Life's Common Challenges

Response: Sense & Respond

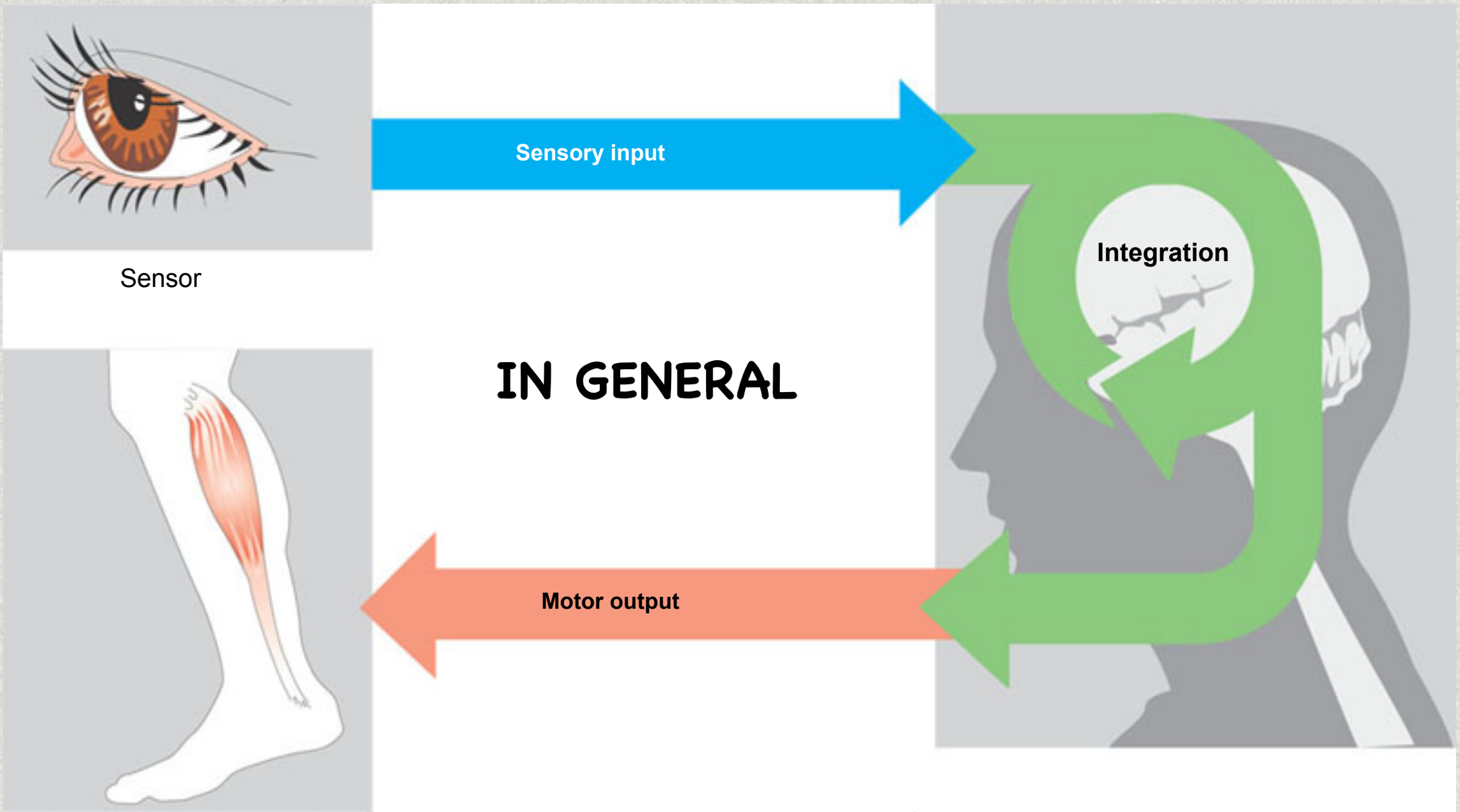
Sensing the World

- ***Sensing and consequently <u>Responding</u> to the environment is an absolute necessity for all organisms.***

Locomotion

- ***For many organisms, Responding to environmental stimuli often involves moving to or away from a stimulus***.
  - *Locomotion*- is the ability to move place to place, the act of self propulsion.

INFORMATION PROCESSING



Life's Common Challenges

"Sensing"

SENSING THE ENVIRONMENT

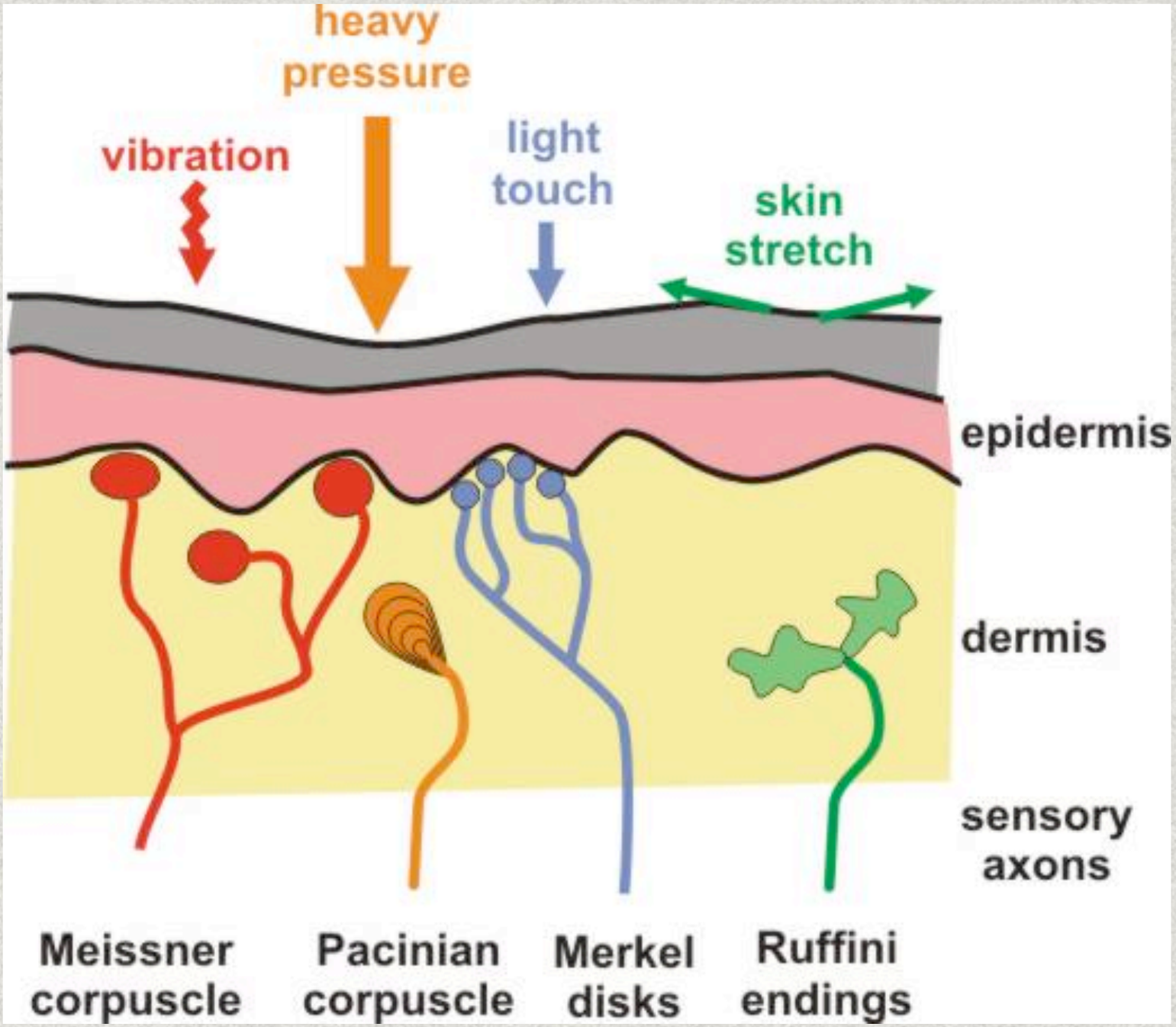
- **Before an animal can RESPOND to its environment it must first sense its environment!**

SENSORY RECEPTION

- Sensory cells have sensory receptors that detect the stimuli directly. (unicellular and multicellular organisms)
  - The type of stimuli regularly detected include: electromagnetic radiation, pressure, temperature, chemicals, light

Mechanoreceptors

- pressure, touch, stretch, motion and sound



Chemoreceptors

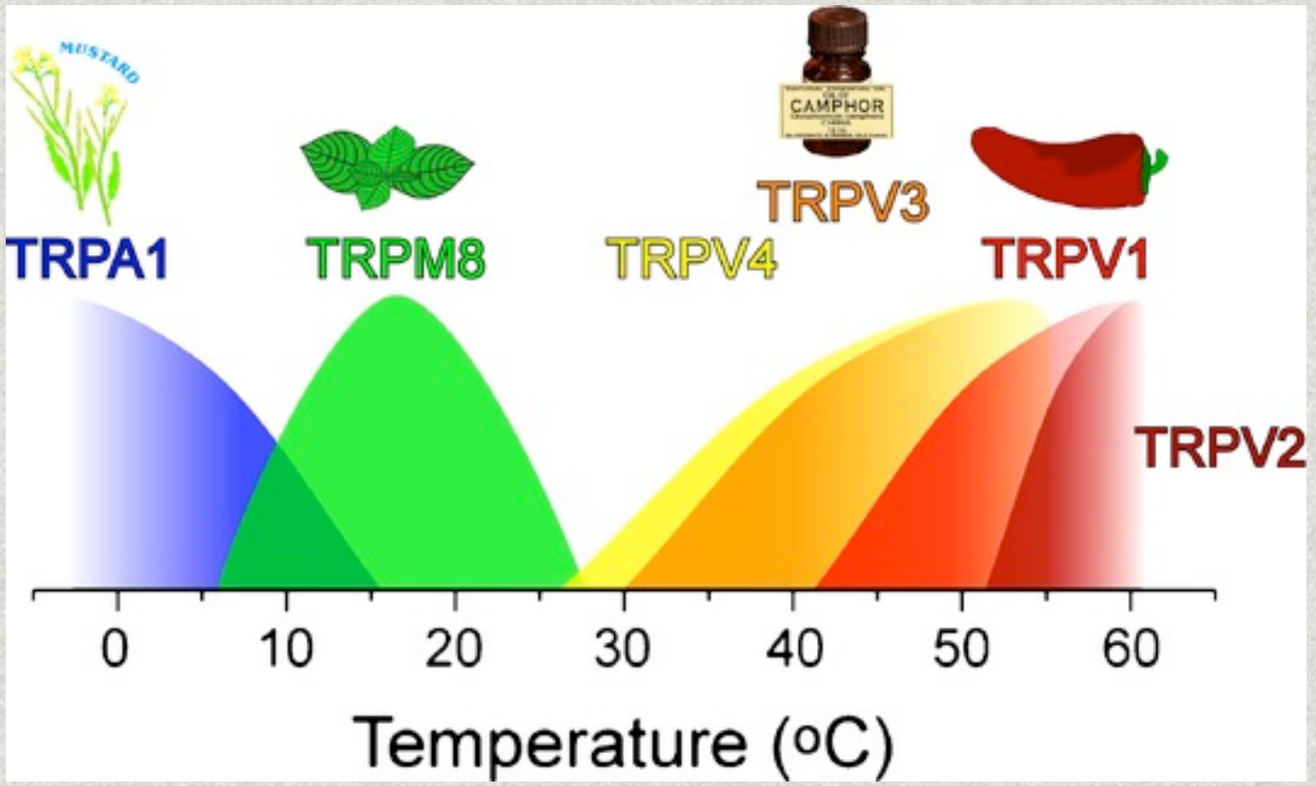
- Transmit information about specific molecules or total solute concentration.
  - oxygen, carbon dioxide, glucose and amino acids.

Electromagnetic Receptors

- light, infrared, UV, electricity and magnetism.

Thermoreceptors

- Detect heat and cold.
  - Each TRP receptor detects a different temperature range.



Photoreceptors

- Detect wavelengths of visible light: Roy G. Biv
  - Rods and cones detect light in vertebrates.

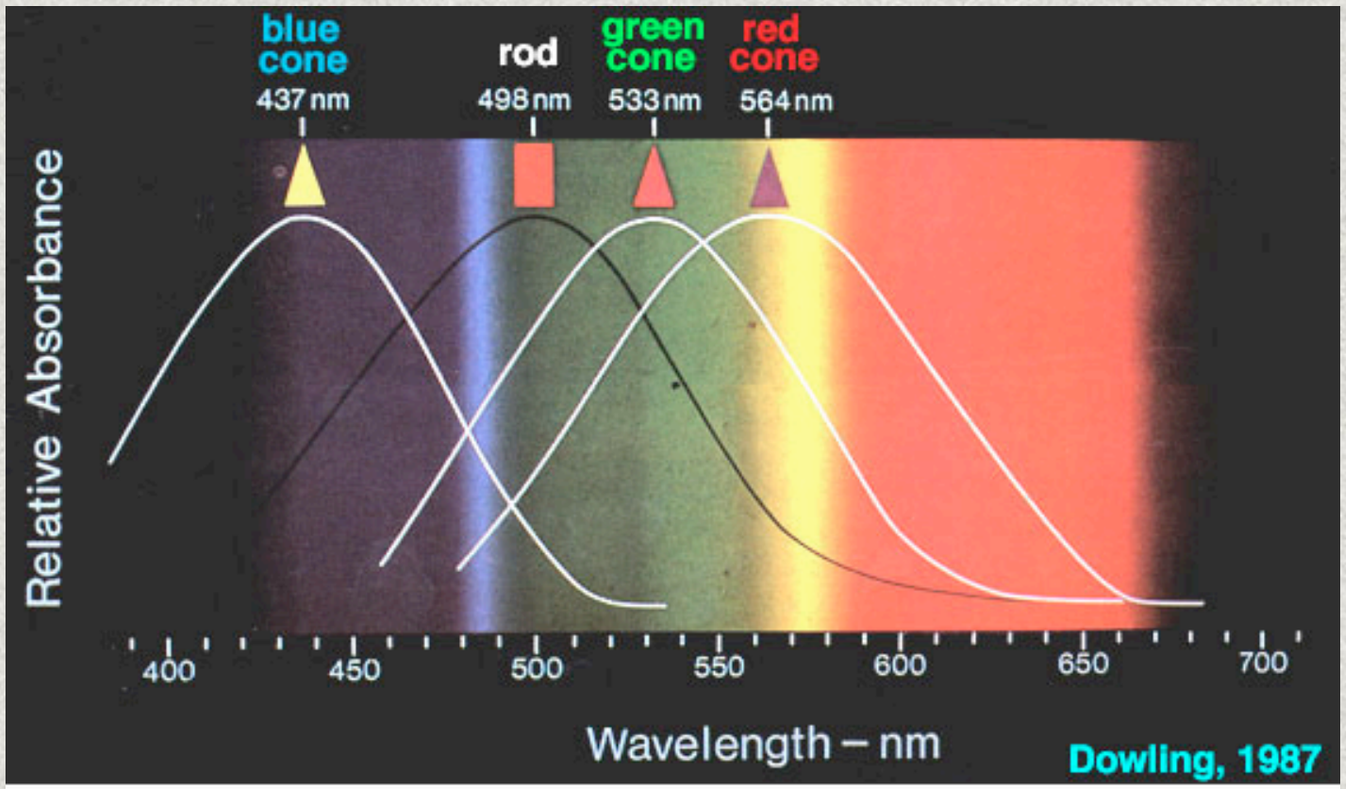


Fig. 14. The peak spectral sensitivities of the the 3 cone types and the the rods in the primate retina (Brown and Wald, 1963). From Dowling's book (1987).

