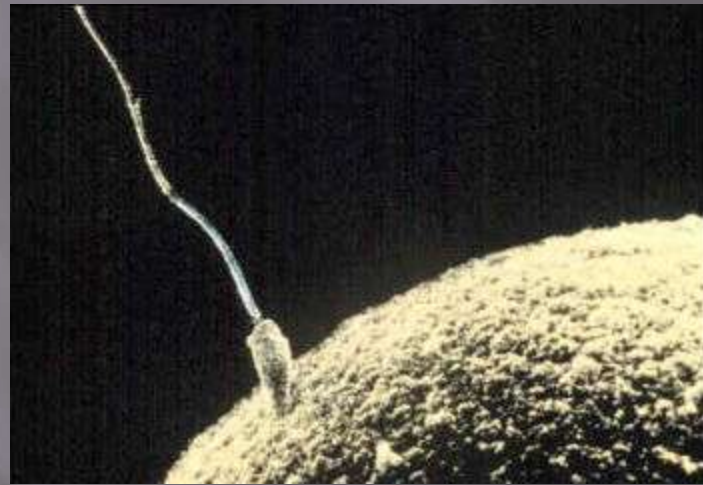


FERTILIZATION

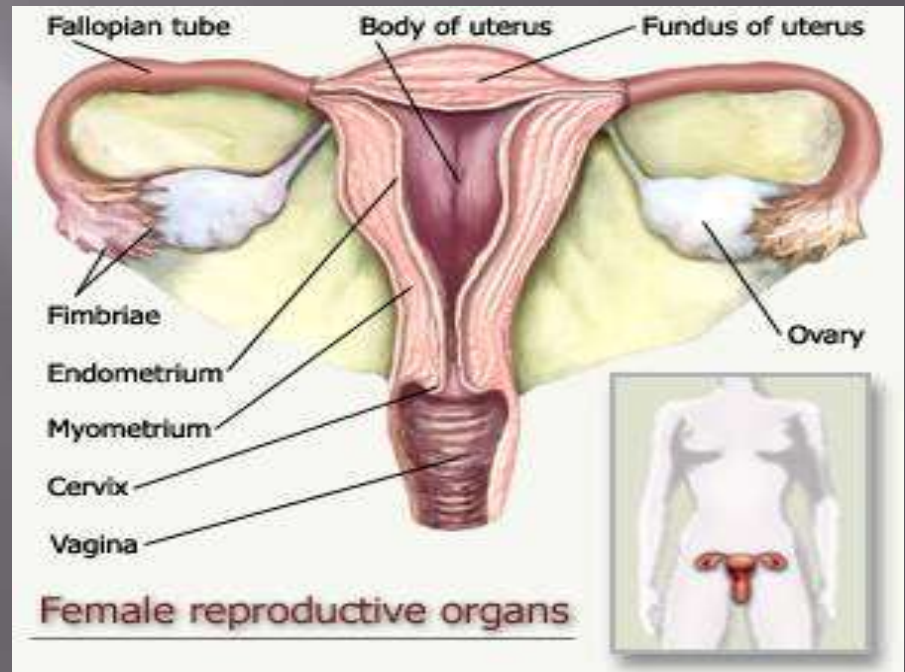


Fertilization:

- ▣ the fusion of the sperm cell nucleus with the egg cell nucleus to produce a zygote (fertilized egg)
- ▣ Brings male and females gametes together - produces diploid zygote
- ▣ It also activates the egg, triggering the beginning of embryonic development

