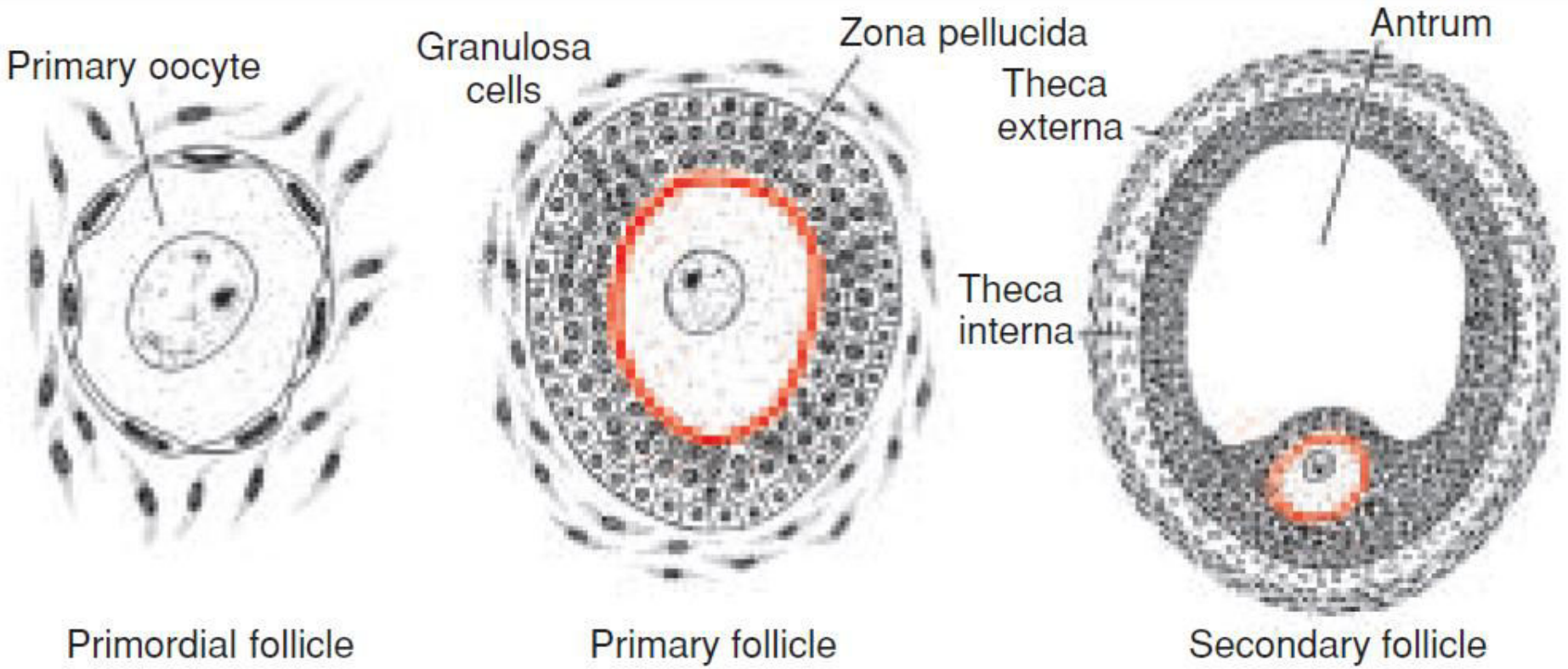
Maturation of oocyte



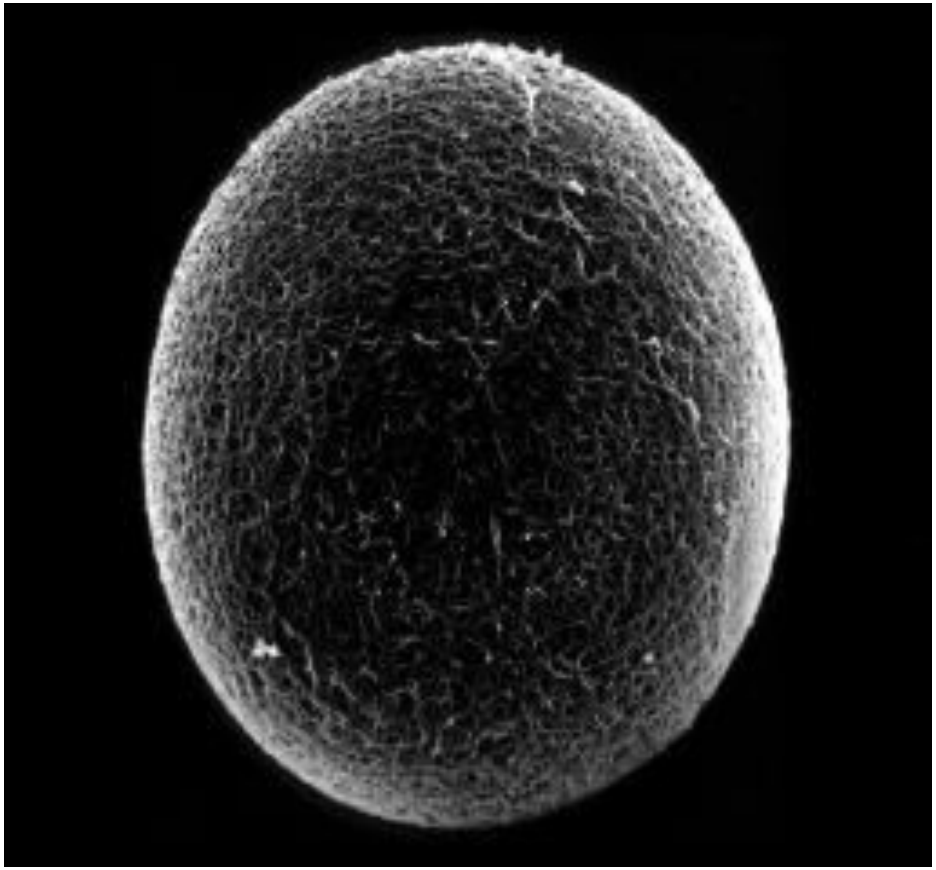
Microscopic picture of secondary oocyte



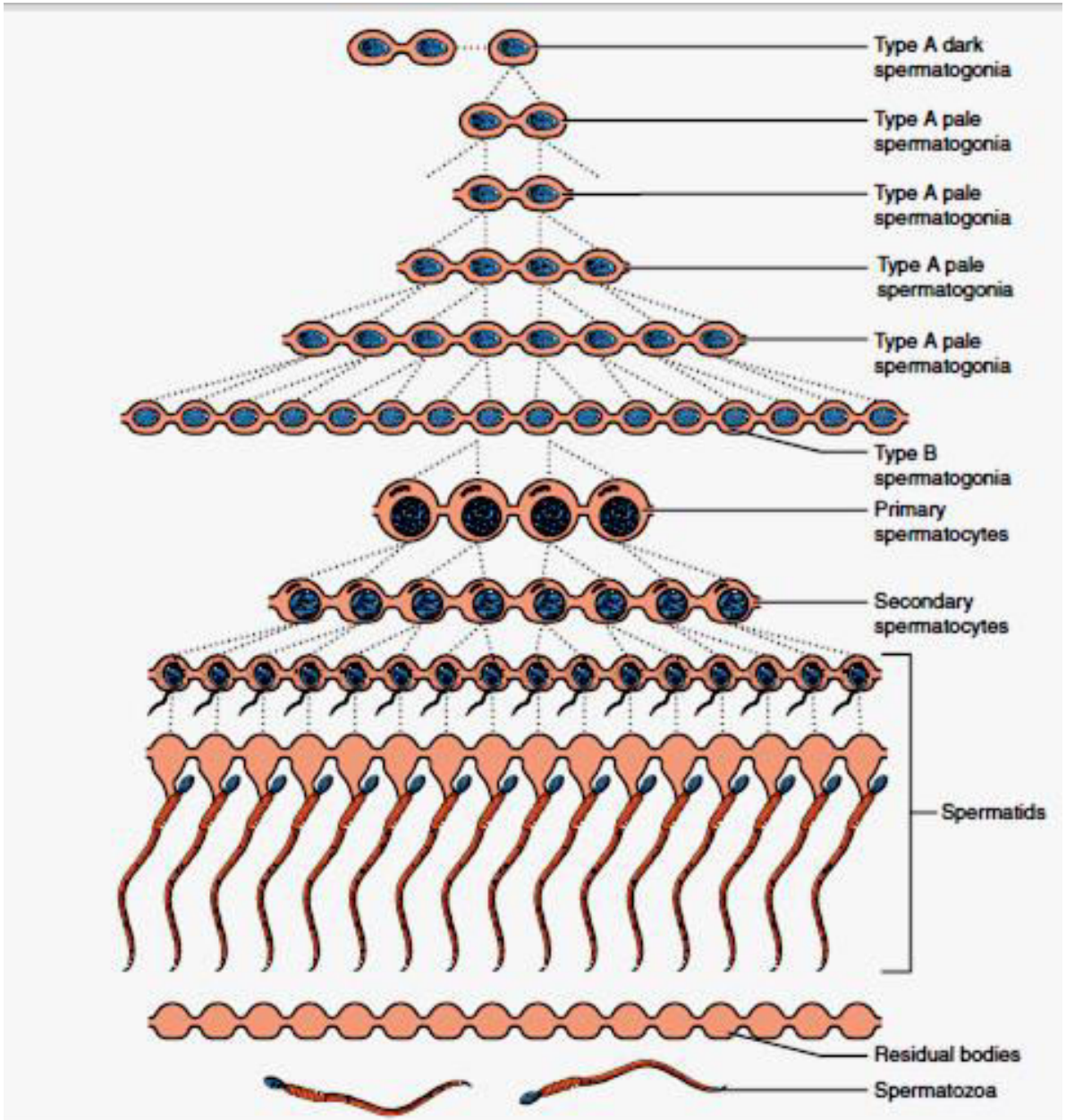