Nociceptors (Pain Receptors)

- Detect extremes: temperature, pressure, heat or chemicals.
  - Many of the other receptors can act as a pain receptors in cases of extreme stimuli.

- ***Although receptors detect certain stimuli this detection is not enough alone to warrant a response.***

- stimulus must be ***transduced***, to turned into electrical impulses and passed onto the brain

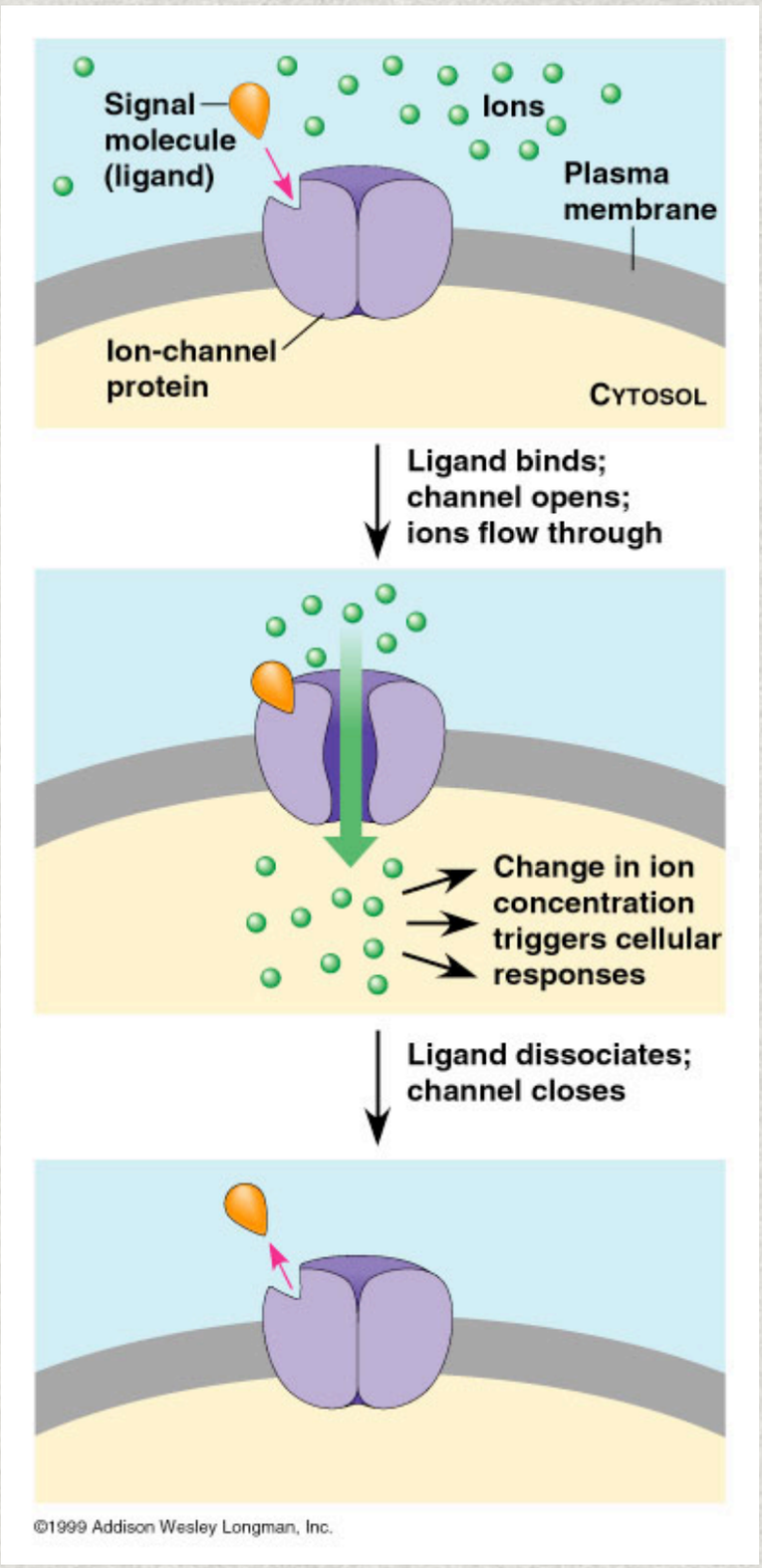
- membrane potentials (electrical impulses) must be ***transmitted*** from the brain to the effector cells.

SENSORY PERCEPTION

- Brain's neuronal circuits interpret this information and generate a perception.
- Perceptions include colors, sounds, tastes, smells
- **Perceptions are constructions formed in the brain and do not exist outside it!**

SENSORY TRANSDUCTION

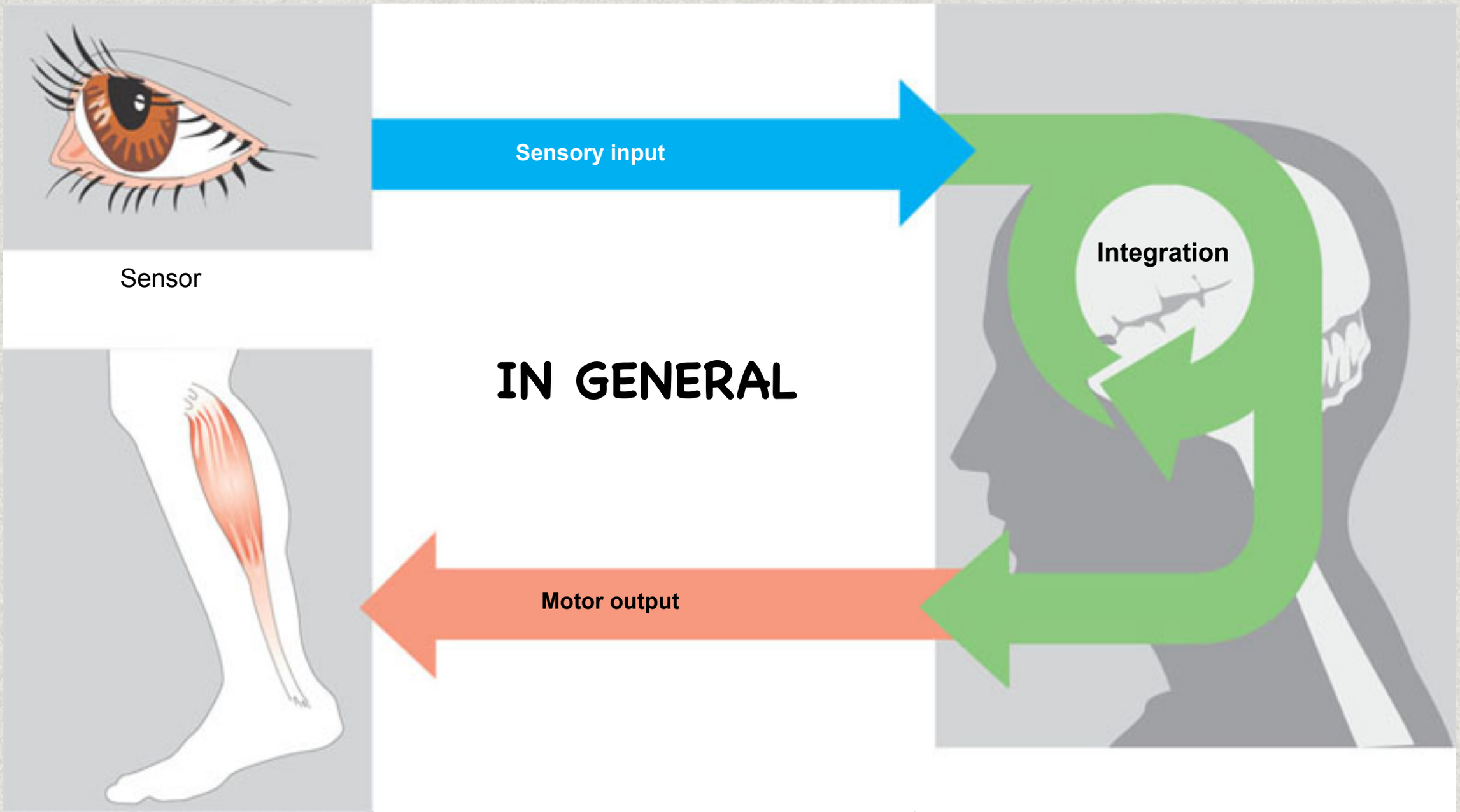
- The conversion of a physical or chemical stimulus to change in membrane potential of the cell with the sensory receptor.
- In other words the stimulus must be converted into an electrical impulse



SENSORY TRANSMISSION

- Changing the membrane potential of the sensory cell initiates the action potential (electrical impulse) which is then carried by neurons to the central nervous system.

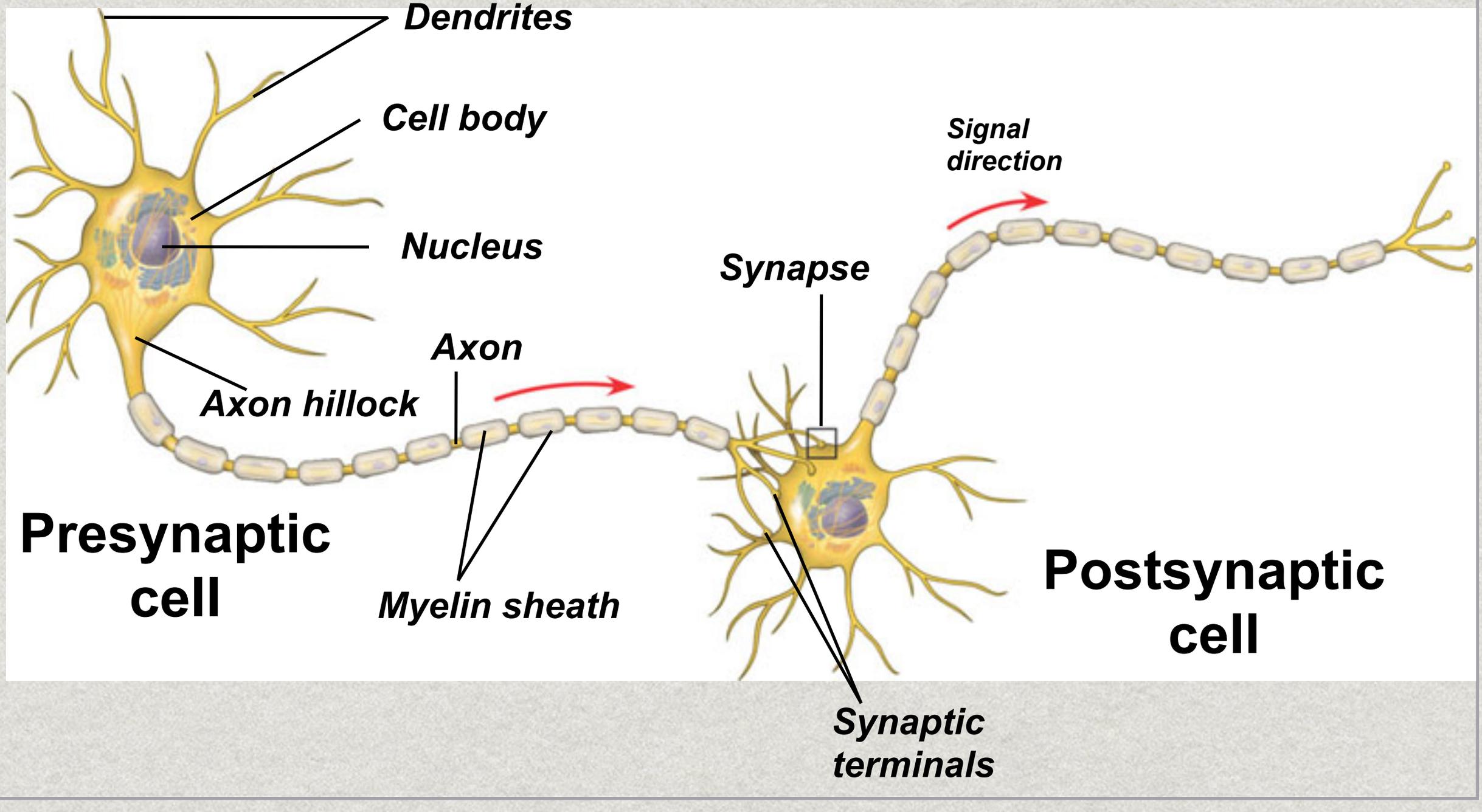
INFORMATION PROCESSING



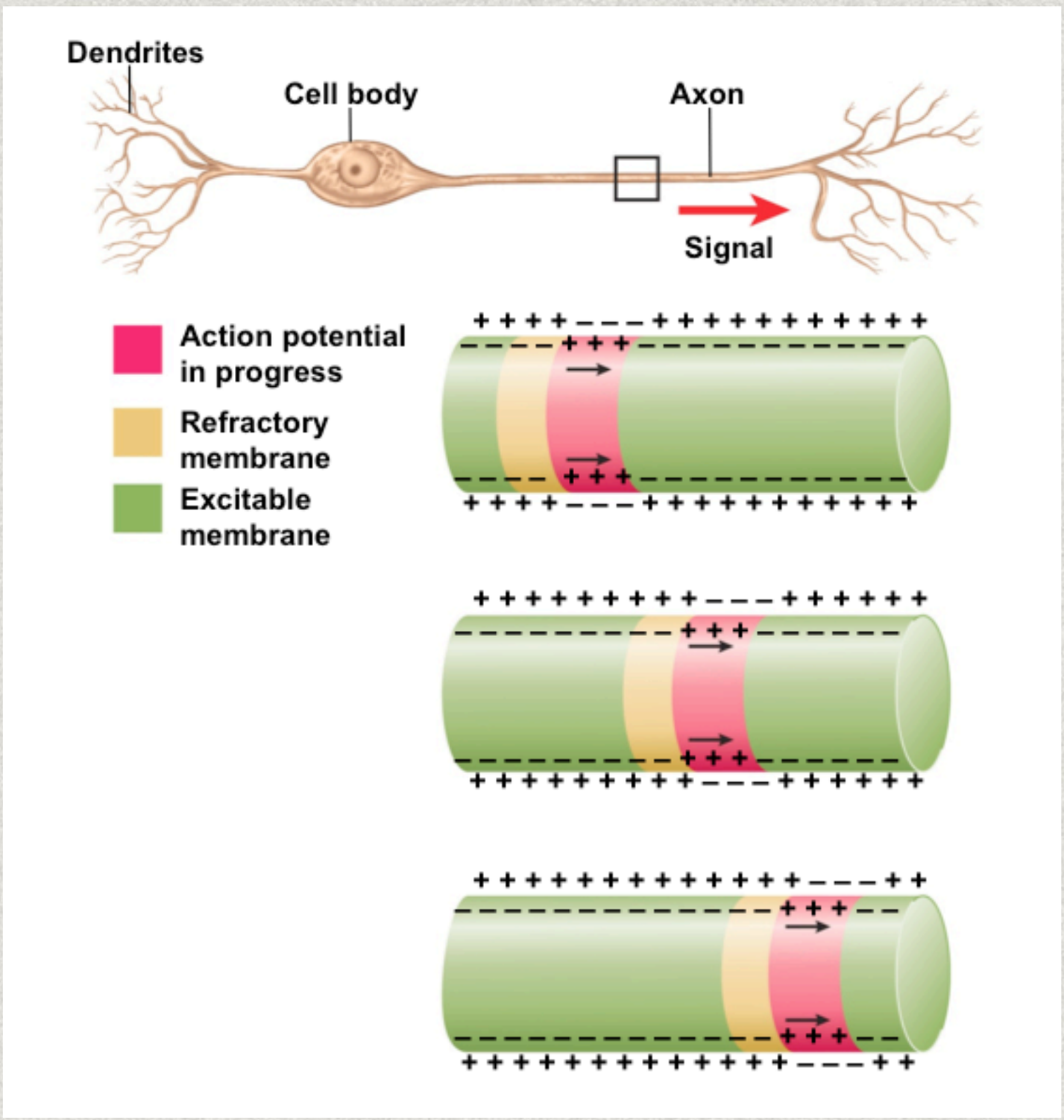
NEURONS: Structure & Function

- **Neurons are the functional units of nervous systems.**
  - **Neurons transmit signals from one location in the body to another .**