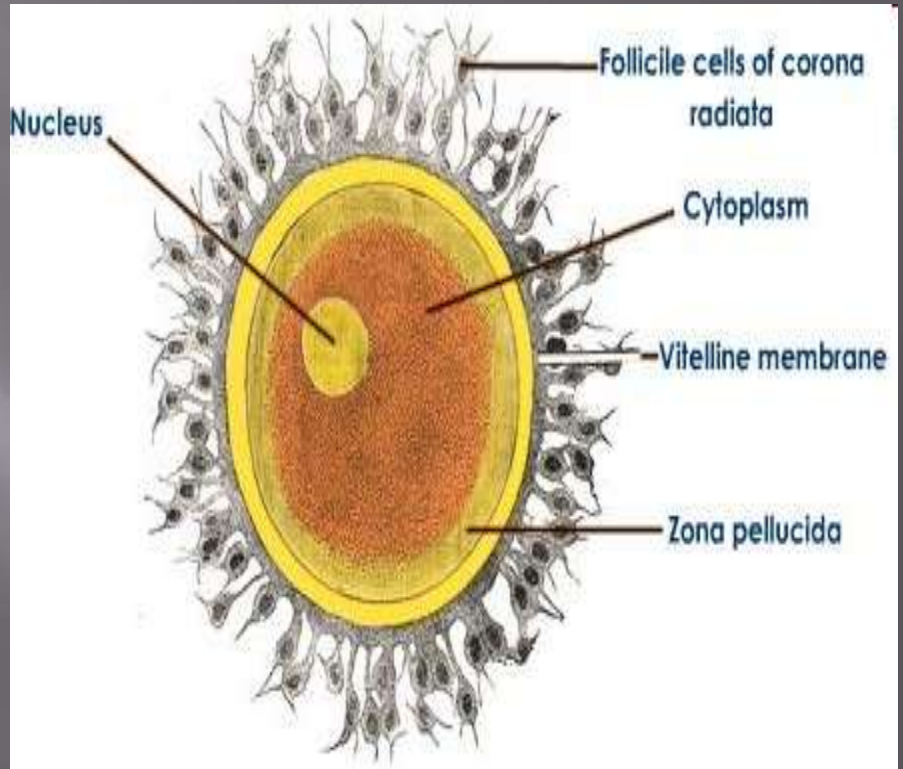
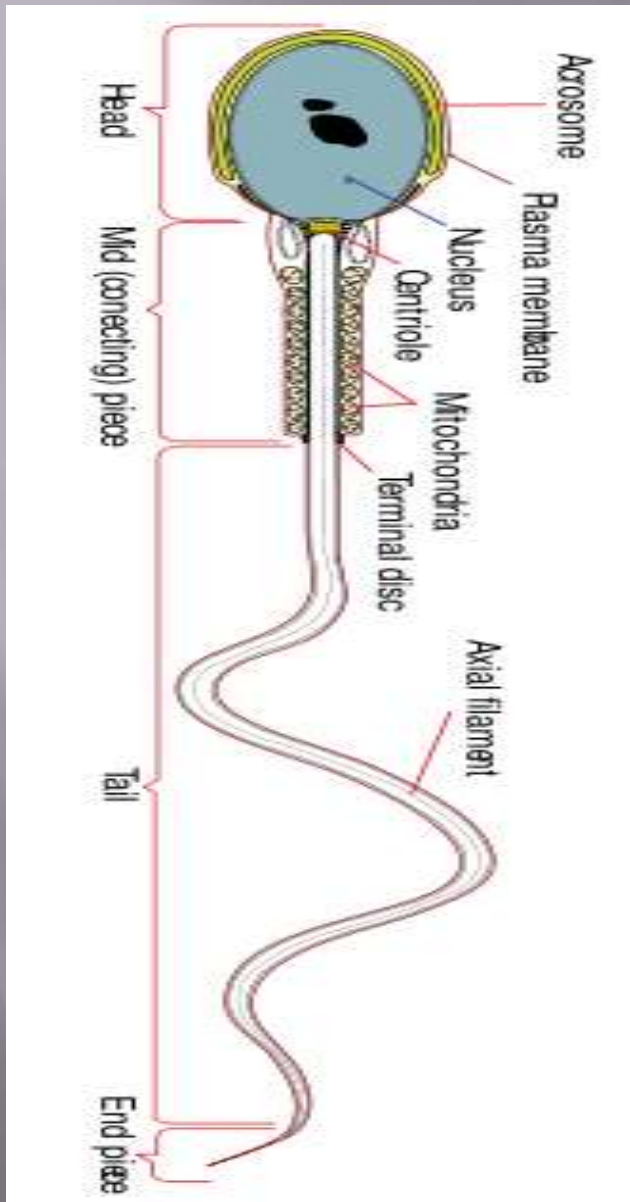
Fertilization:

- fertilization in mammals occurs in the oviduct
- The ova is viable for approximately 24 hours after ovulation



MECHANISM OF FERTILIZATION

1. ENCOUNTER OF SPERMATOZOA AND OVA
2. CAPACITATION AND CONTACT
3. ACROSOME REACTION AND PENETRATION
4. FUSION OF THE SPERM WITH THE EGG
5. ACTIVATION OF OVUM



ENCOUNTER OF SPERMATOZOA AND OVA

- During the fertile phase, millions of sperm travel from the vagina to the uterus and into the fallopian tubes.
- Chemotaxis – A chemical substance is found in the cortex of eggs.
- In general interaction is through special devices or particular forms of behaviour.
- The primary need is a fluid medium for the act of fertilization and delivery of sperm to the eggs at the right time.
- 2 types of fertilization

Fertilization:

External

- ▣ Occurs outside of the body of the female
- ▣ Increased number of eggs produced to insure the survival of the species

Eg: fish and amphibians

Fertilization:

Internal

- ▣ Occurs inside the body of the female
- ▣ Fewer number of eggs are produced
- ▣ Increased parental care insures species survival

Eg: mammals, reptiles, birds

❑ Several thousand sperm reach the egg and one will fertilize it.

❑ When the sperm fuses with the egg it initiates a series of chemical changes that prevent any other sperm from entering.