Maturation of Secondary oocyte



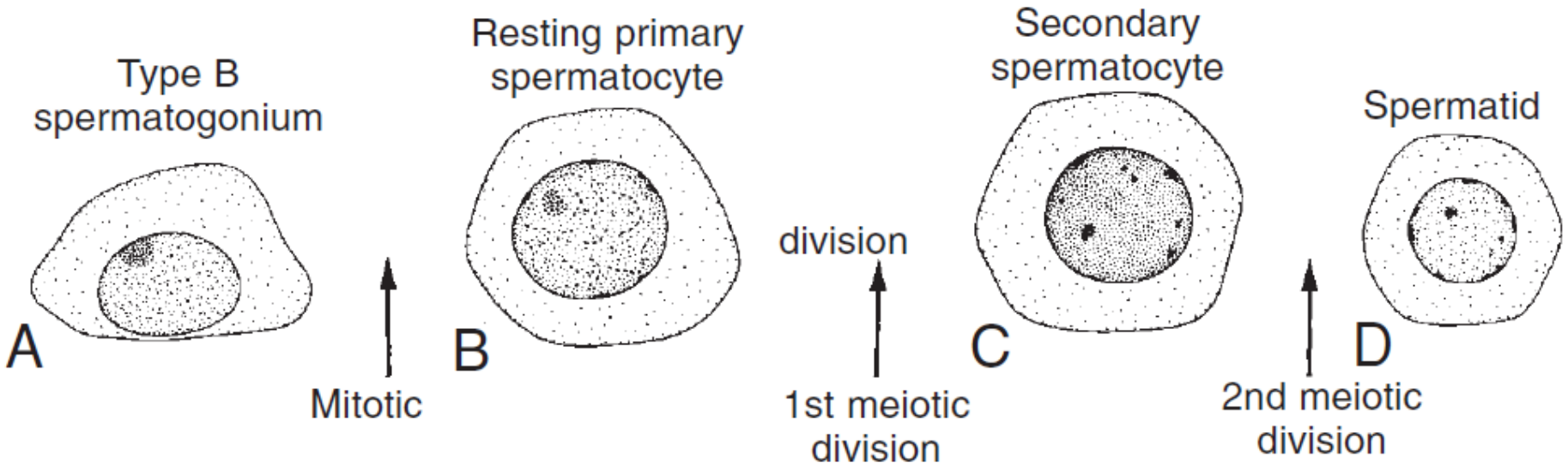
OVUM



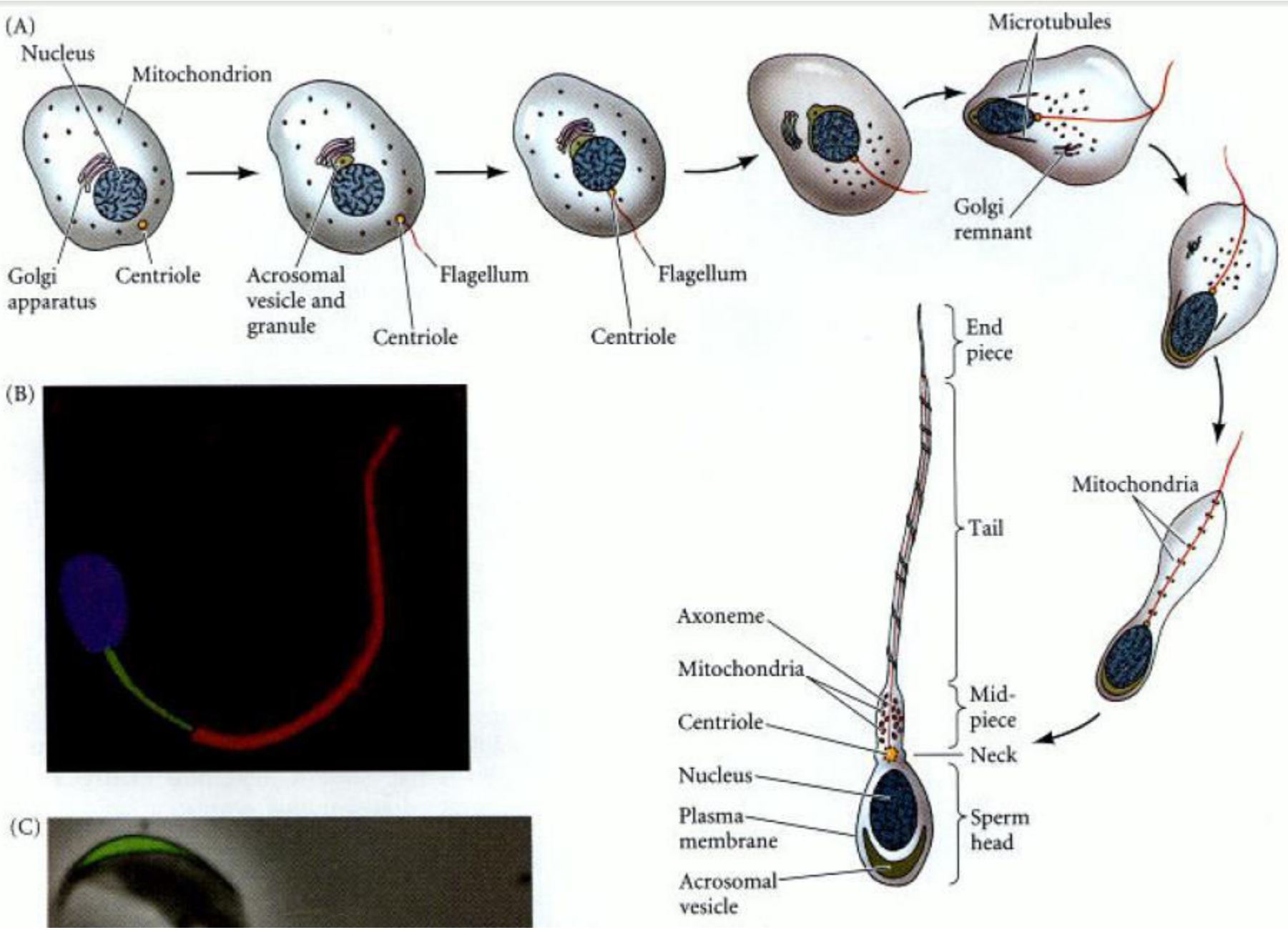
Differentiation of germ cells - male gamete