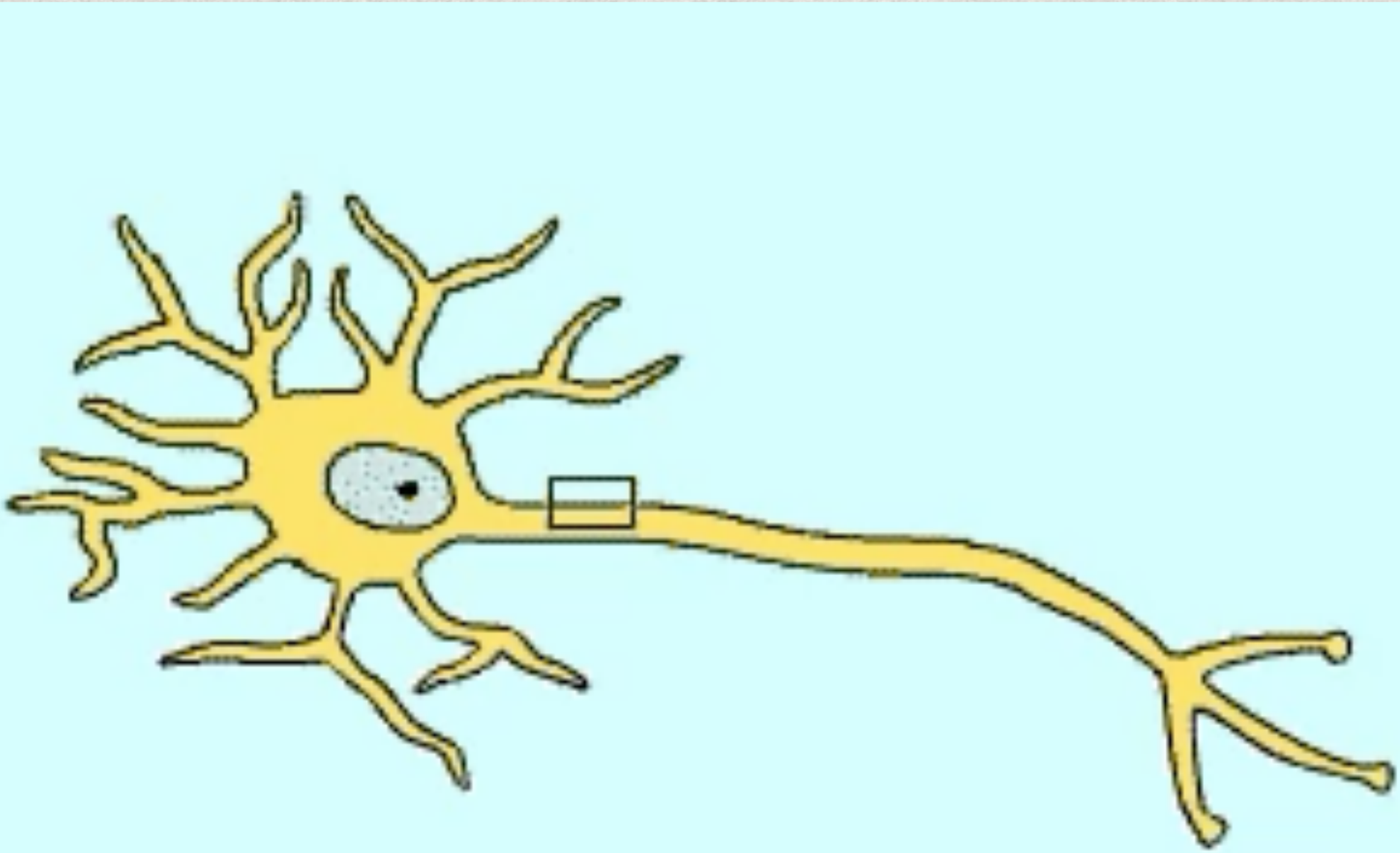
NEURON: Structure



Neuron: (action potential conduction)



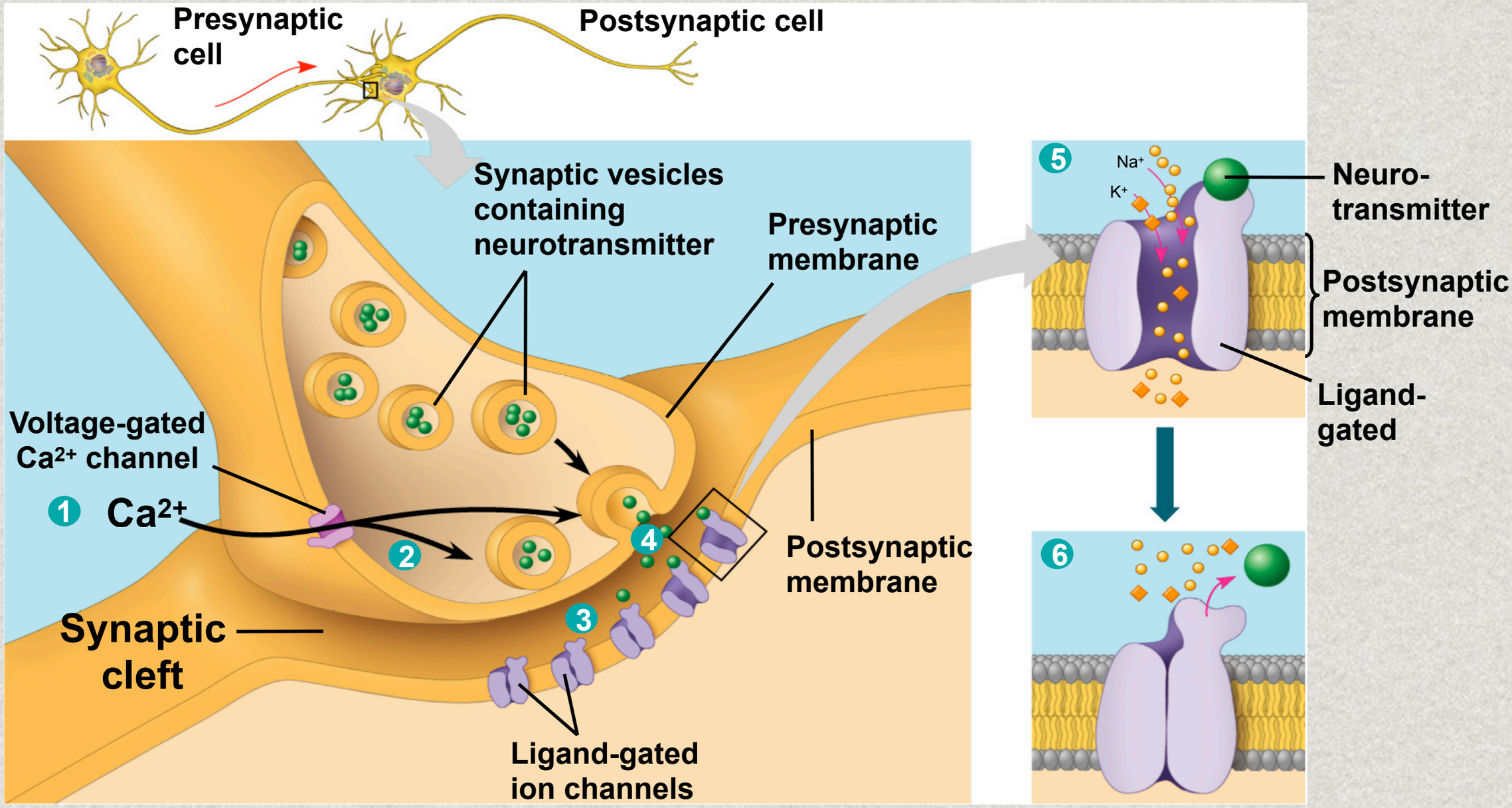
Neuron: FUNCTION (action potentials)



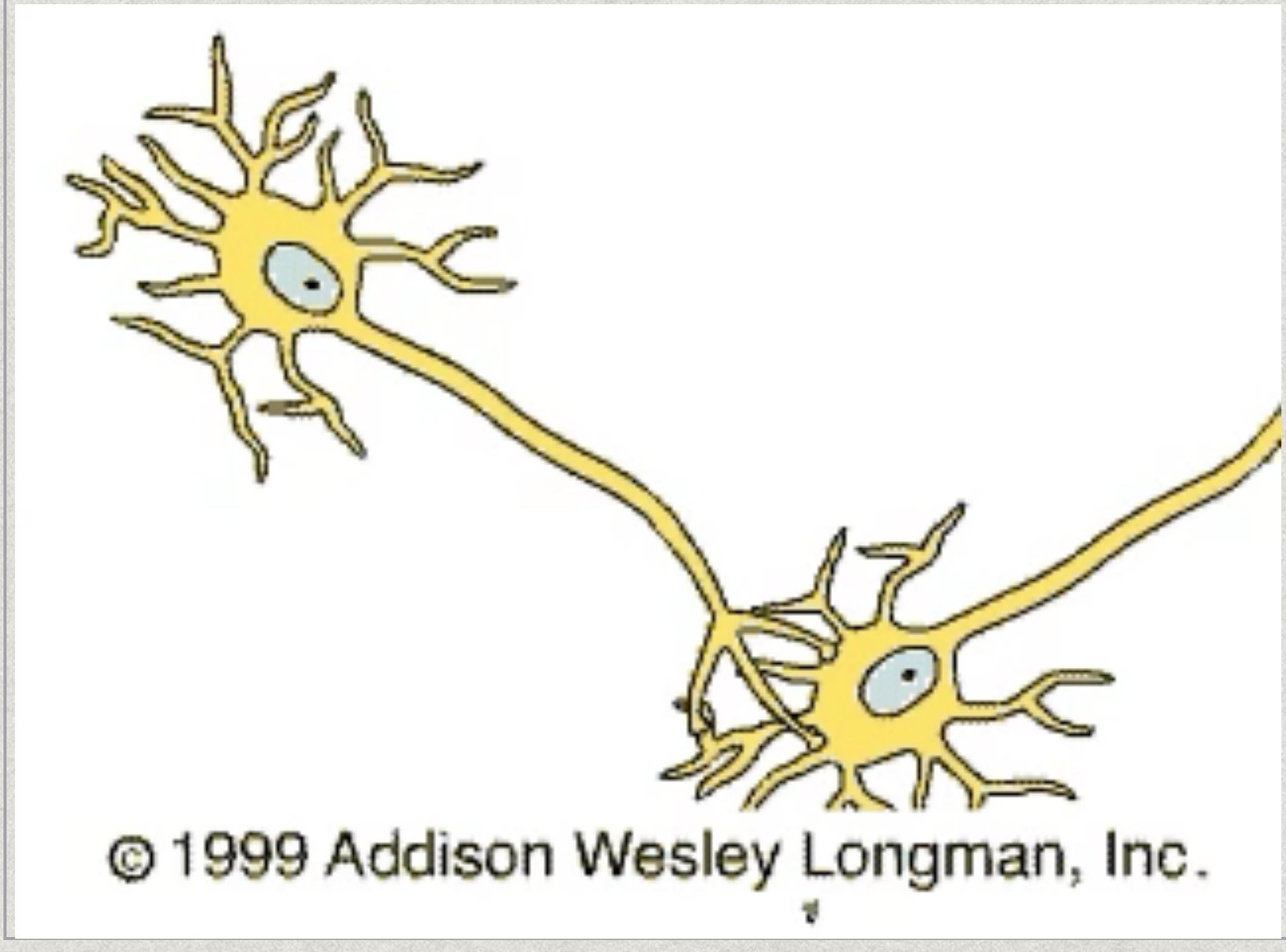
Neuron: FUNCTION (synaptic transmission)

- Nerve cells communicate with other cells at synapses.
  - Effector cells include other nerves, muscles or glands
- Electric synapse.
- Chemical synapse.

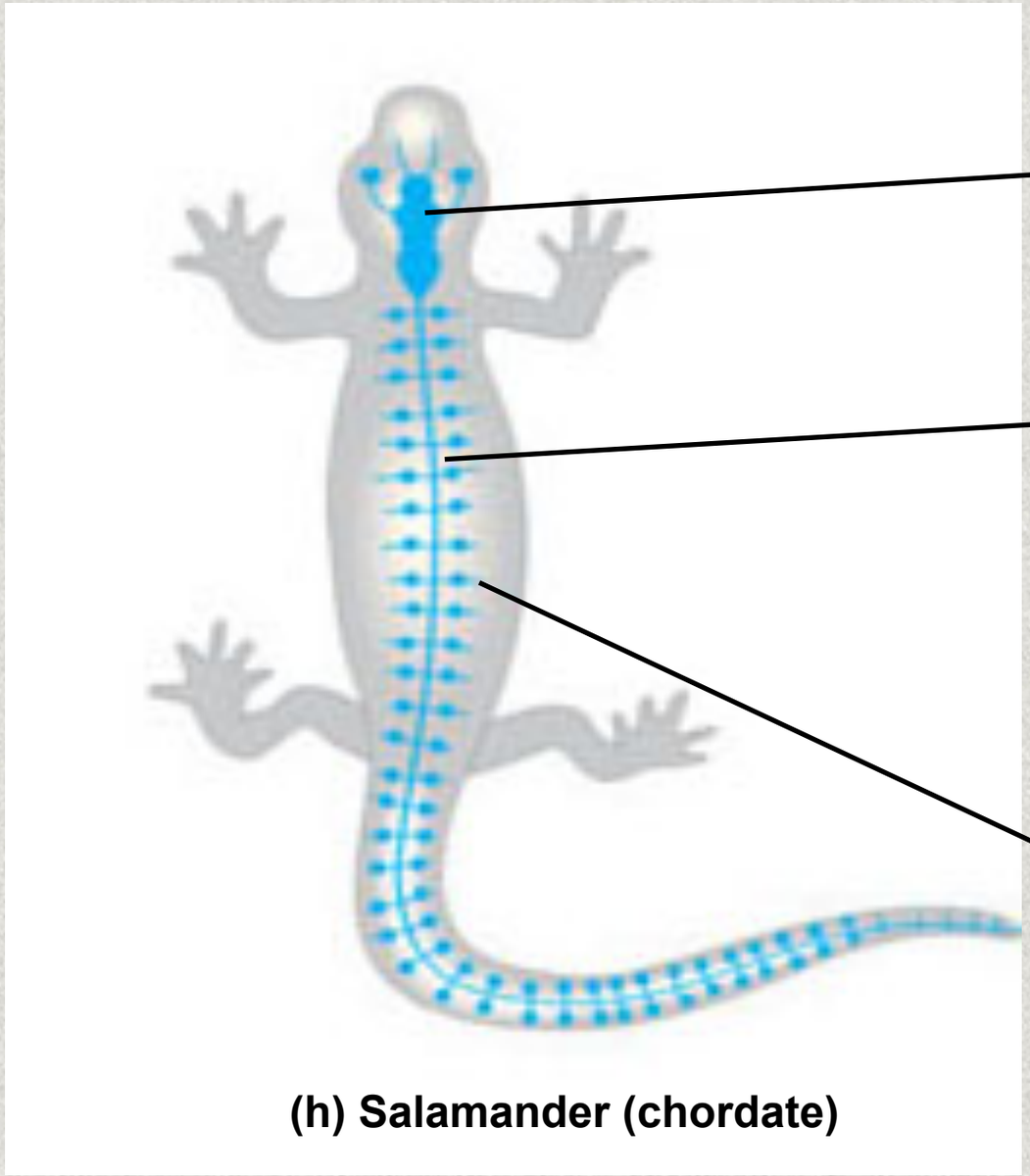
Neuron: FUNCTION (synaptic transmission)