CAPACITATION AND CONTACT

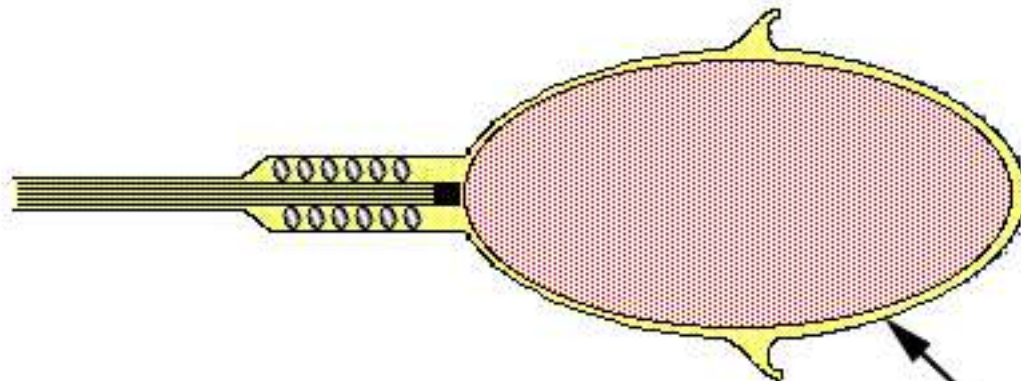
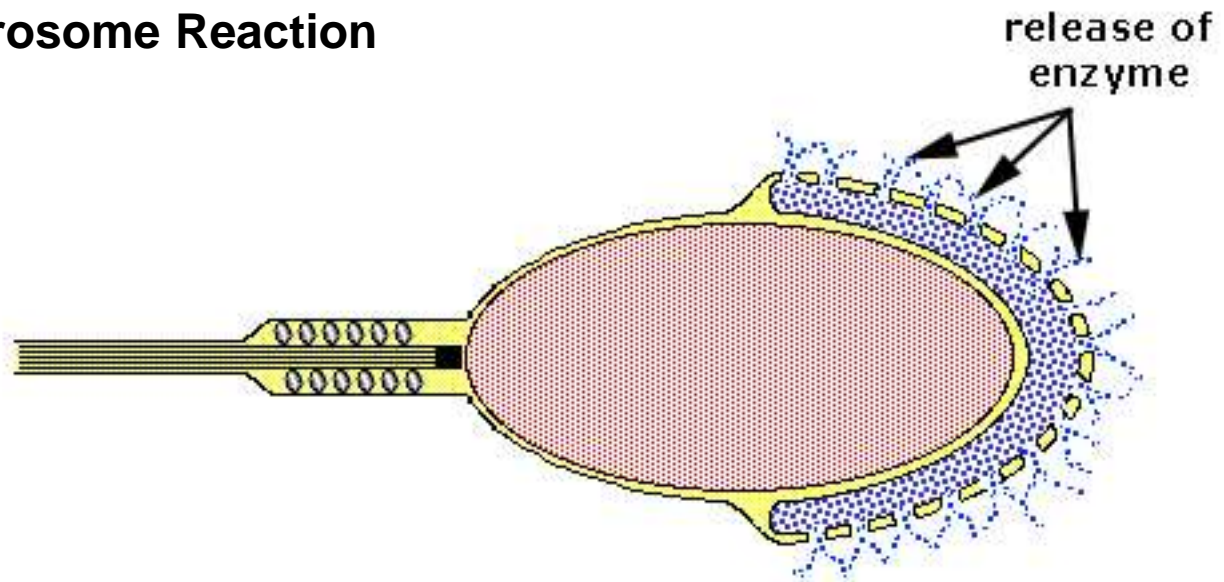
Capacitation

- ✓ Sperm undergo capacitation (further maturation) within the female reproductive tract.
- ✓ occurs in the female's vagina.
- ✓ Vaginal secretions cause a molecular change in the sperm plasmalemma (removal of decapacitating factor - semen proteins, results in increased membrane fluidity,).
- ✓ Takes 4-5 hr in humans

ACROSOME REACTION AND PENETRATION

- ▣ When the acrosome reaction occurs, a number of proteolytic enzymes are exposed or released.
- ▣ One or more of these enzymes is responsible for digesting the hole through the zona pellucida through which the sperm enters the perivitelline space.