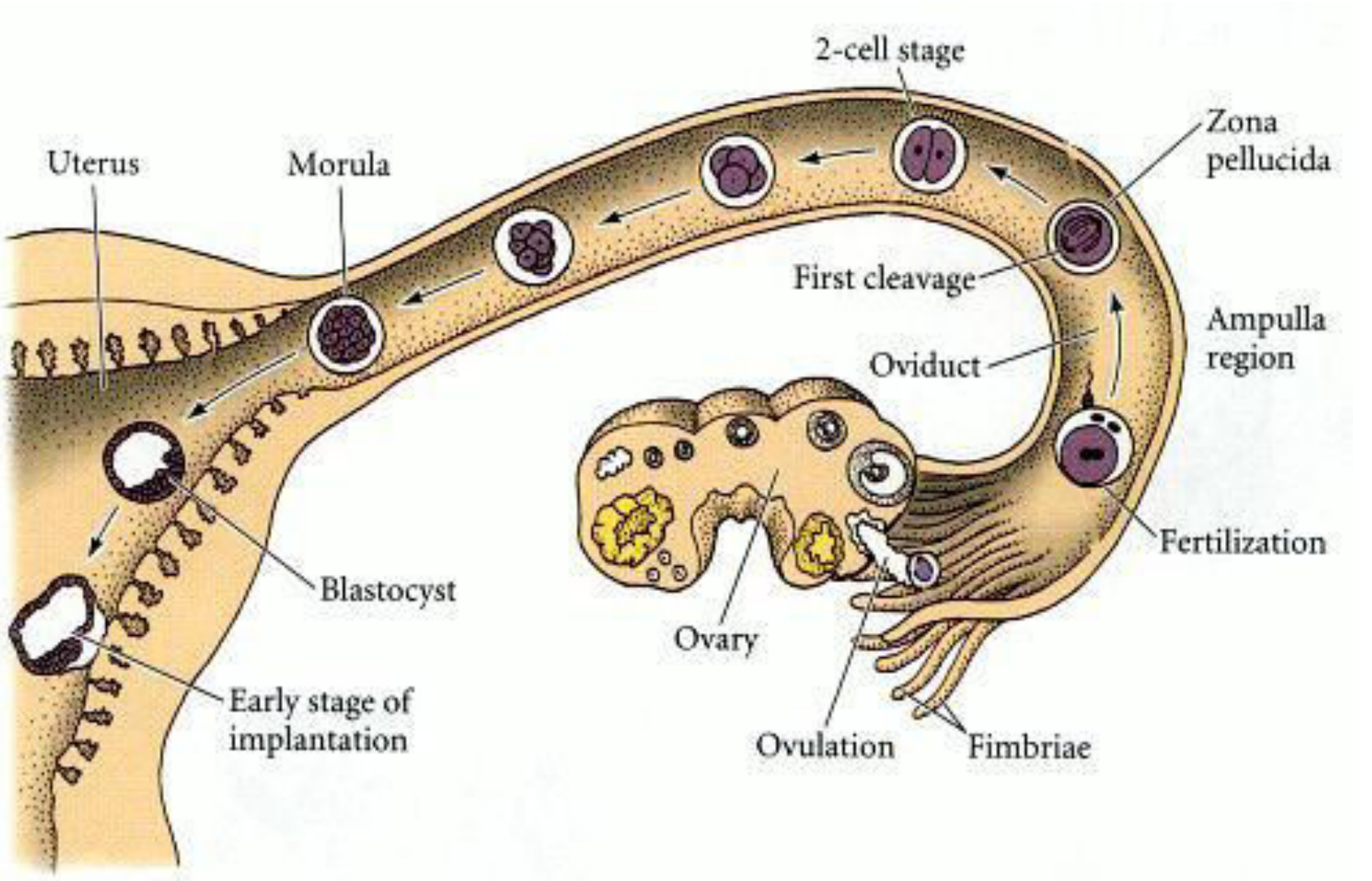


Maturation of Secondary spermatocyte



Maturation of Spermatozoan




2-cell stage
Zona pellucida
Uterus
Morula
First cleavage
Ampulla region
Oviduct
Fertilization
Blastocyst
Ovary
Early stage of implantation
Ovulation
Fimbriae