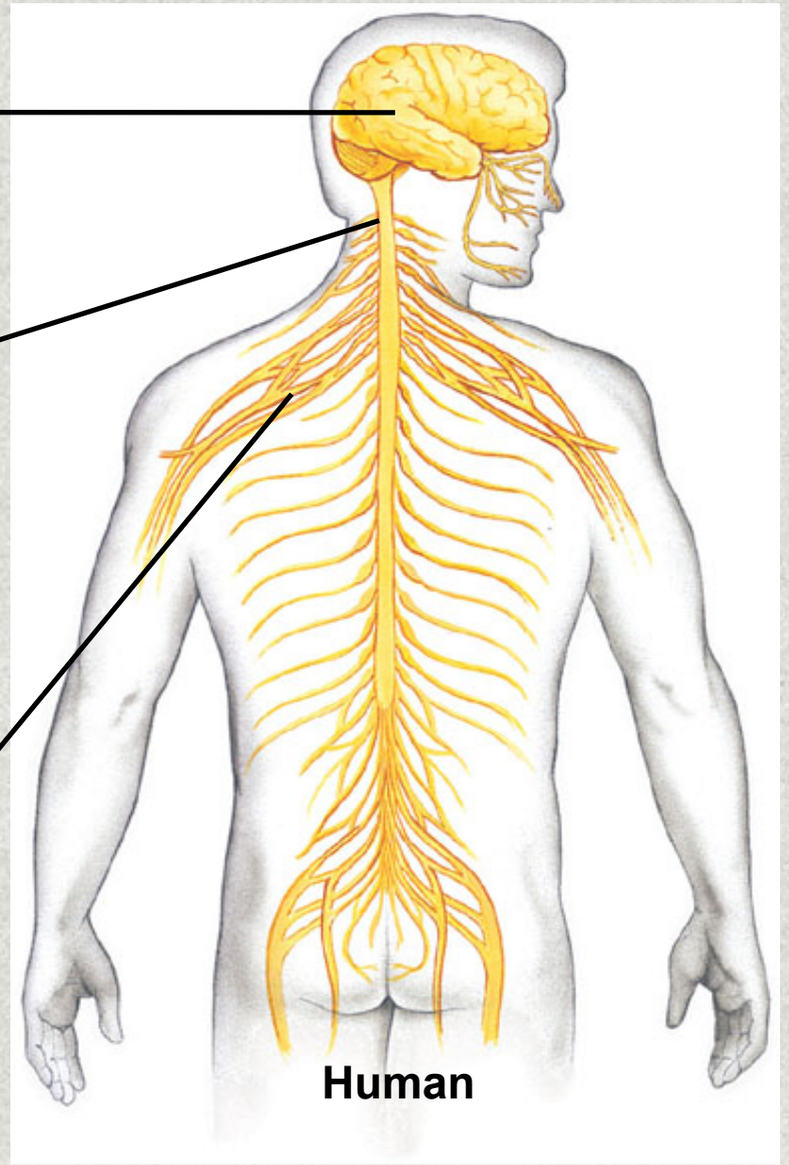
Neuron: FUNCTION (synaptic transmission)



- **Vertebrates have a (CNS) with a brain and spinal cord and a peripheral nervous system that connects to CNS.**



(h) Salamander (chordate)



Human

Human Brain & Spinal Cord

- **The brain provides integrative power that underlies the complex behavior of vertebrates.**
- **The spinal cord integrates simple processes and conveys information to and from the brain**

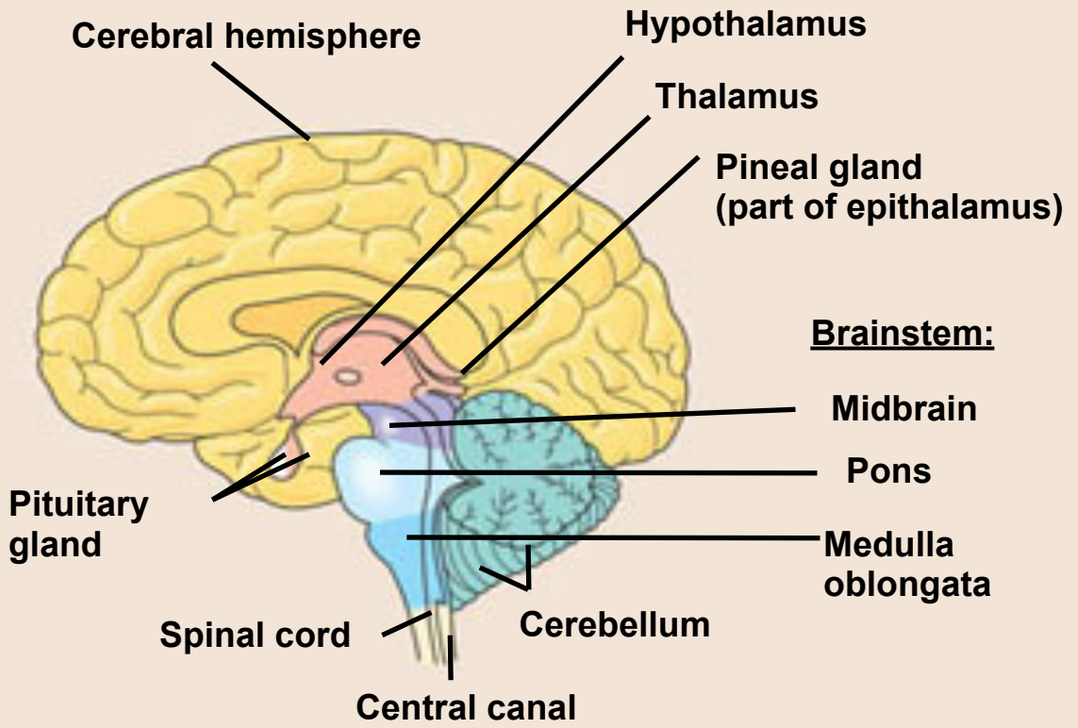
Cerebrum (cerebral hemispheres; includes cerebral cortex, white matter, basal nuclei)

Diencephalon (thalamus, hypothalamus, epithalamus)

Midbrain (part of brainstem)

Pons (part of brainstem), cerebellum

Medulla oblongata (part of brainstem)



Adult

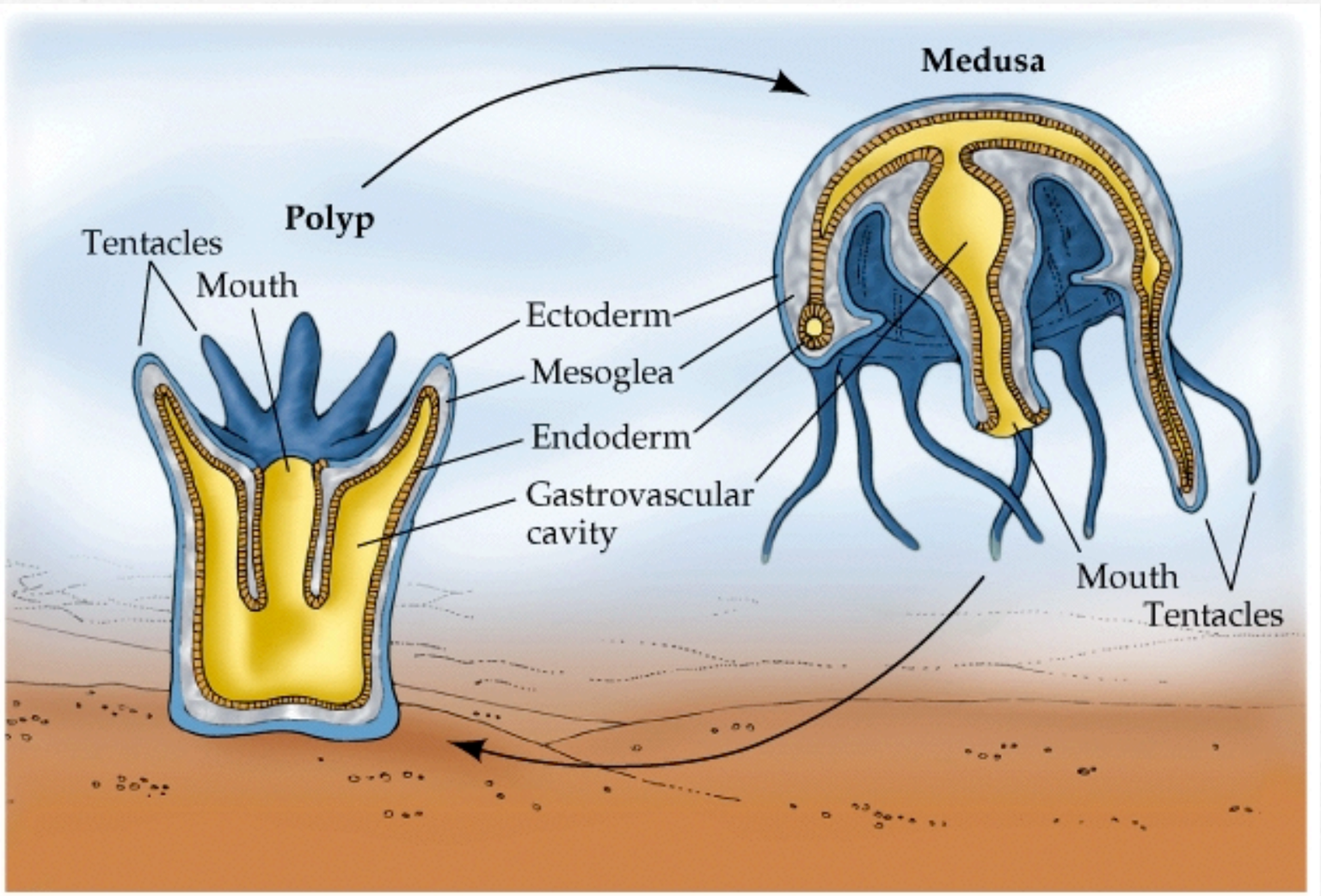
Animals

Circulatory System

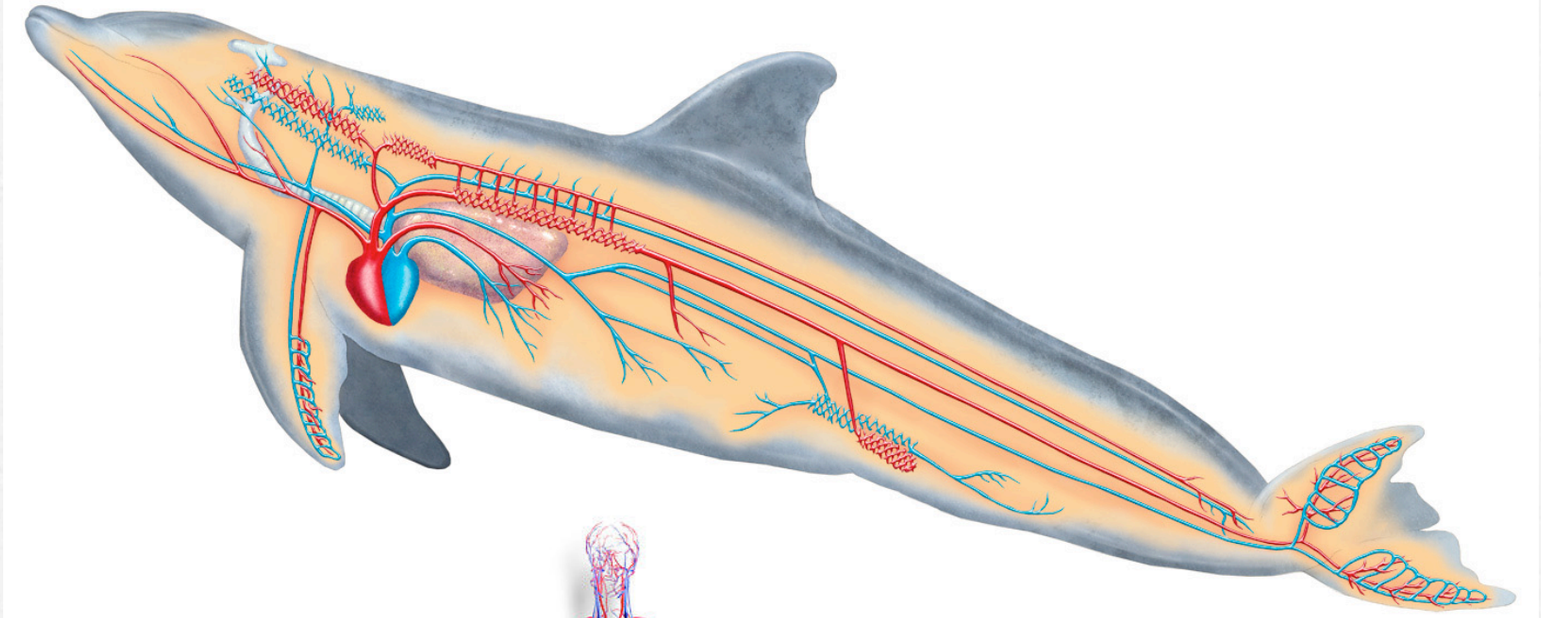
Circulatory Systems- Link Exchange Surfaces

- Recall: Diffusion is slow! (ex. 100 seconds to go 1mm)
- Since gases diffuse, this puts a significant constraint on the body plan of any animal.
- Natural selection has resulted in TWO general solutions.