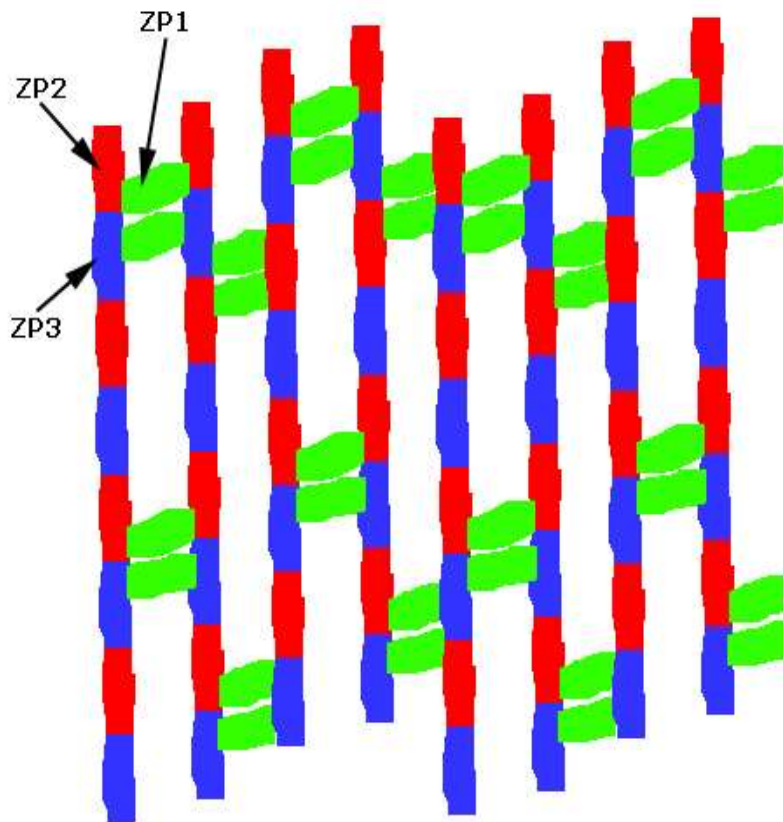
Acrosome Reaction



anterior sperm plasmalemma
now consists of the inner
acrosomal membrane

Zona pellucida

Glycoprotein Structure of the Zona Pelucida



✓ Found that zona pellucida is composed of 3 glycoproteins

✓ ZP1, ZP2, ZP3

✓ Repeating subunits of ZP2 and ZP3 form filaments that are bound together by ZP1

FUSION OF THE SPERM WITH THE EGG

- The male nucleus enters the egg cytoplasm and becomes the male pronucleus.
- As a result of the sperm fusing with the egg plasmalemma, the oocyte nucleus, which is at metaphase of the second meiotic division, completes that division giving rise to another polar body.
- Following the second meiotic division, what is now the nucleus of the ovum becomes the female pronucleus.
- The haploid male and female pronuclei move toward one another, meet, and fuse to form the diploid nucleus of the zygote.
- The zygote will now proceed to undergo cleavage.

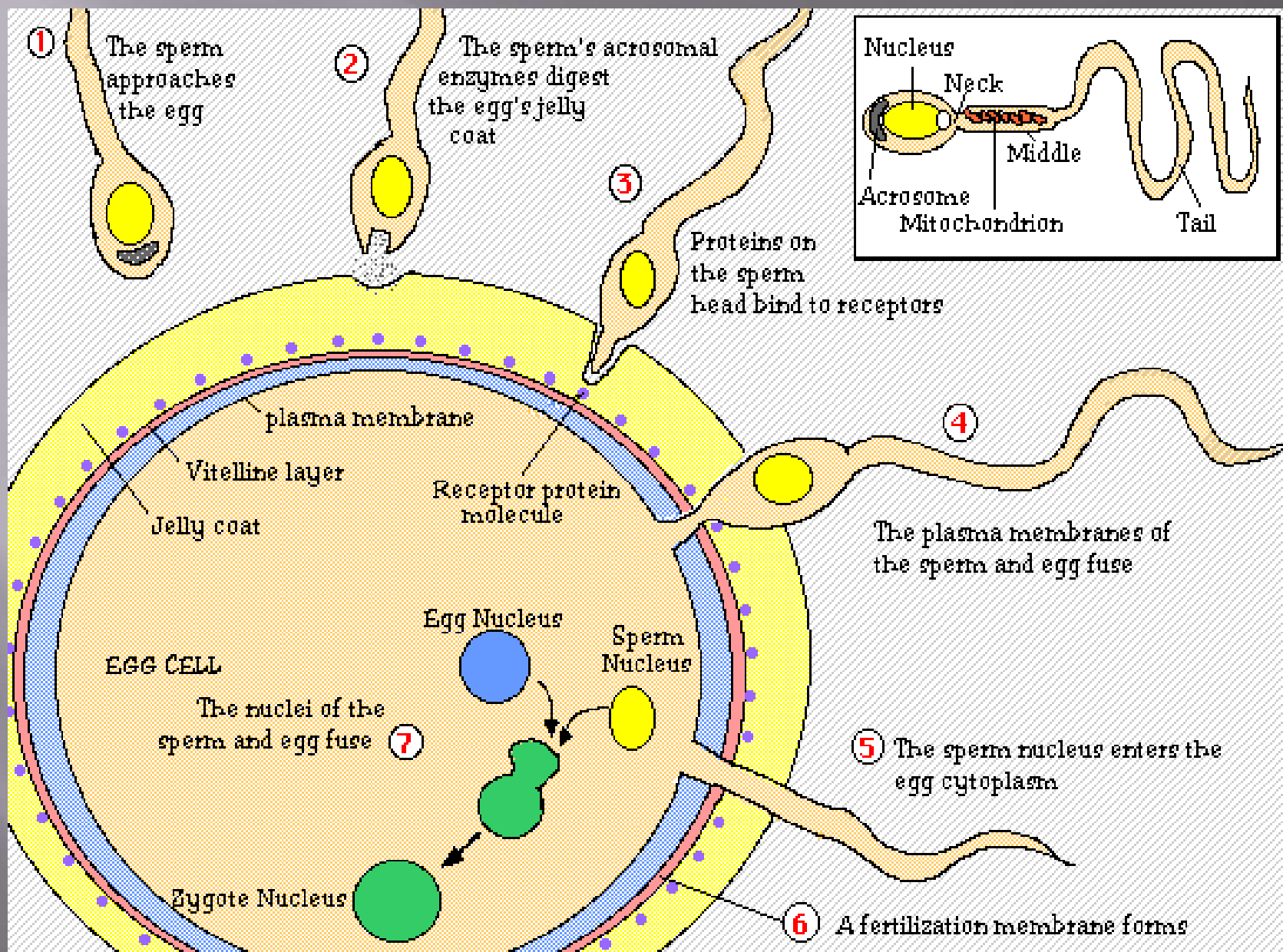
ACTIVATION OF OVUM

- ▣ A series of morphological, physiological and molecular changes that occur in the egg in response to fusion of the sperm with the egg.