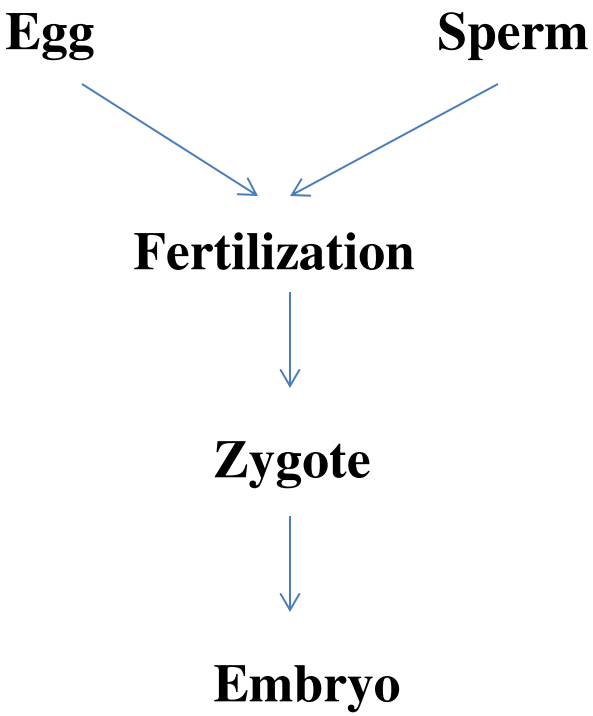
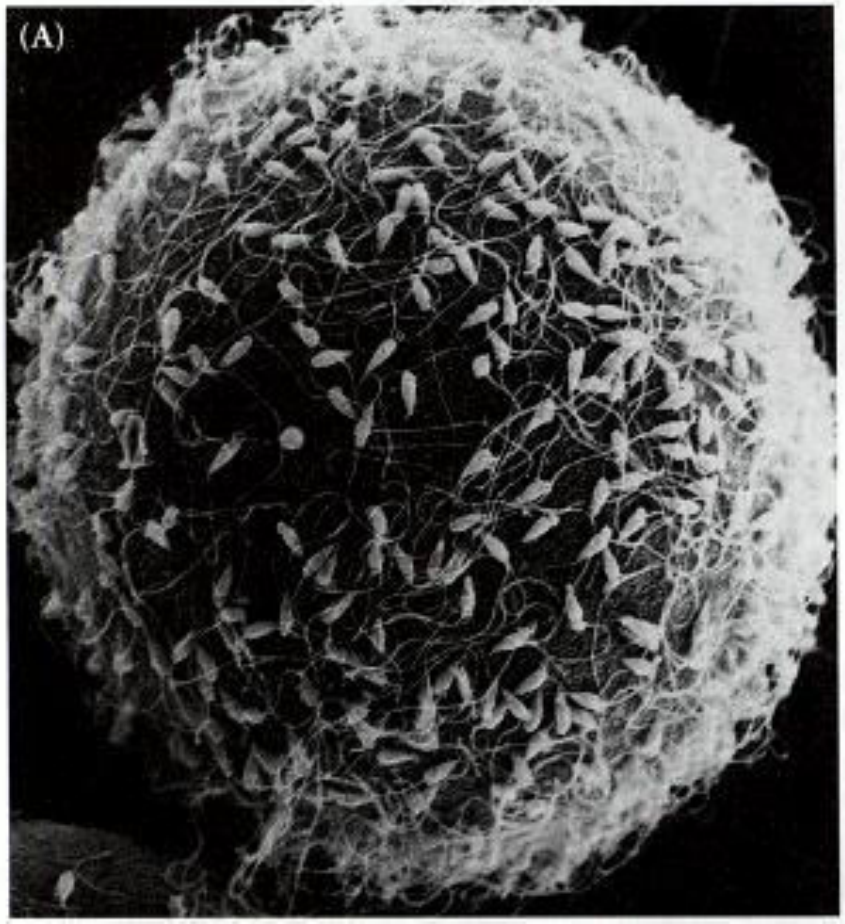
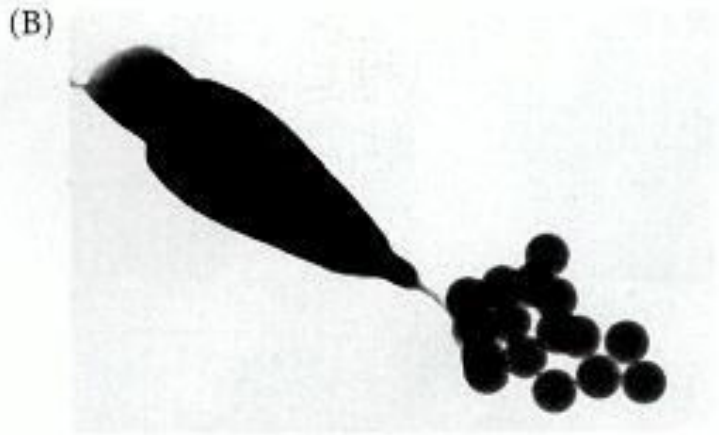
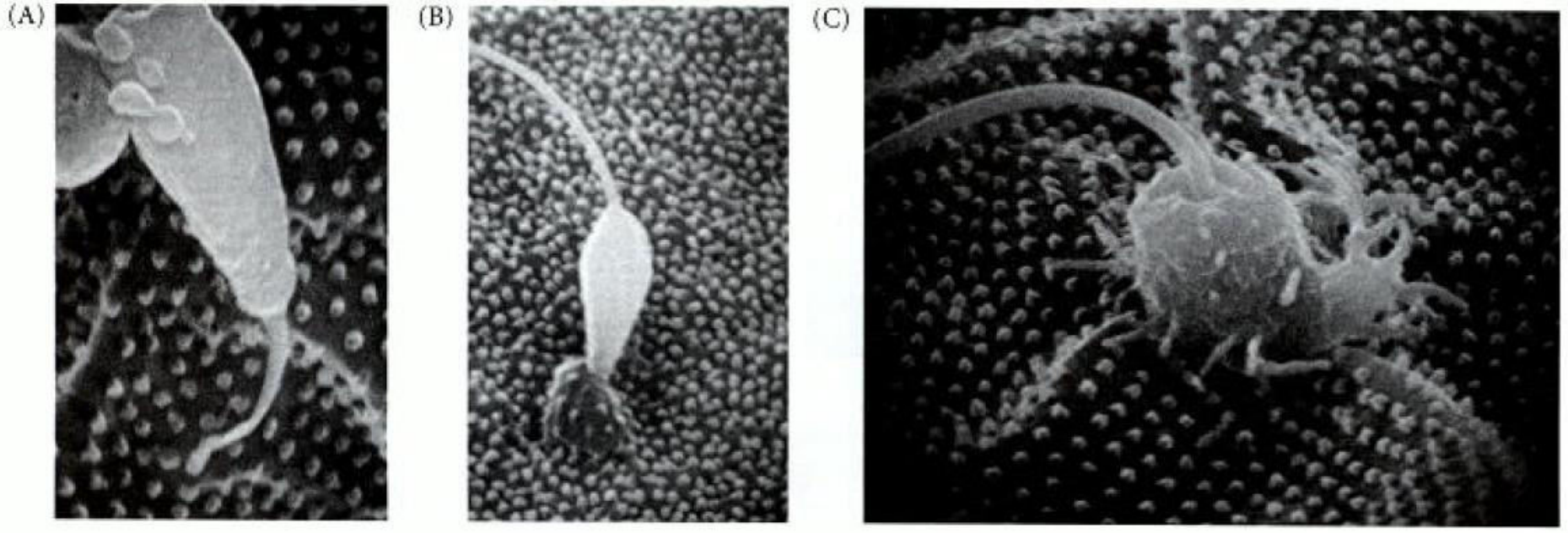


Fig. Simple concept of formation of embryo

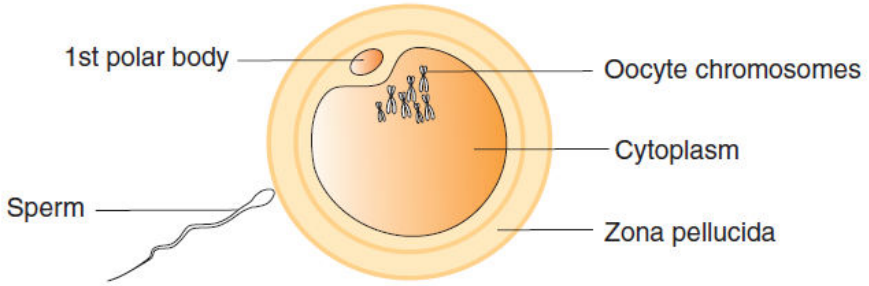

(A)


(B)