- **Solution One:** A body size & shape that keeps all or most cells in direct contact with the environment.
  - invertebrates and flatworms



- **Solution Two:** A circulatory system.
- found in all other animals



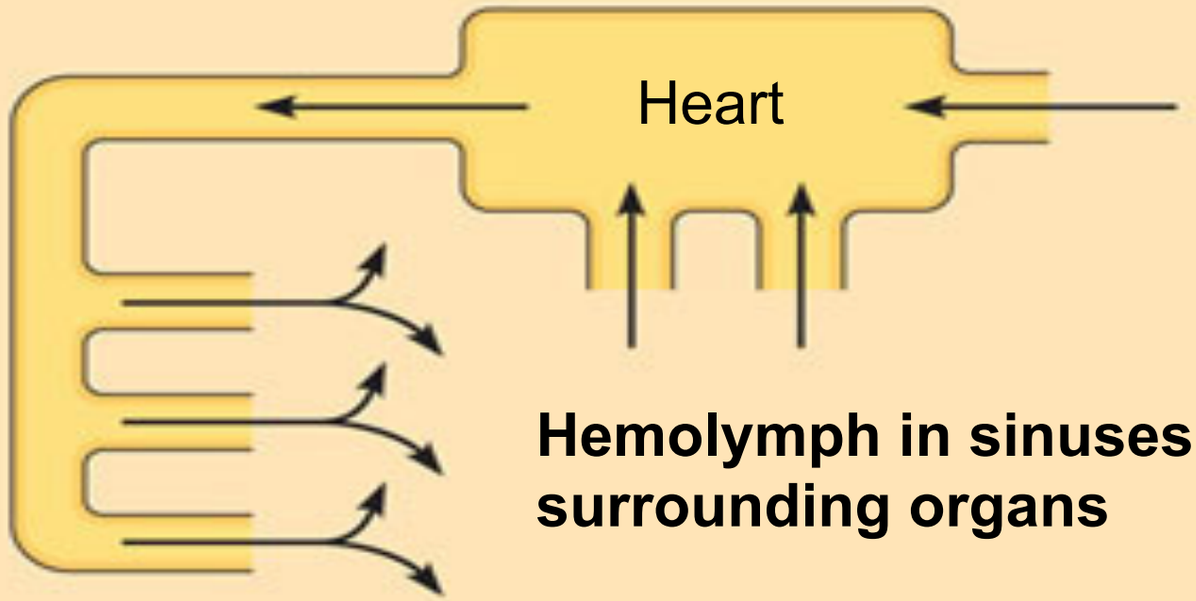
General Properties of Circulatory Systems

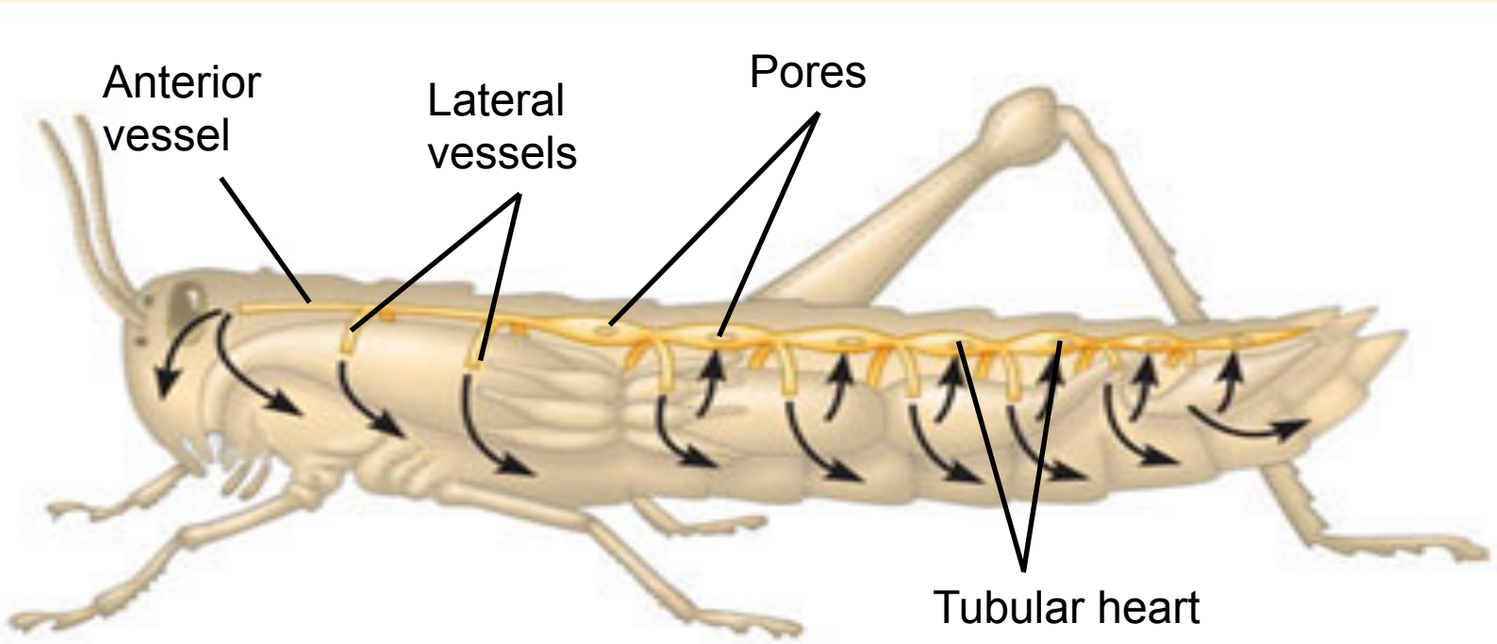
- A circulatory system has three basic components:
  - a fluid, vessels, a pump(s)

General Properties of Circulatory Systems

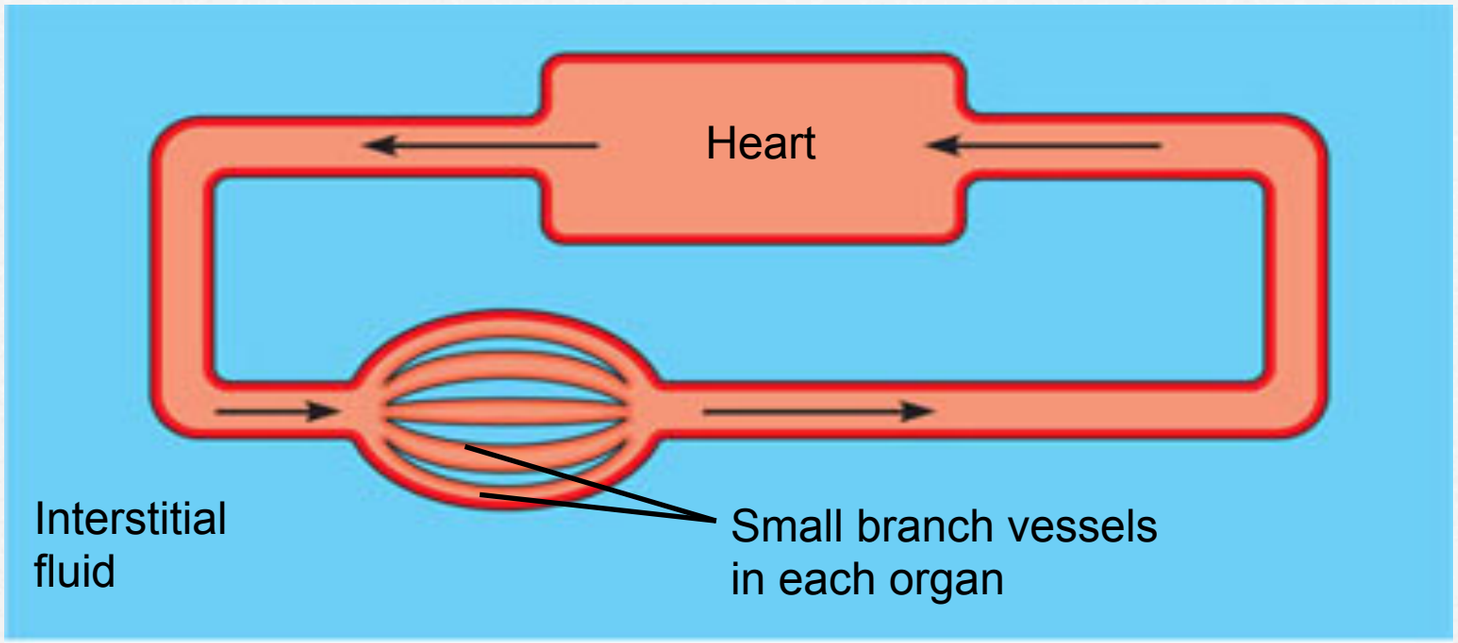
- **A circulatory systems are varied:**
- Several basic types of systems have evolved, each adapted to the constraints imposed by anatomy and environment...
  - open or closed systems, number of circuits, number of pumps ,organization of pump(s), structure of pump(s)

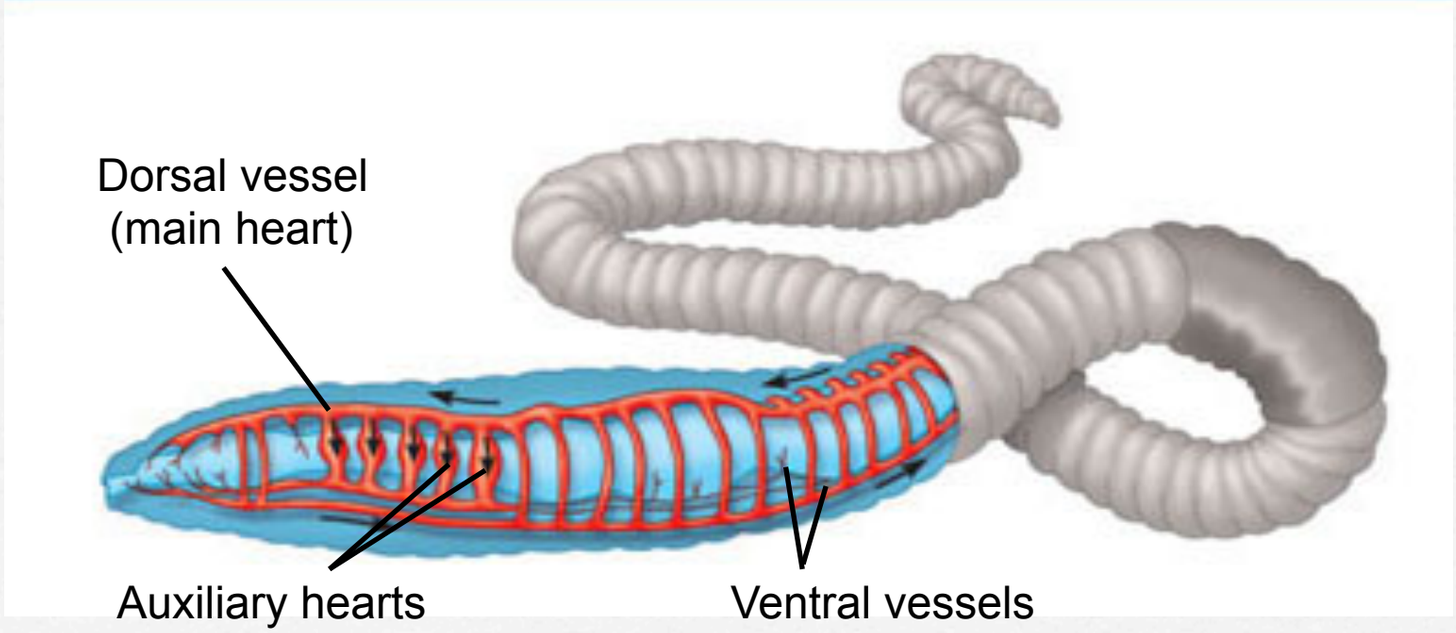
Open Circulatory Systems





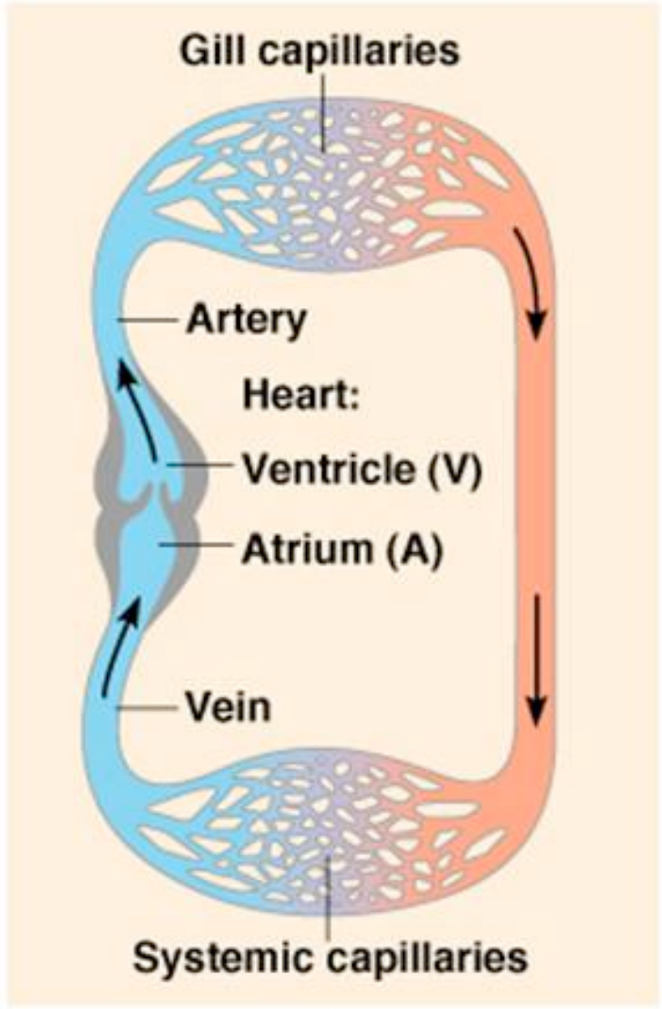
Closed Circulatory Systems





Single Circulation

- The heart consists of two chambers an atria and a ventricle. Blood passes through the heart once in one complete circuit.
  - bony fish, rays and sharks

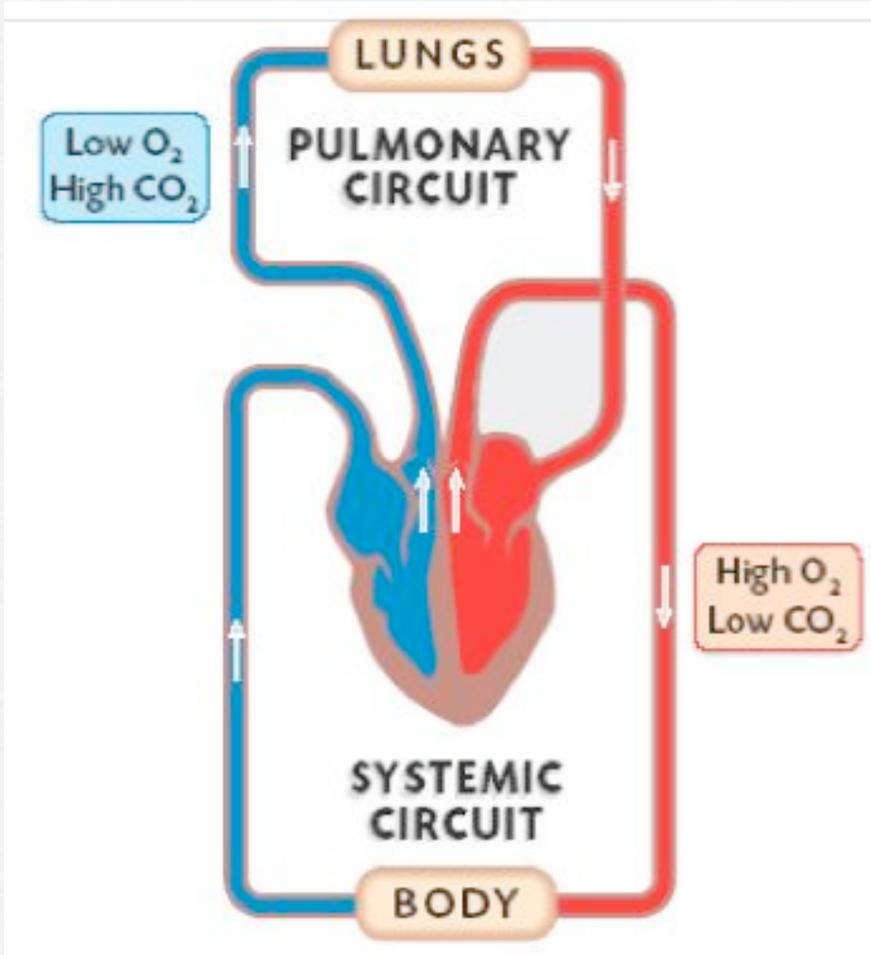


(a) Fish

Pressure drops when blood flows through capillary beds as a result blood flow to the rest of the body is sluggish. Fortunately as fish swim their contracting muscles help move blood along.

Double Circulation

- The heart consists of two pumps one for each circuit.
  - amphibians, reptiles, mammals



The two pumps provide vigorous flow throughout the body. When blood moves through the capillary beds of lungs it loses much pressure however blood returns to the heart's second pump which reestablishes a hydrostatic pressure

“In Summary”

- Animals can either have a body plan that puts every cell in contact with its environment so that gas exchange occurs a rate to sustain life OR...
- Animals can use a circulatory system to deliver oxygen to every cell and remove carbon dioxide waste from every cell.
- The circulatory system also transports hormones, nutrients and waste around the body.