Events that characterize egg activation

- ▣ **1. Release of Ca⁺⁺** (calcium) stored in the egg endoplasmic reticulum - appears to be the critical step in the process.
- ▣ **2. Cortical reaction** - rupture of cortical granules that occurs concurrently with the Ca⁺⁺ release. Contents of granules are released into perivitelline space and cause “hardening” of the vitelline membrane or zona pellucida. Causes vitelline/fertilization membrane to rise away from surface of egg **in some species**.

- 3. In many species, an influx of Na⁺ (sodium) into the egg cytoplasm that causes a change in membrane potential - fast block to polyspermy.
- 4. In many species a reorganization of the egg cytoplasm.
- 5. In most cases, completion of meiosis by the egg.
- 6. An efflux of H⁺ (hydrogen) ions causing an increase in cytoplasmic pH - this activates previously inhibited synthetic pathways.
- 7. Increase in metabolism - zygote gears up for development.



1

The sperm approaches the egg

2

The sperm's acrosomal enzymes digest the egg's jelly coat

3

Proteins on the sperm head bind to receptors

4

The plasma membranes of the sperm and egg fuse

5

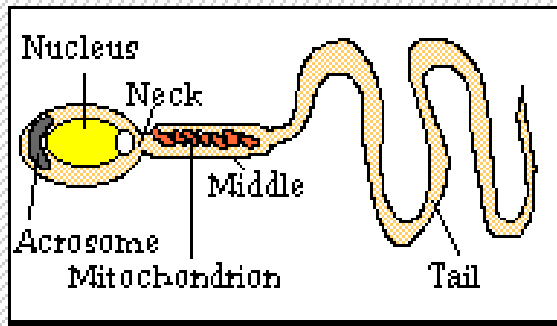
The sperm nucleus enters the egg cytoplasm

6

A fertilization membrane forms

7

The nuclei of the sperm and egg fuse



EGG CELL

Jelly coat
Vitelline layer
plasma membrane

Receptor protein molecule

Egg Nucleus

Sperm Nucleus

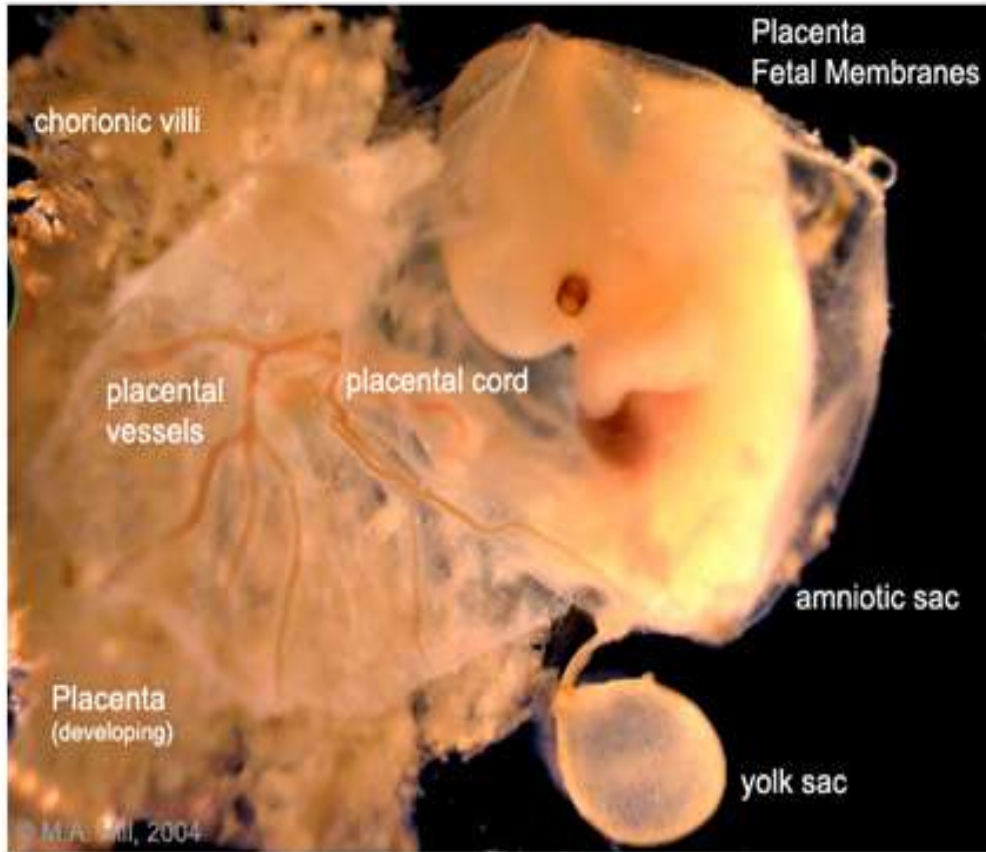
Zygote Nucleus



As early as 12 hours after fertilization you can see the two bundles of genetic material (two pronuclei), one from each parent.