Fusion of the egg and sperm plasma membranes

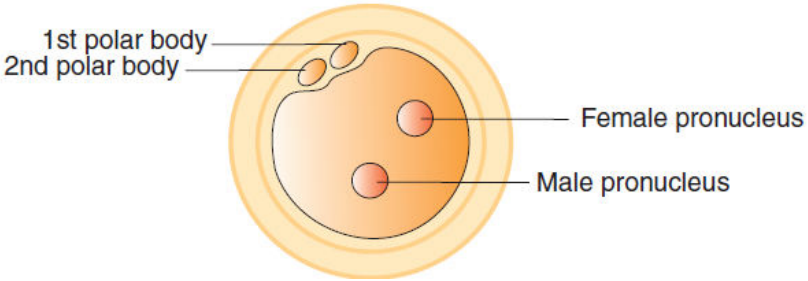


Before fertilisation



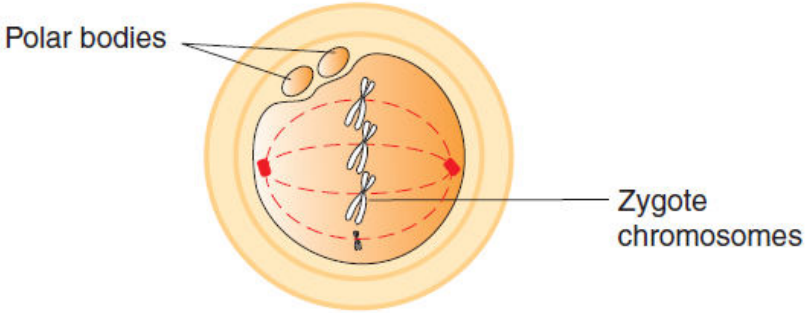
A sperm begins to enter the oocyte

During fertilisation



Two pronuclei are clearly visible within the oocyte: one containing genetic material (DNA) from the sperm and one from the oocyte. The two pronuclei are drawn together by microtubules in the cytoplasm

Fertilisation complete

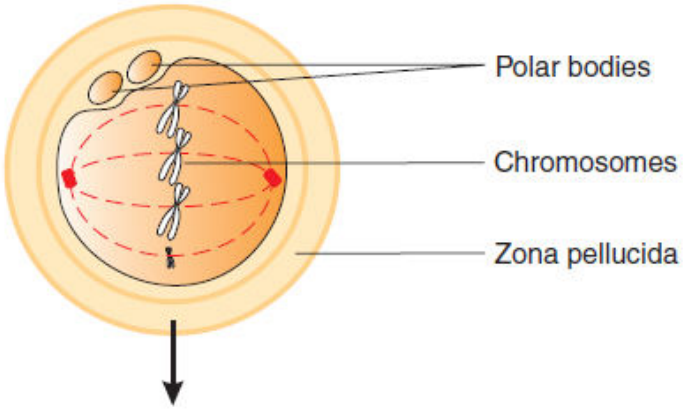


The membranes of the two pronuclei fuse and the chromosomes of the sperm and the oocyte are combined to form the zygote which is a genetically unique entity. In 1-3 hours the zygote will undergo the first cleavage division.