Life's Common Challenges

Response: Defense

Main Idea

- *Life is faced with a number of threats.*
  - *biotic factors: predators, pathogens, and parasites.*
  - *extreme abiotic factors can threaten the life.*

Main Idea

- ***Living organisms defend themselves by using four general strategies protective barriers, fleeing, hiding, or fighting back.***
  - ***Adaptations are both unique and fascinating.***

Animal Defenses against Predators

- **DETECTION**

- **Prey must posses great senses in order to respond to the threat of predators.**

  - *visual-*

  - *auditory-*

  - *chemical-*

  - *tactile-*

Animal Defenses against Predators

- **FLEEING**

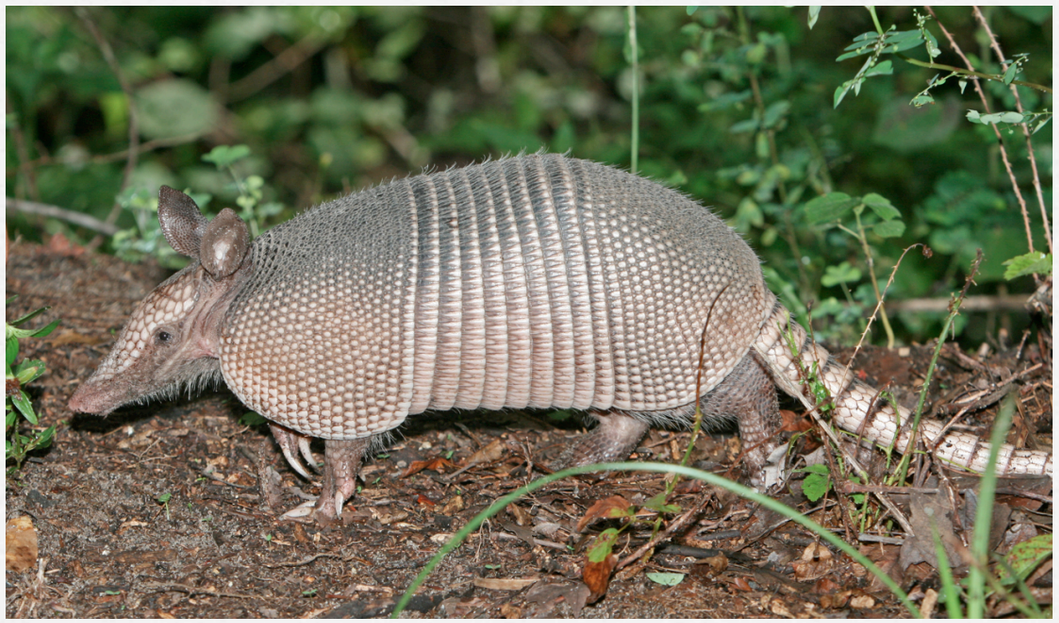
- **Some animal prey species rely on speed, agility and stamina in order to elude predators.**

- **However this is far more successful if the predator is detected from afar.**

Animal Defenses against Predators

- **PROTECTIVE BARRIERS**

- **Animal barriers include skin, armor, scales, fur, feathers, hair, mucous and saliva.**



- **Skin**
- largest organ
- protection against physical & chemical
- multiple layers of cells to protect.
- **Mucous**
- Where skin is thin animals
- mucous

Animal Defenses against Predators

- **HIDING & CAMOUFLAGE**
- **Animal's can hide in places where predators can not go or see.**
- **Animal's can also hide out in the open by employing camouflage.**

Animal Defenses against Predators

- **Types of Camouflage:**
  - *Solid Colors* or *Colored patterns* to match background
  - *Counter-shading* dark upper bodies and light lower bodies
  - *Copy-cats* involve shape, behavior or looking like something else that is common in the environment.

Animal Defenses against Predators

- **FIGHTING BACK!**

- **The fight may come to the predator in the form a chemical or physical defense.**

  - Chemical defenses include poisons/toxins
  - Physical defenses include horns, antlers, spines, quills, tusks, claws.
  - Mobbing

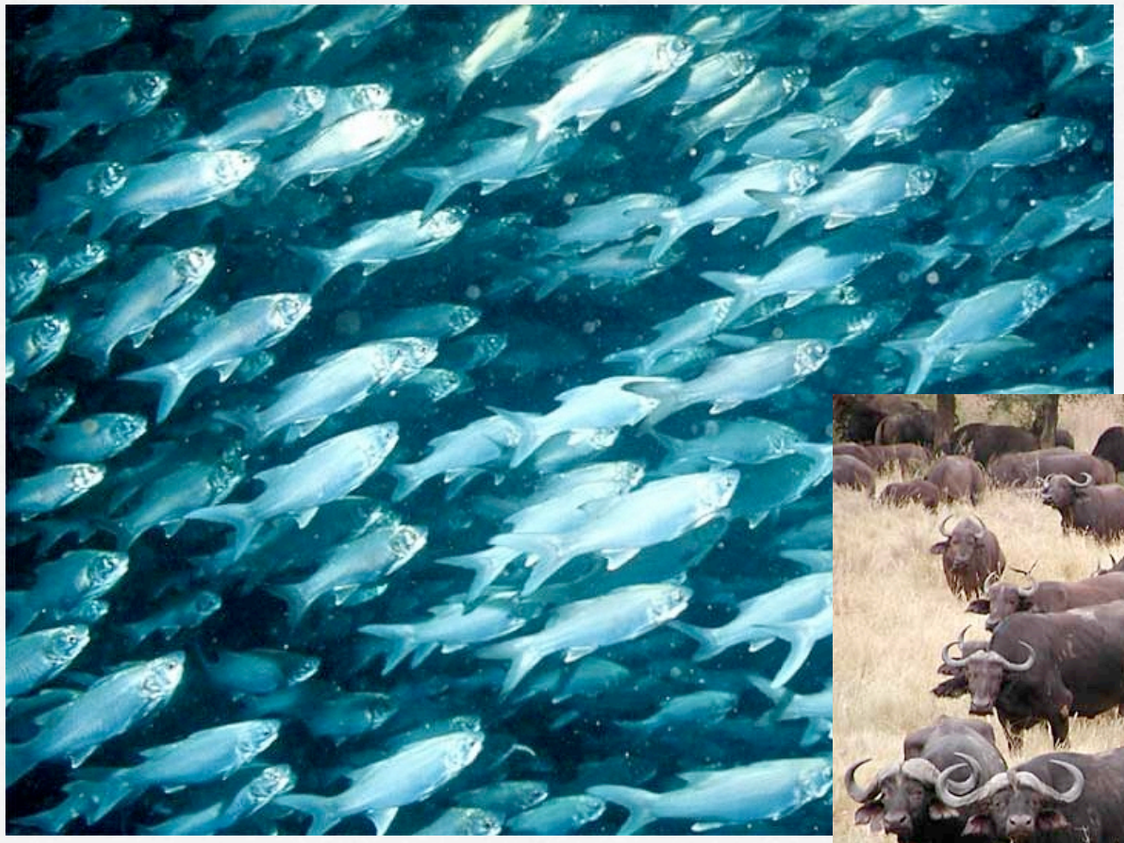
Animal Defenses against Predators

- **INTIMIDATION**

- **Some animals warn predators by visual displays**

Animal Defenses against Predators

- **SAFETY in NUMBERS**
- **Some animals travel in herds or schools.**



Animal Defenses against Predators

- **BEHAVIOR**
- **Some behaviors are innate.**
  - avoiding habitats where predators are found
  - being active at different times of the day than the predators
  - inflating bodies & some physical act that conveys a larger size or greater fitness to the predator
    - ex. lizards, gazelles

Animal Defenses against Predators

- **BEHAVIOR**
- **Some behaviors are learned.**
  - altering activities due to threat
  - play dead since most predators due want carrion
  - some animals use alarm calls to warn fellow prey

Animal Defenses against Pathogens

- The animal strategy against bacteria, viruses and parasites has two goals.
- **First goal:** Do not let the pathogen in the body or cell(s).
- **Second goal:** Should the pathogen "get in" find, recognize and destroy it before it inflicts it damage.

Animal Defenses against Pathogens

- **First** goal: Do not let the pathogen in the body or cell(s).
  - *This is accomplished through the Integumentary, Lymphatic & Immune Systems*
  - *This immunity is called innate immunity or non-specific defenses.*

Animal Defenses against Pathogens

- **Second** goal: Should the pathogen "get in" then the animal must find, recognize and destroy it before it inflicts it damage.
  - *This is accomplished through the Immune System.*
  - *This immunity is called acquired immunity or specific defenses.*

Animal Defenses against Pathogens

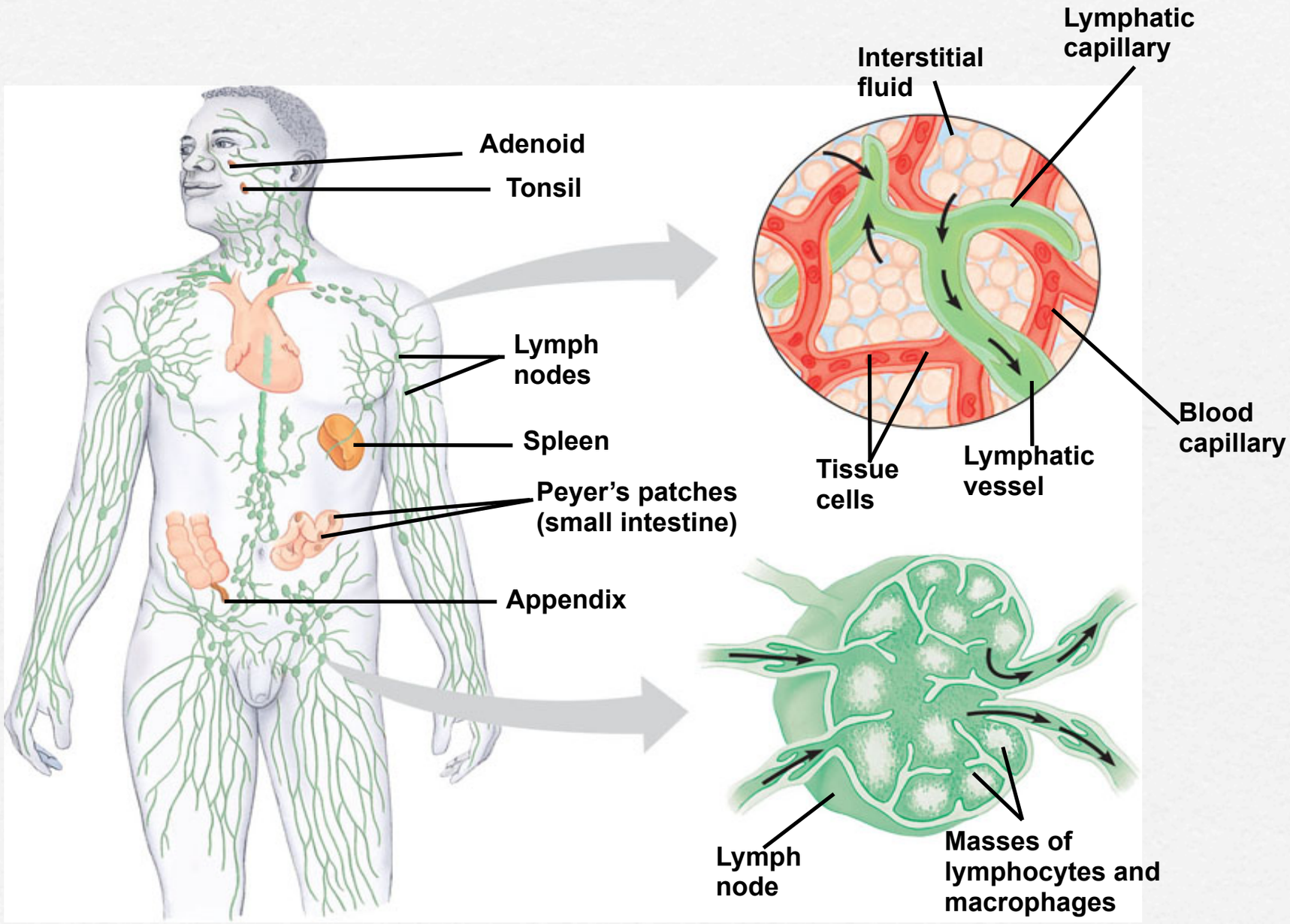
Why do you suppose pathogens "want in"?

Why do they infect multicellular organisms?

Animal Defenses against Pathogens

	INNATE IMMUNITY Rapid responses to a broad range of ALL ANIMALS		ACQUIRED IMMUNITY Slower responses to specific microbes VERTEBRATES
	External defenses	Internal defenses	
Invading microbes (pathogens)	▶ Skin ▶ Mucous membranes ▶ Secretions	▶ Phagocytic cells ▶ Antimicrobial proteins ▶ Inflammatory response ▶ Natural killer cells	▶ Humoral response (antibodies) ▶ Cell-mediated response (cytotoxic lymphocytes)

Lymphatic System Plays an important role in defense as well.



<u>Specific</u> Internal Defenses.

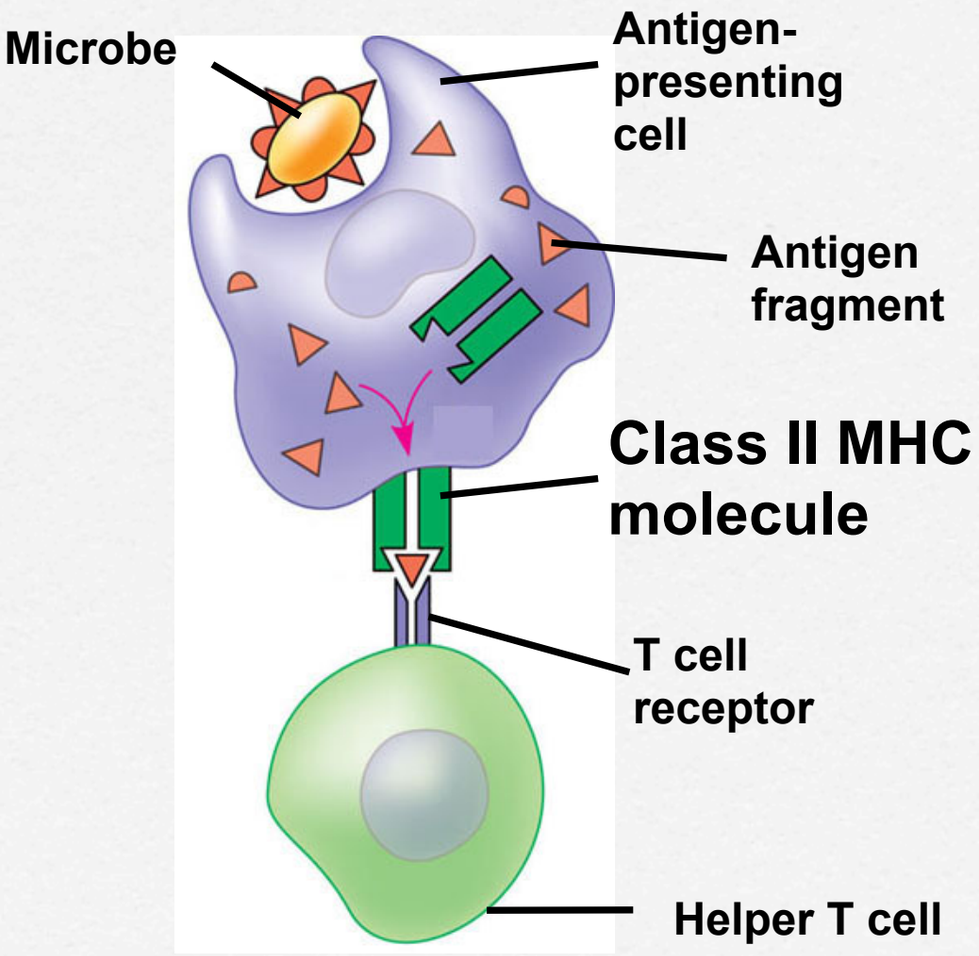
- ACQUIRED or ADAPTIVE IMMUNITY: lymphocytes provide ***specific*** defenses against infection.
    - it again involves lymphocytes
        - (general=white blood cells) (specifically T cells and B cells)
    - it looks for and recognizes ***antigens***

Antigens

- An antigen is foreign molecule that is recognized by T cells and B cells as “not self”

Antigen: Presentation & Recognition

- Class II MHC molecules, found on dendritic cells, macrophages and B cells.
    - Display peptide antigens to helper T cells



<u>Specific</u> Internal Defenses.