By 18-20 hours after fertilization, these pronuclei fuse, and what starts out as two cells becomes one (called a zygote)

EMBRYONIC DEVELOPMENT



Embryo:

- ▣ a multicellular organism in the early stages of development

2 four cell stage embryos



Eight cell stage embryo



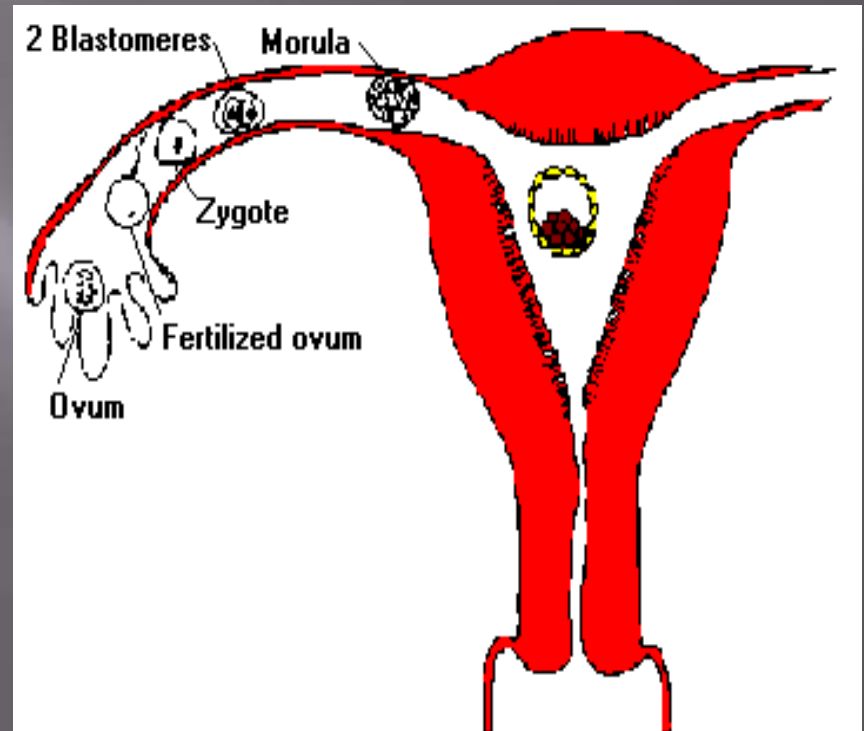
Embryo:

The beginning developmental processes are always the same in all animals:

- 1) cleavage
- 2) growth
- 3) differentiation

Embryo:

- after fertilization the diploid ZYGOTE undergoes cleavage divisions in the oviduct



Cleavage

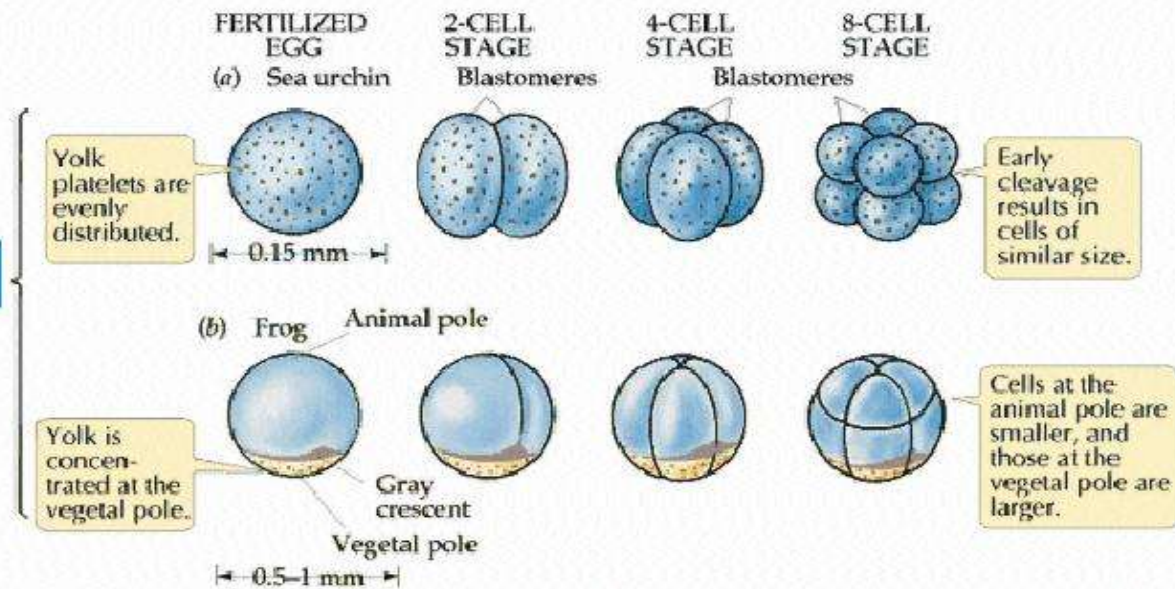
the first series of cell divisions by mitosis
after fertilization