PREIMPLANTATION DEVELOPMENT

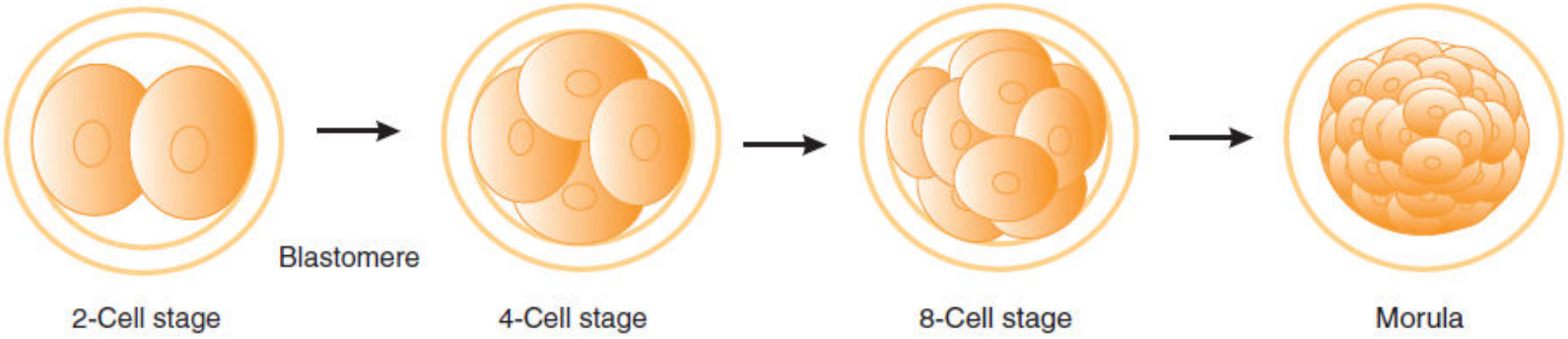
Zygote

DAY 1



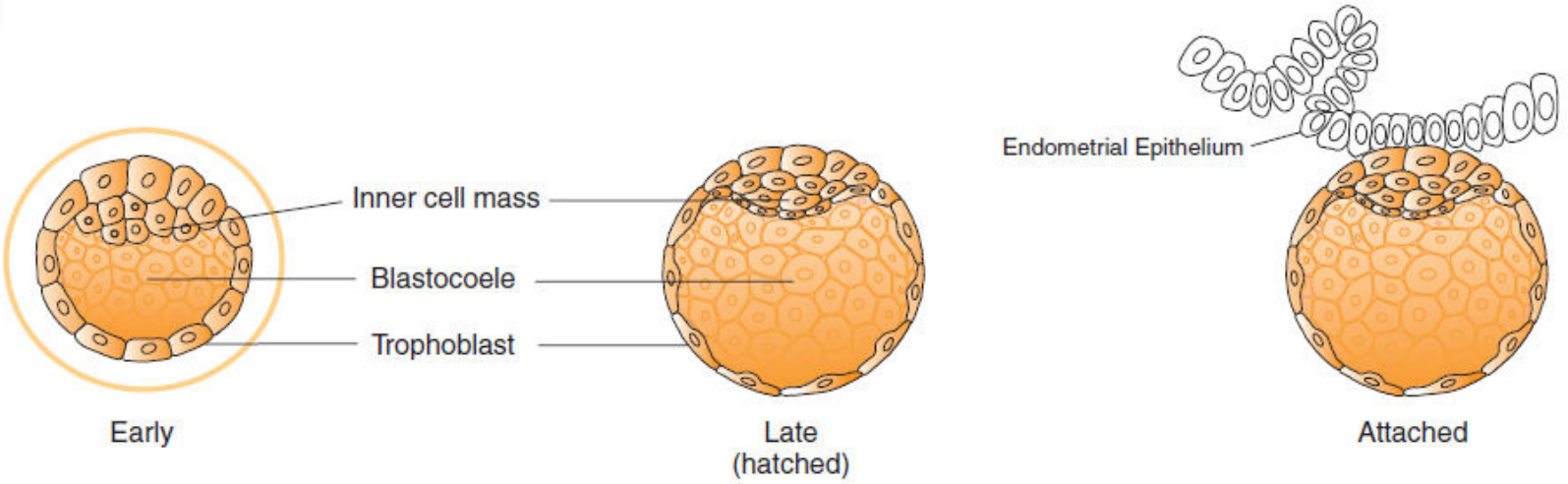
Cleavage stages

DAYS 2-3



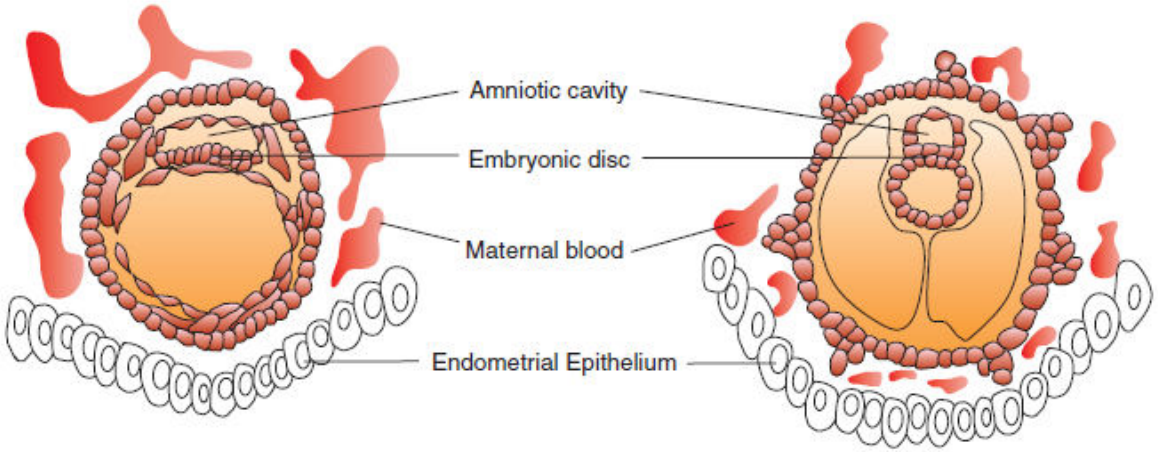
Blastocyst

DAYS 4-7



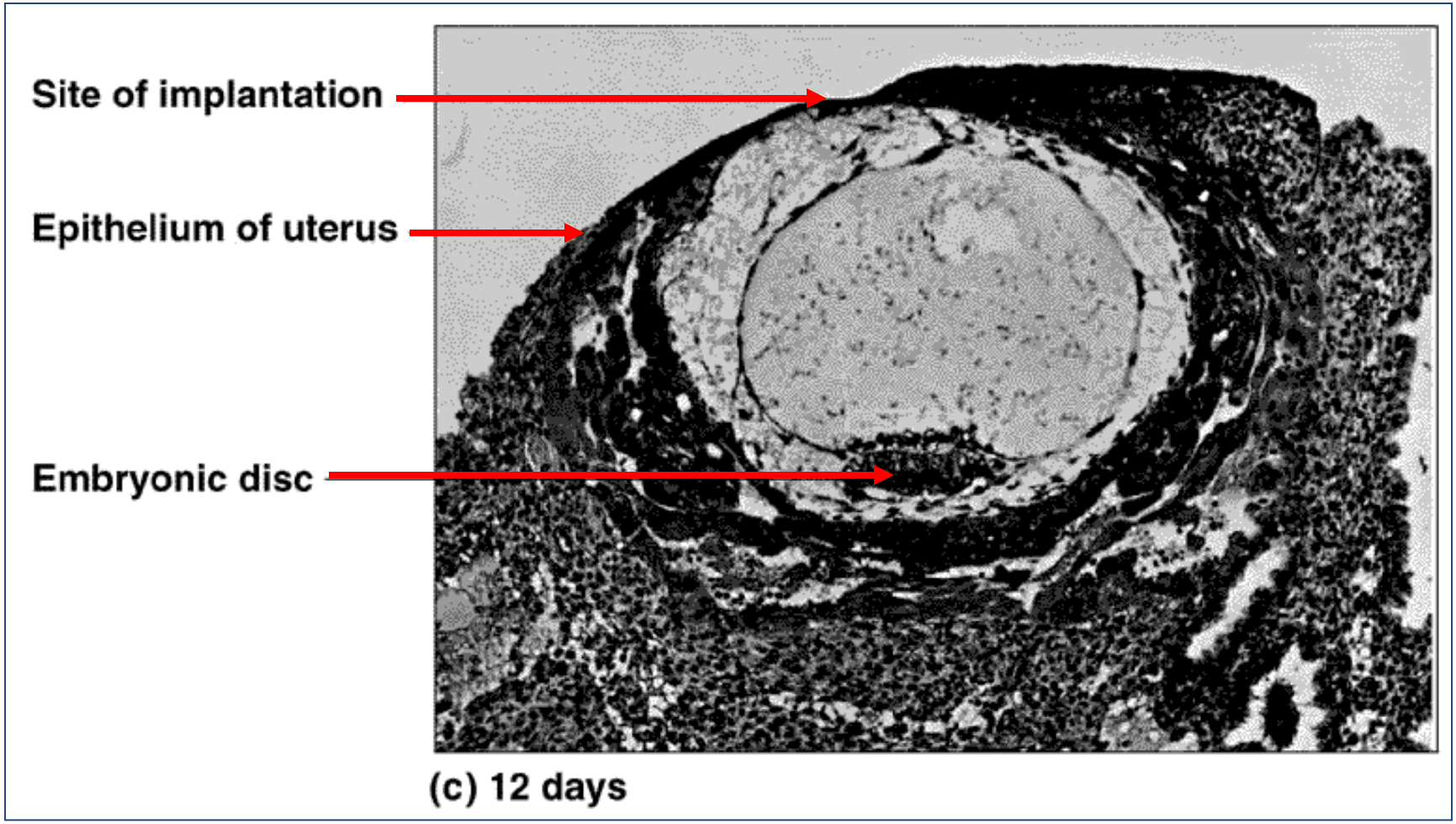
Bilaminar embryonic disk

DAYS 12-14

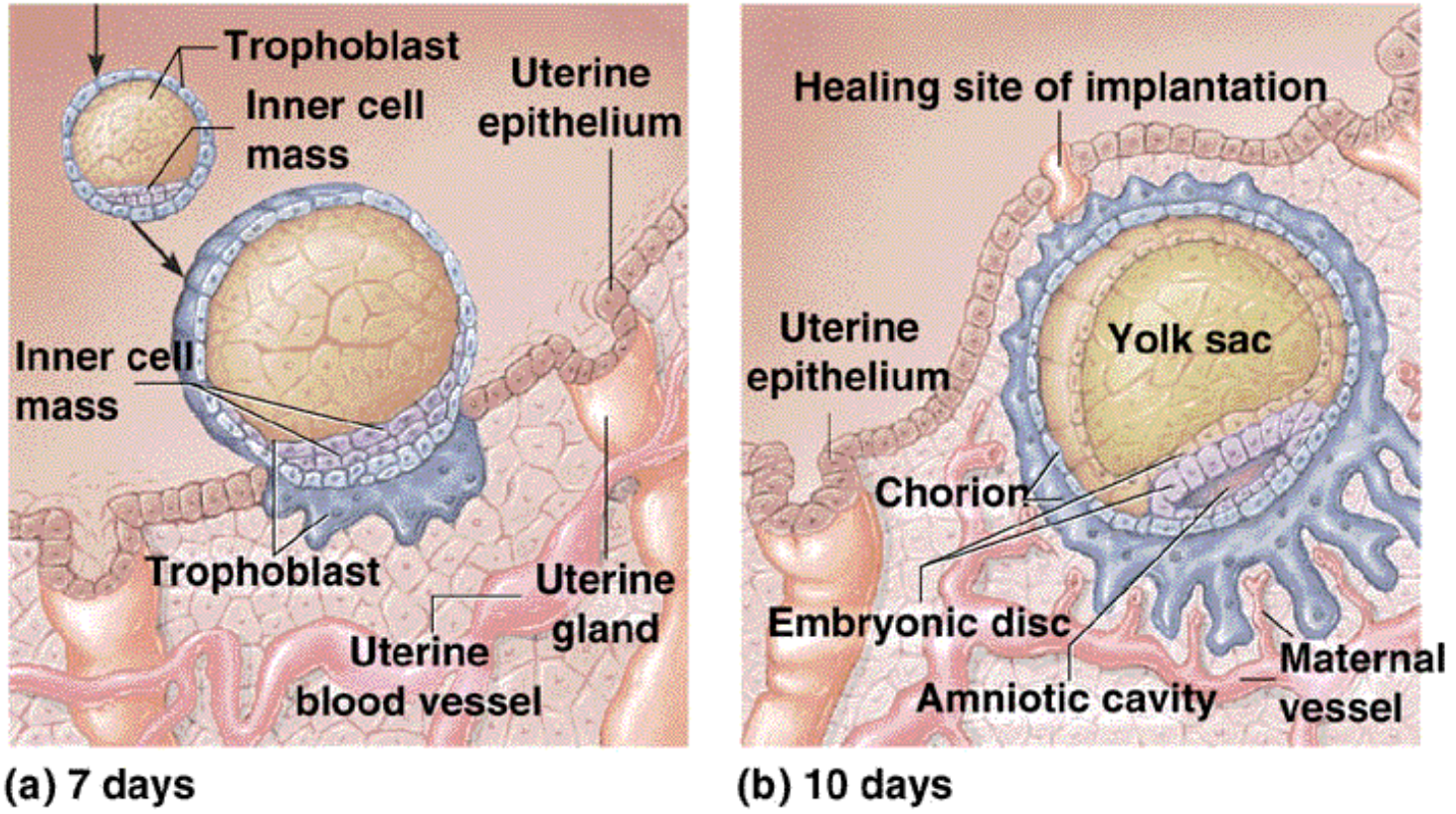


Bilaminar pre-embryo, implantation complete and embryogenesis begins