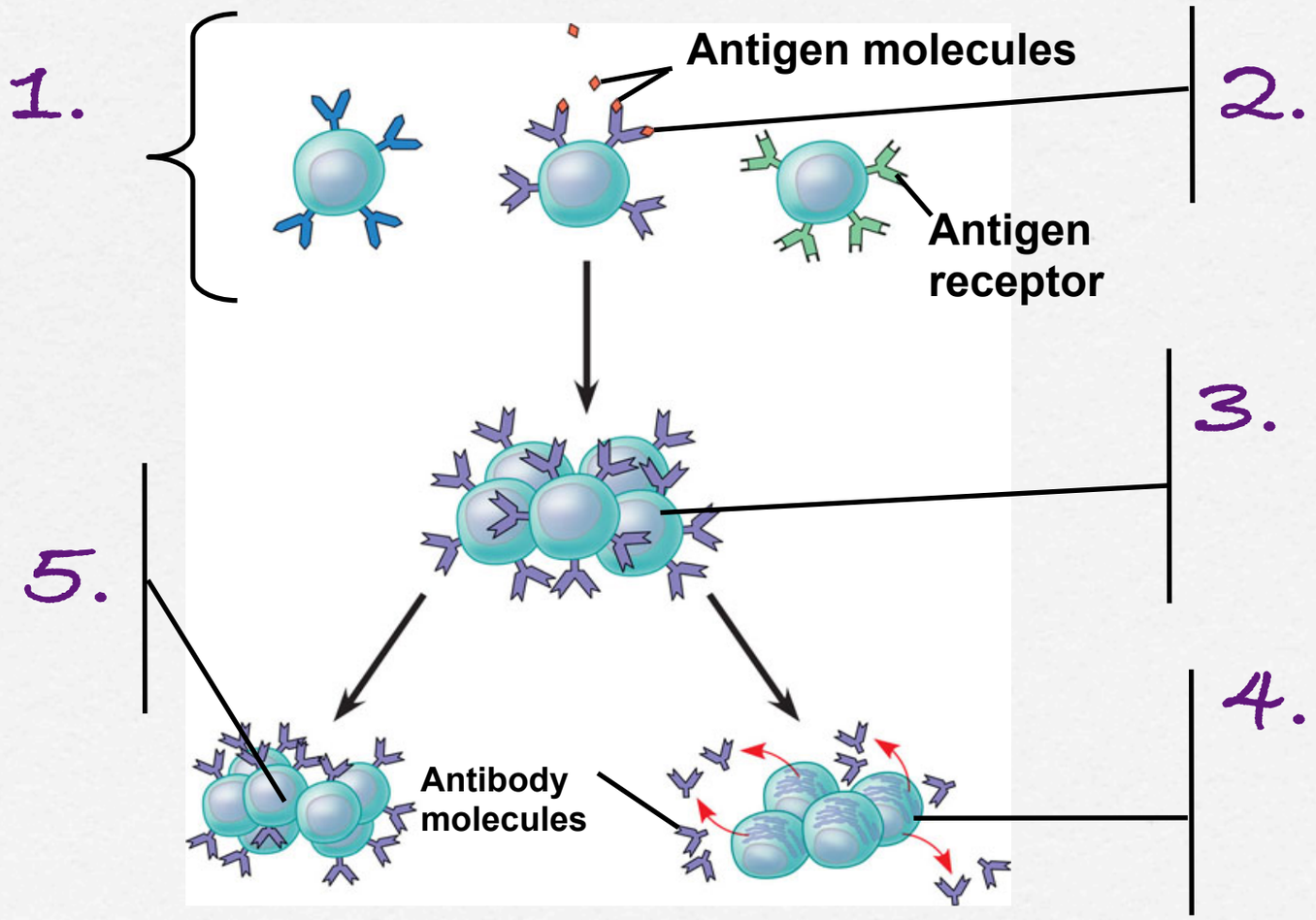
- ACQUIRED or ADAPTIVE IMMUNITY: 4 Characteristics
  - 1. Immense diversity-
  - 2. Self Tolerant-
  - 3. Proliferation-
  - 4. Immunological Memory-

Review & Build

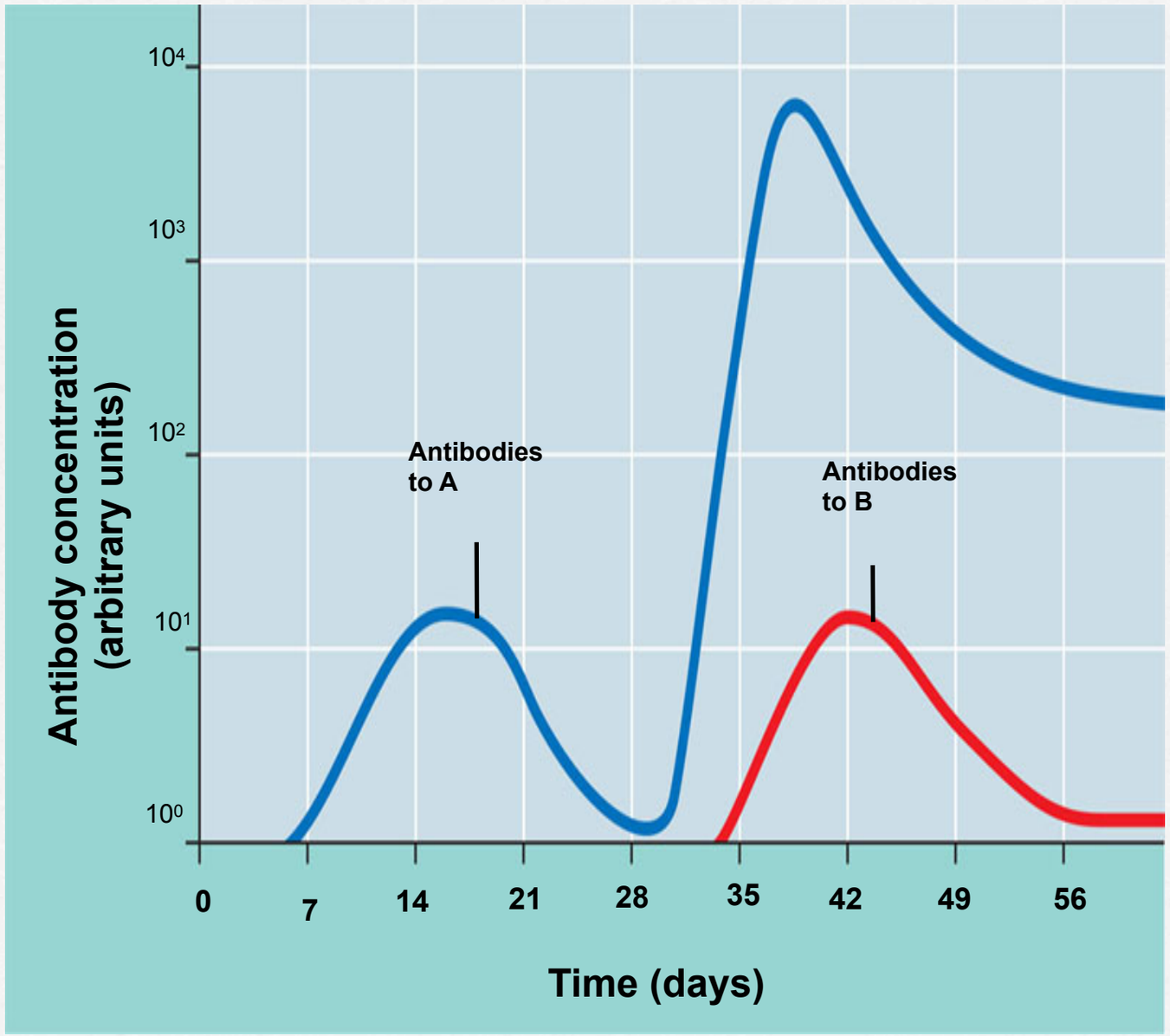
- ACQUIRED or ADAPTIVE IMMUNITY: 4 Characteristics
  - **1. Immense diversity- of lymphocytes & receptors (millions)**
    - achieved by shuffling genes

- ACQUIRED or ADAPTIVE IMMUNITY: 4 Characteristics
  - **2. Self Tolerant- should not attack own cells**
    - the generation of B cell and T cell diversity is somewhat random, as a result some carry receptors for its own epitopes
    - as **B cells** mature in **B**one marrow
    - as **T cells** mature in **T**hymus

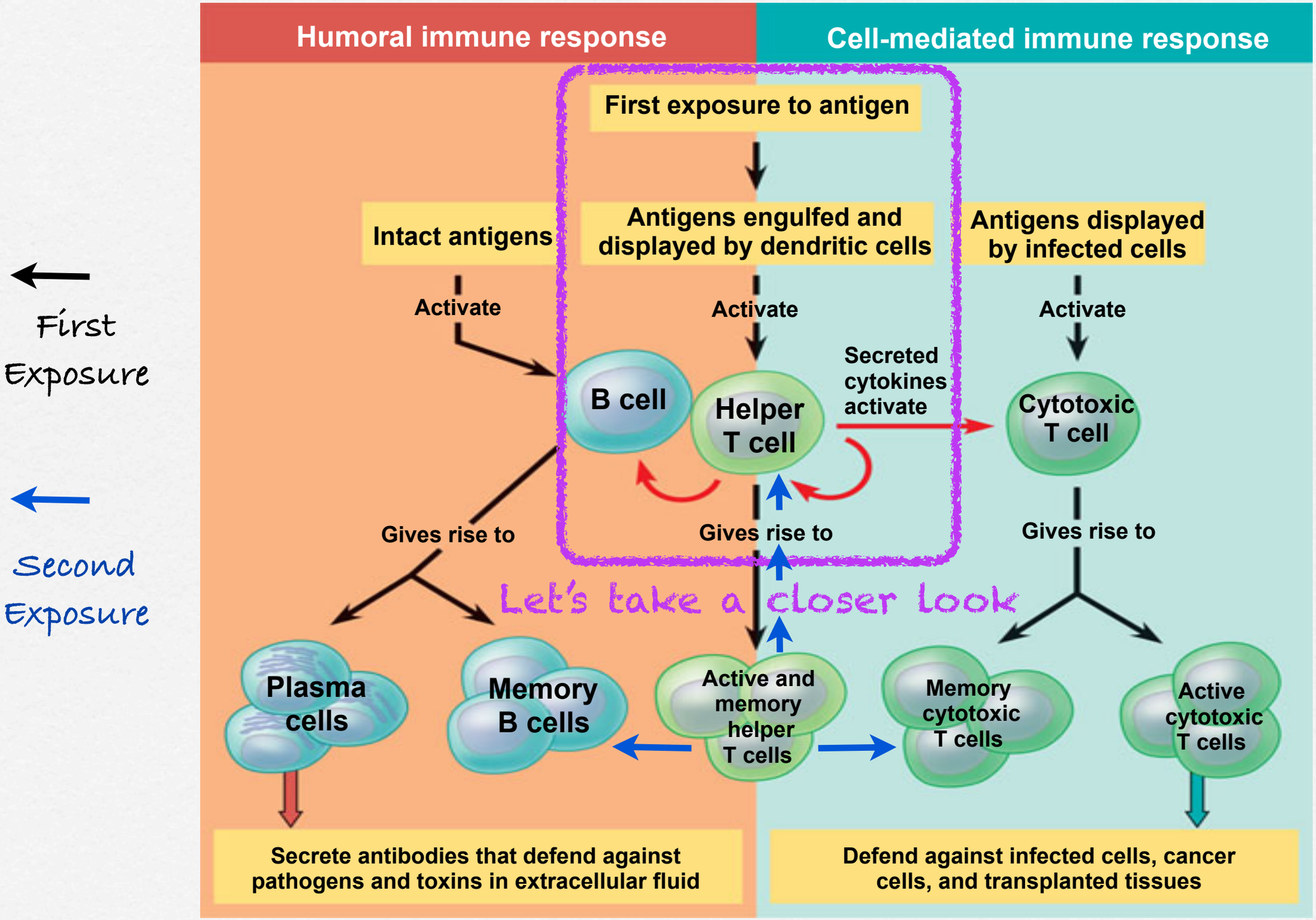
- ACQUIRED or ADAPTIVE IMMUNITY: 4 Characteristics
  - 3. Proliferation- activation of immune response creates many more T cells and B cells



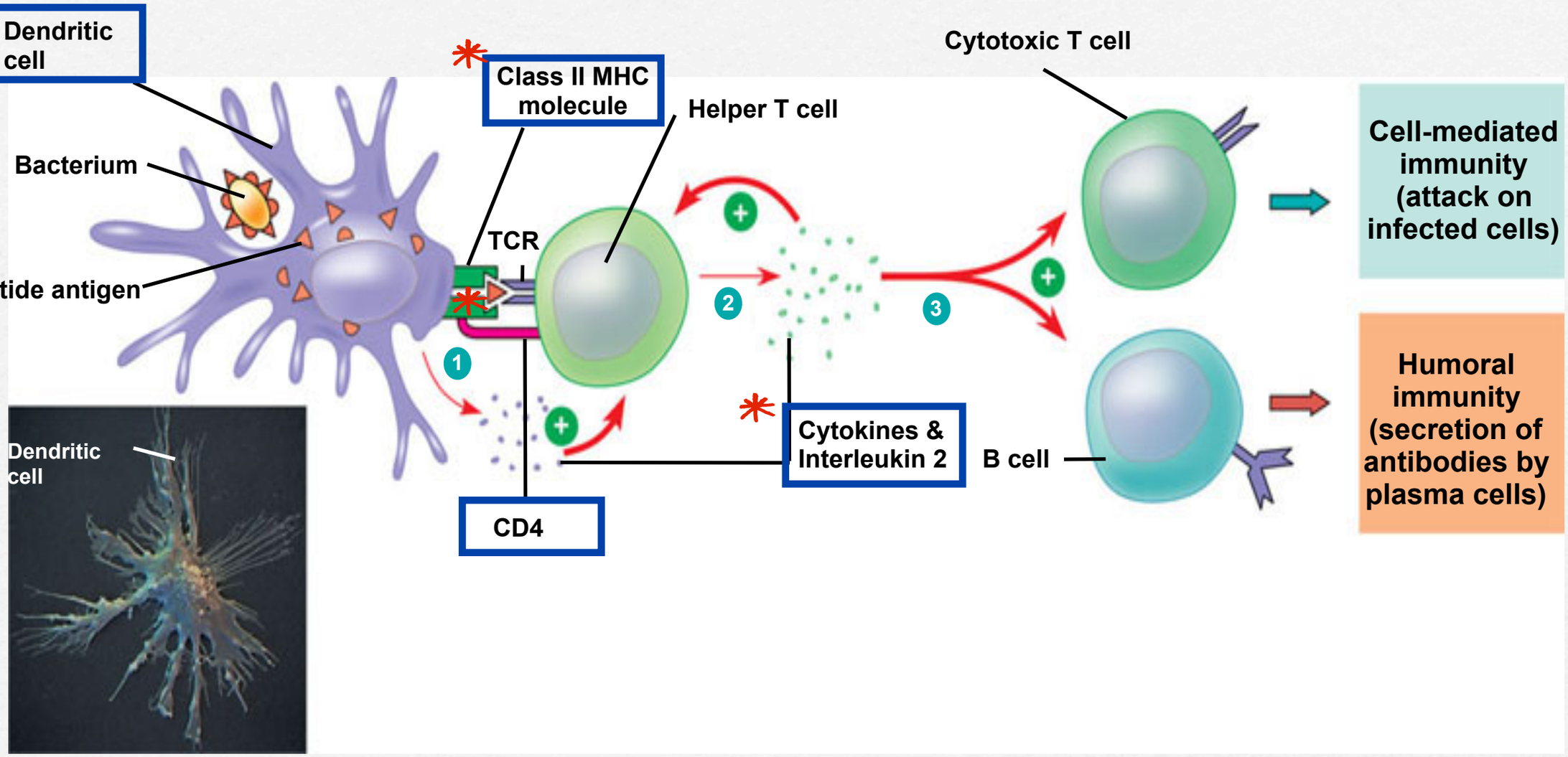
- ACQUIRED or ADAPTIVE IMMUNITY: 4 Characteristics
  - 4. Immunological Memory- stronger and more rapid response to a previously encountered antigen