Cell division is rapid, new cells do not take
time for the growth phase G_1

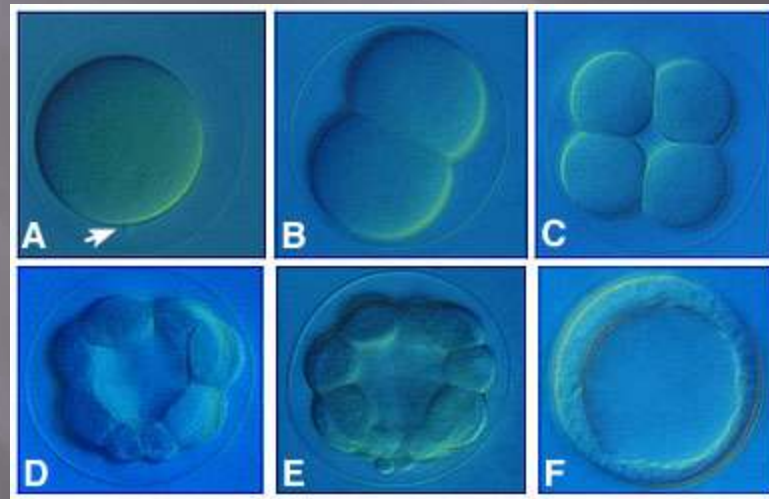
**cell growth does not occur so cells decrease
in size with each cleavage division**