12-day Human Embryo



Solomon/Berg/Martin, Biology, 6/e
Figure 49.16

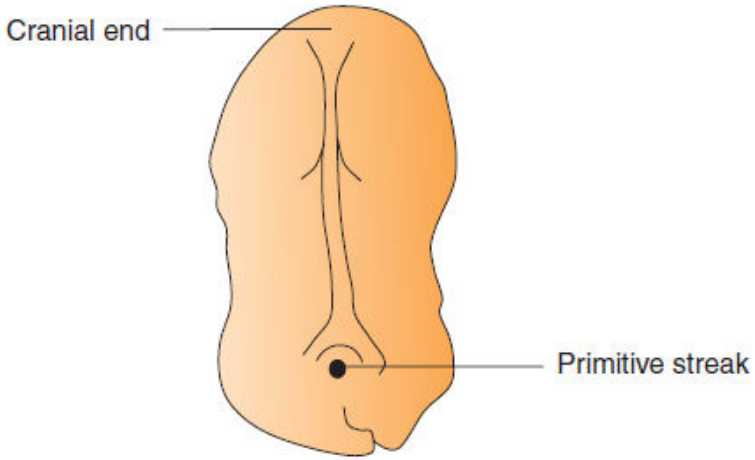


(a) 7 days

(b) 10 days

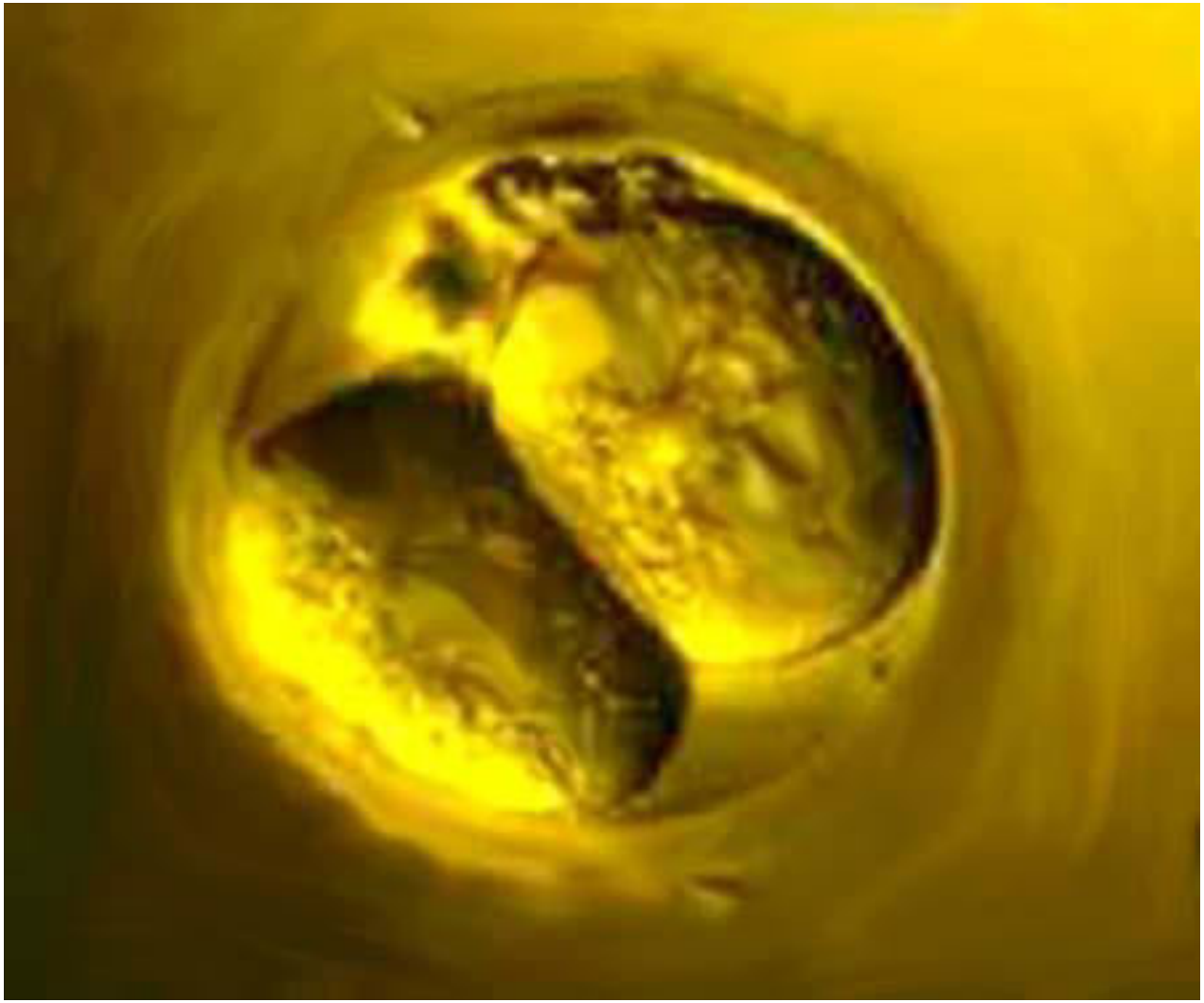
Embryo proper

DAY 15



Dorsal view of an embryo showing the appearance of the primitive streak that characterises the formation of the multi-cellular structure that will uniquely develop into the new individual encoded by the new genome

Cleavage (divide via mitosis) forms the 2 cell stage

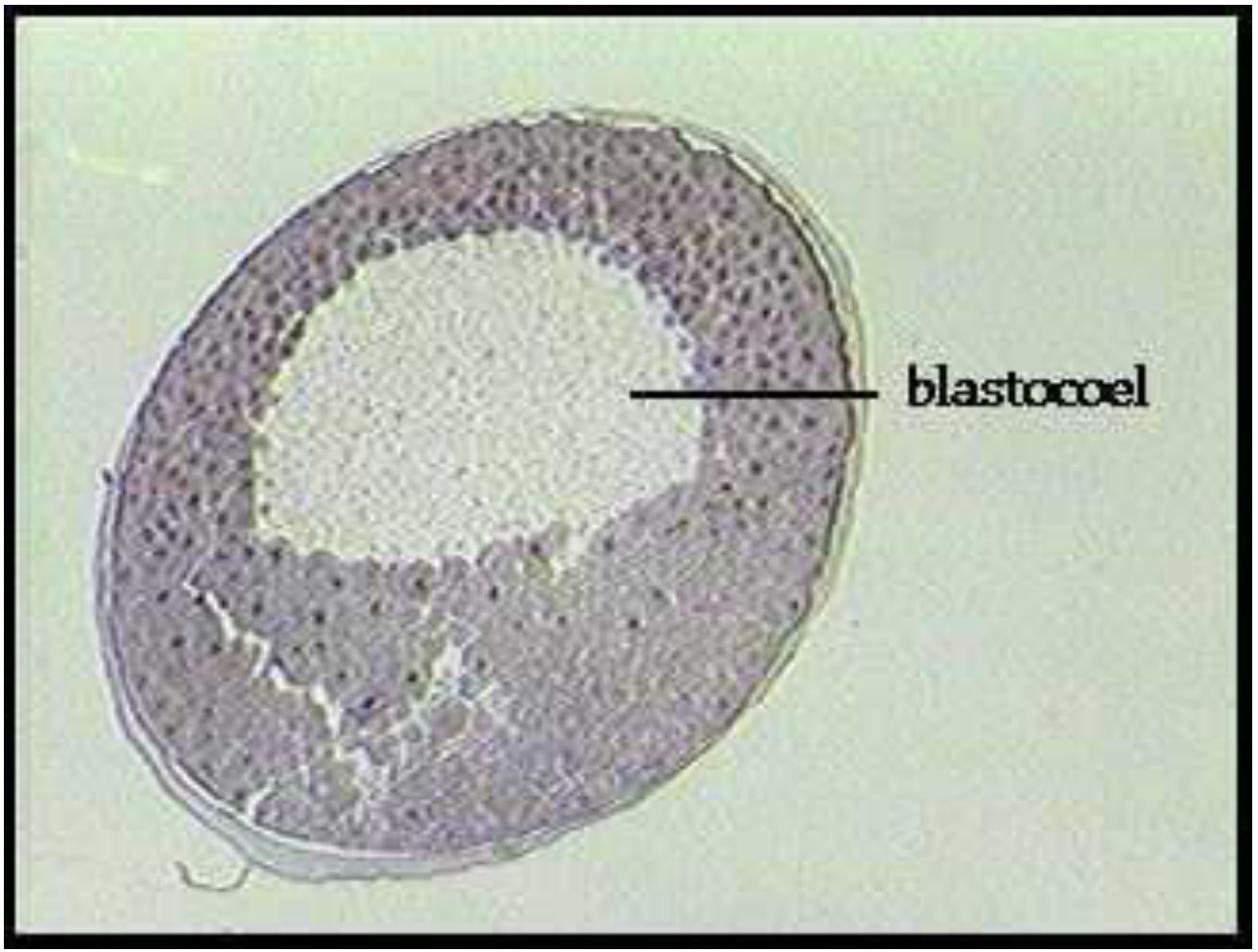


They split again to form the 4 cell stage

And again to form the 8 cell stage…

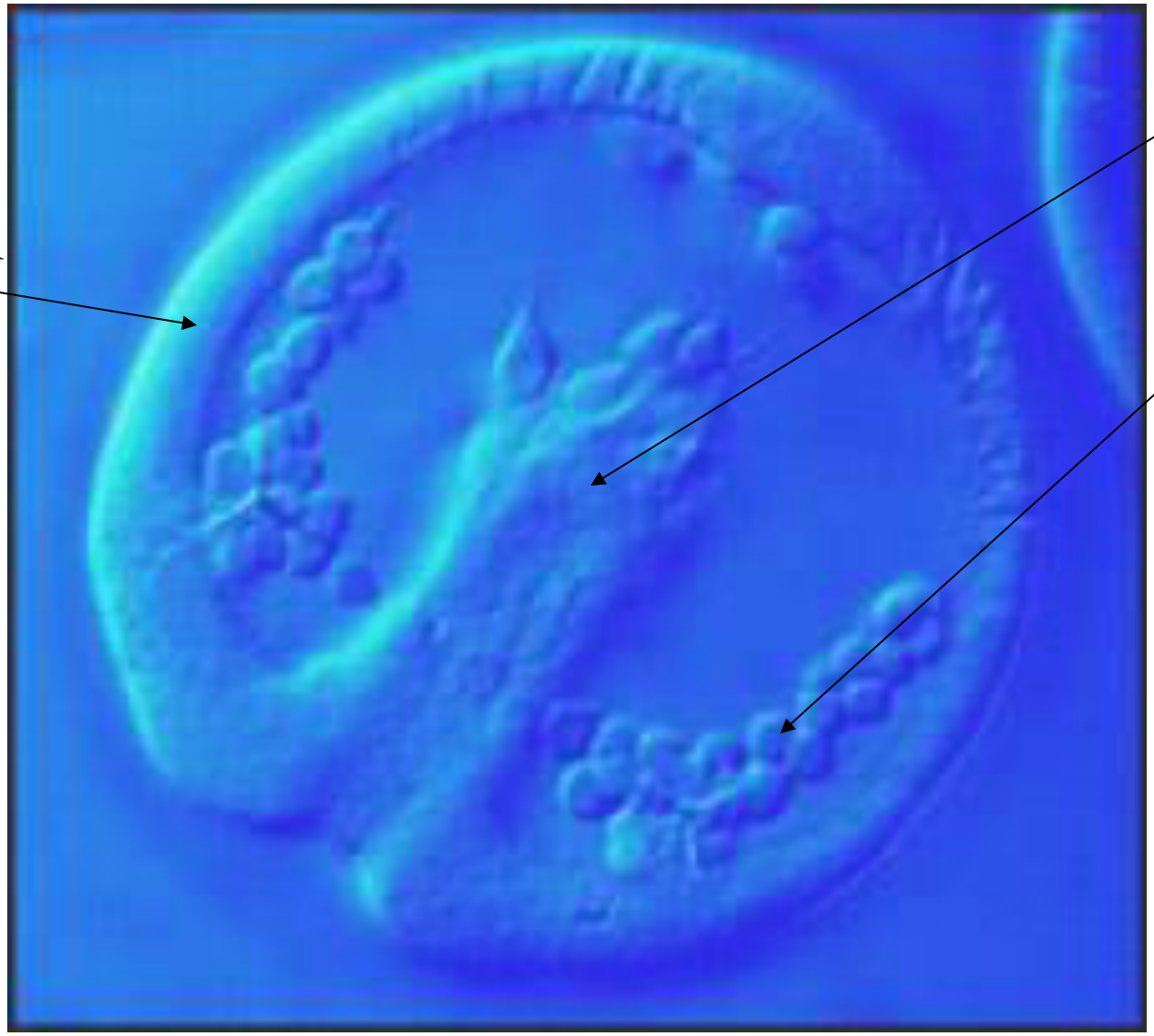
And eventually form a Morula

Next it becomes a blastula



And next, a gastrula

Late Gastrula



Human Fetus at Ten Weeks