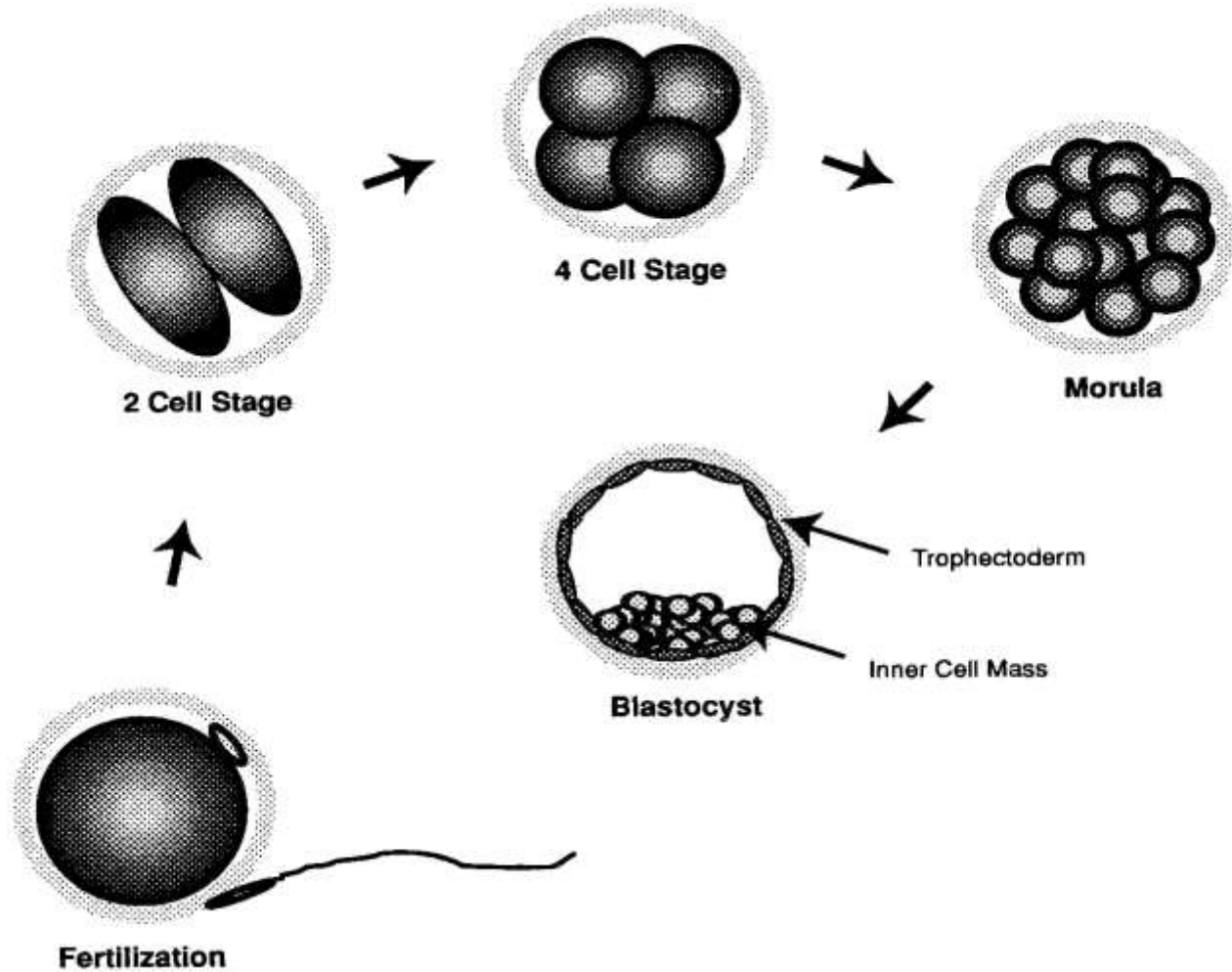
Cleavage divisions

Complete Cleavage



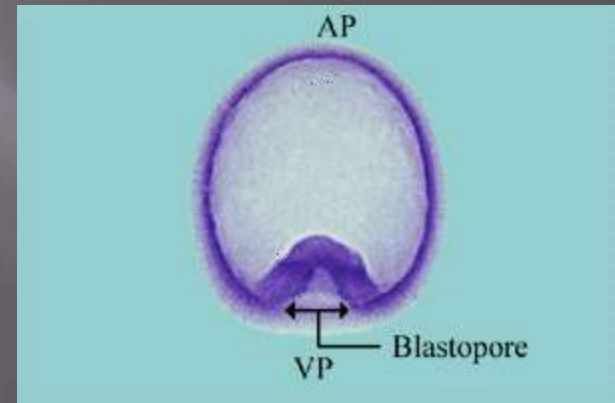
- ▣ Morula forms (solid ball of cells)
- ▣ Blastula forms (hollow ball of cells)
- ▣ Cells begin to grow before dividing



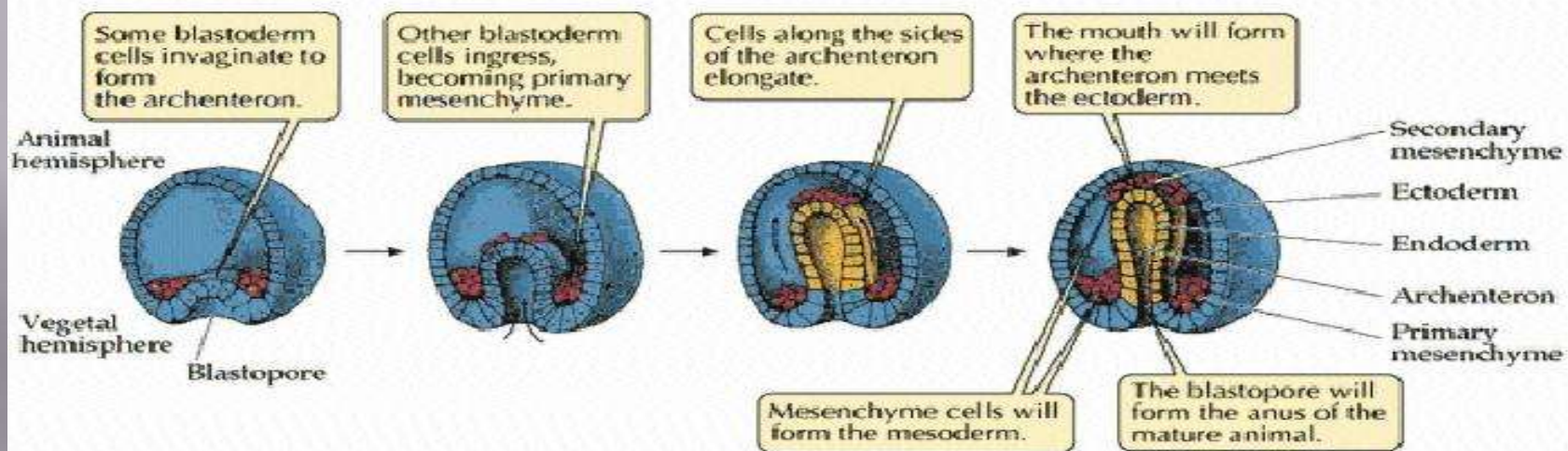


Differentiation

- ▣ **Gastrulation:** one side of the blastula invaginates (indents) forming a gastrula
- ▣ Three cell layers form



Differentiation



Differentiation

- ▣ The changing of unspecialized embryonic cells into the specialized cells, tissues and organs of a multicellular animal

Germ Layers

- ▣ **Ectoderm** **Outer layer**
- ▣ Nervous system including brain, spinal cord and nerves
- ▣ Lining of the mouth, nostrils, and anus
- ▣ Epidermis of skin, sweat glands, hair, nails

Germ Layers

- ▣ **Mesoderm** **Middle Layer**
- ▣ Bones and muscles
- ▣ Blood and blood vessels
- ▣ Reproductive and excretory systems
- ▣ Inner layer (dermis) of skin

Germ Layers

- ▣ **Endoderm Inner Layer**
- ▣ Lining of digestive tract
- ▣ Lining of trachea, bronchi, and lungs
- ▣ Liver, pancreas
- ▣ Thyroid, parathyroid, thymus, urinary bladder

Later Stages of Fetal Development