Overview Of Acquired Immunity

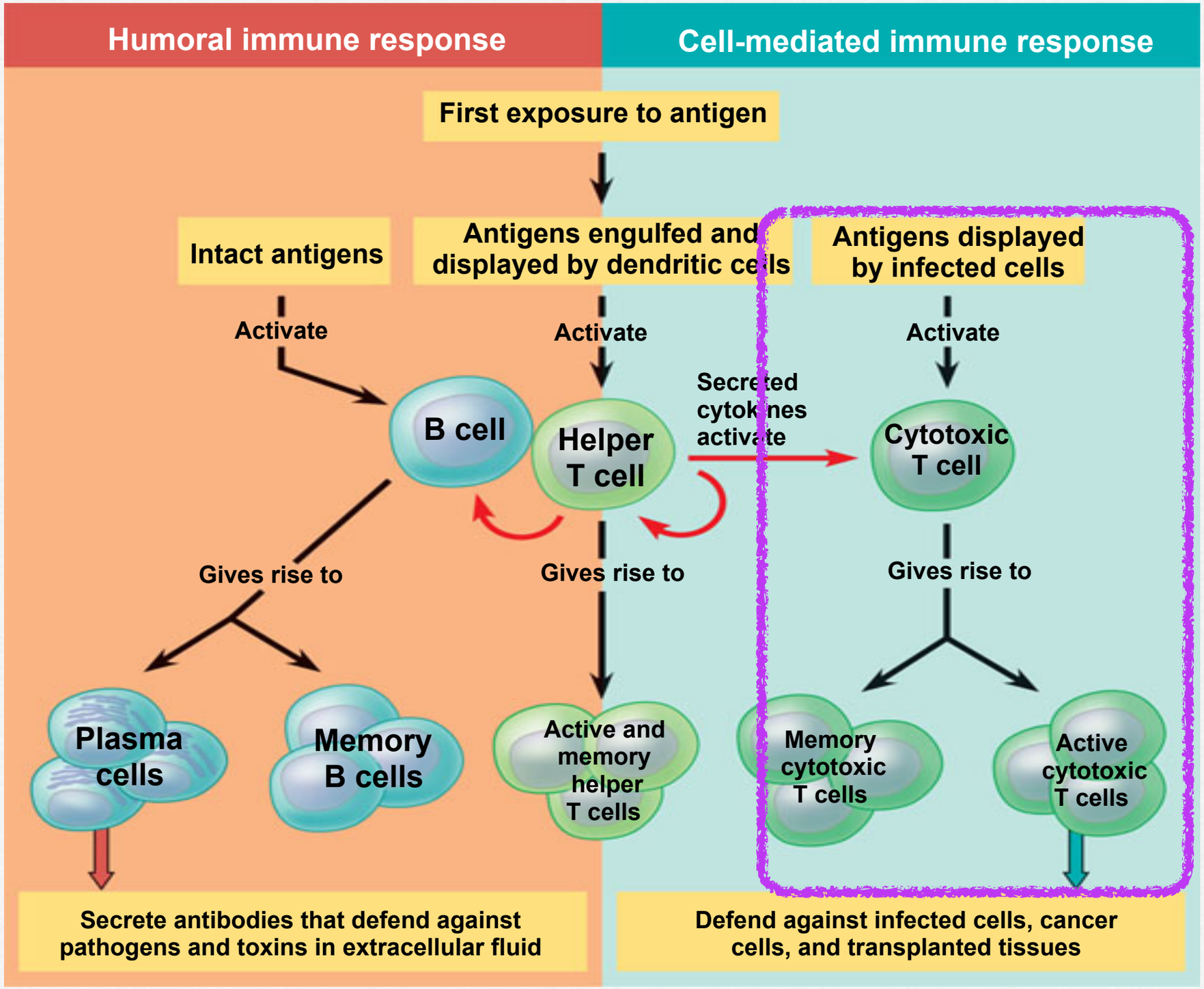


Central Role of Helper T Cells



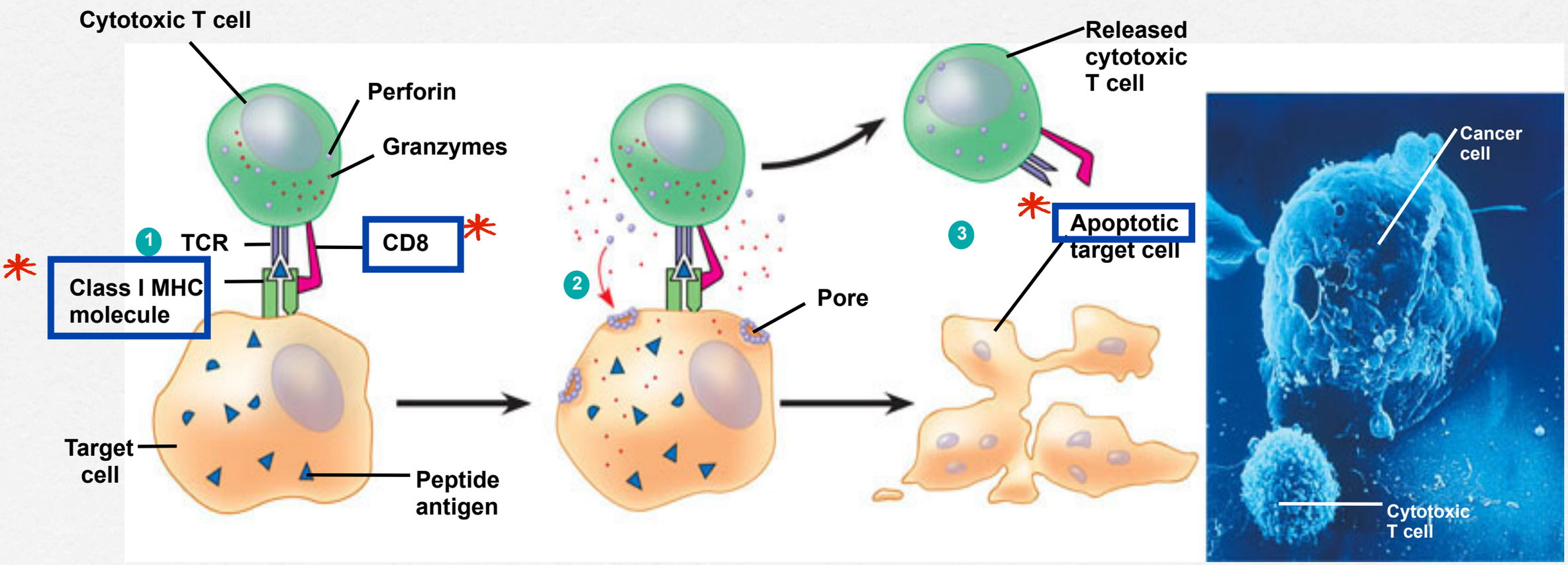
If dendritic cell presents antigen it is likely a primary immune response

Overview Of Acquired Immunity



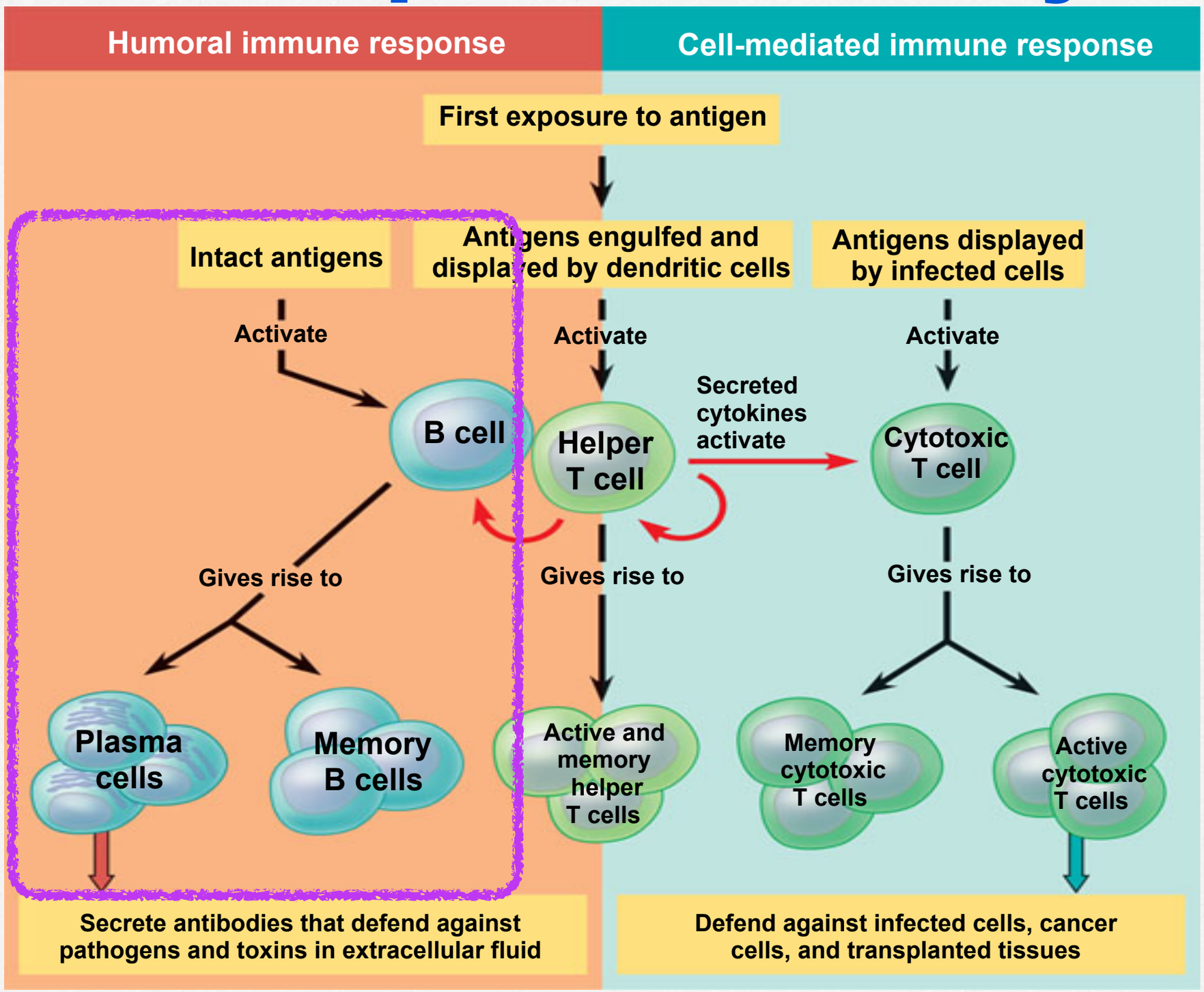
Let's take a closer look

Cytotoxic T Cells

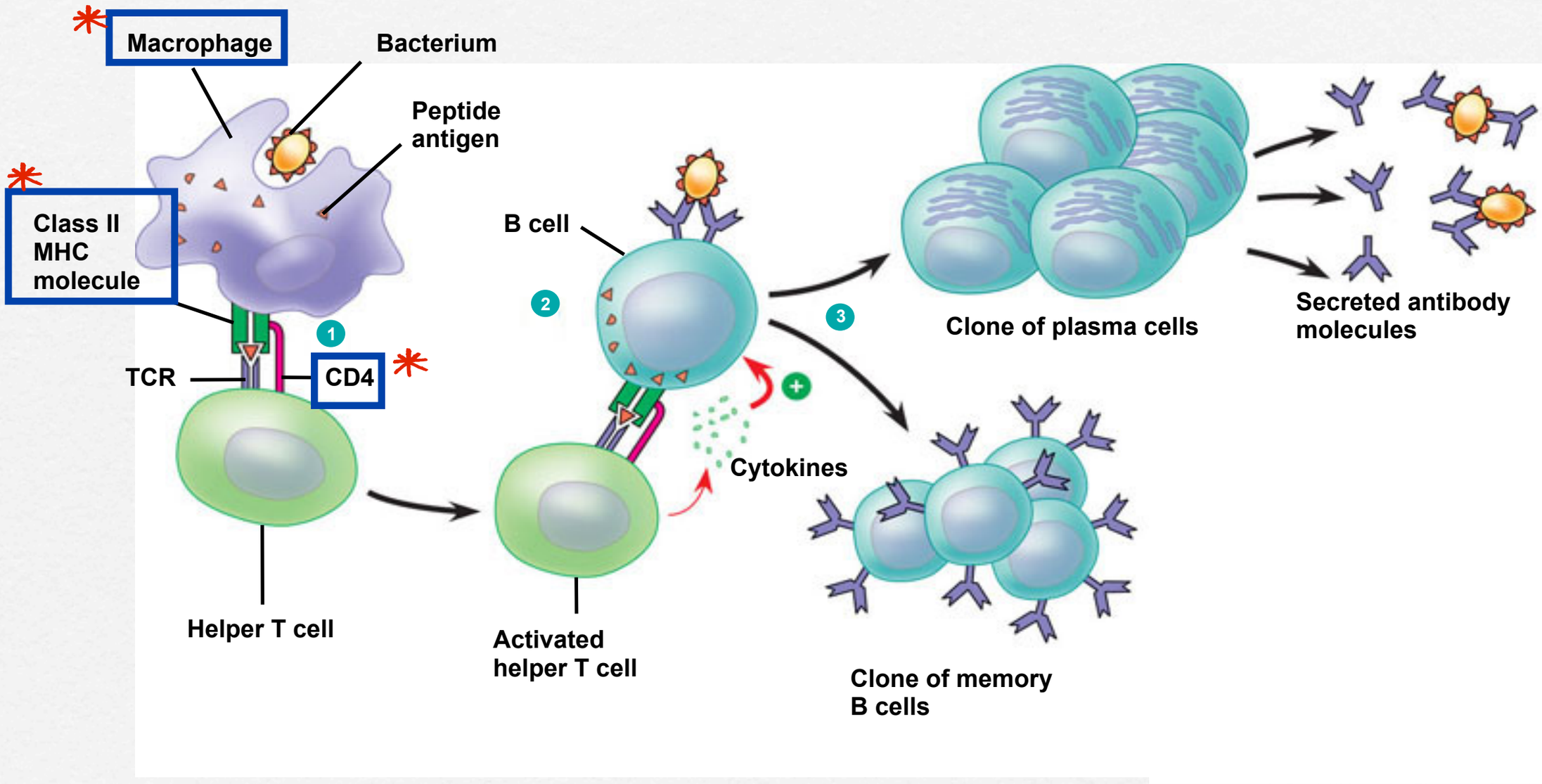


Overview Of Acquired Immunity

Let's take a closer look

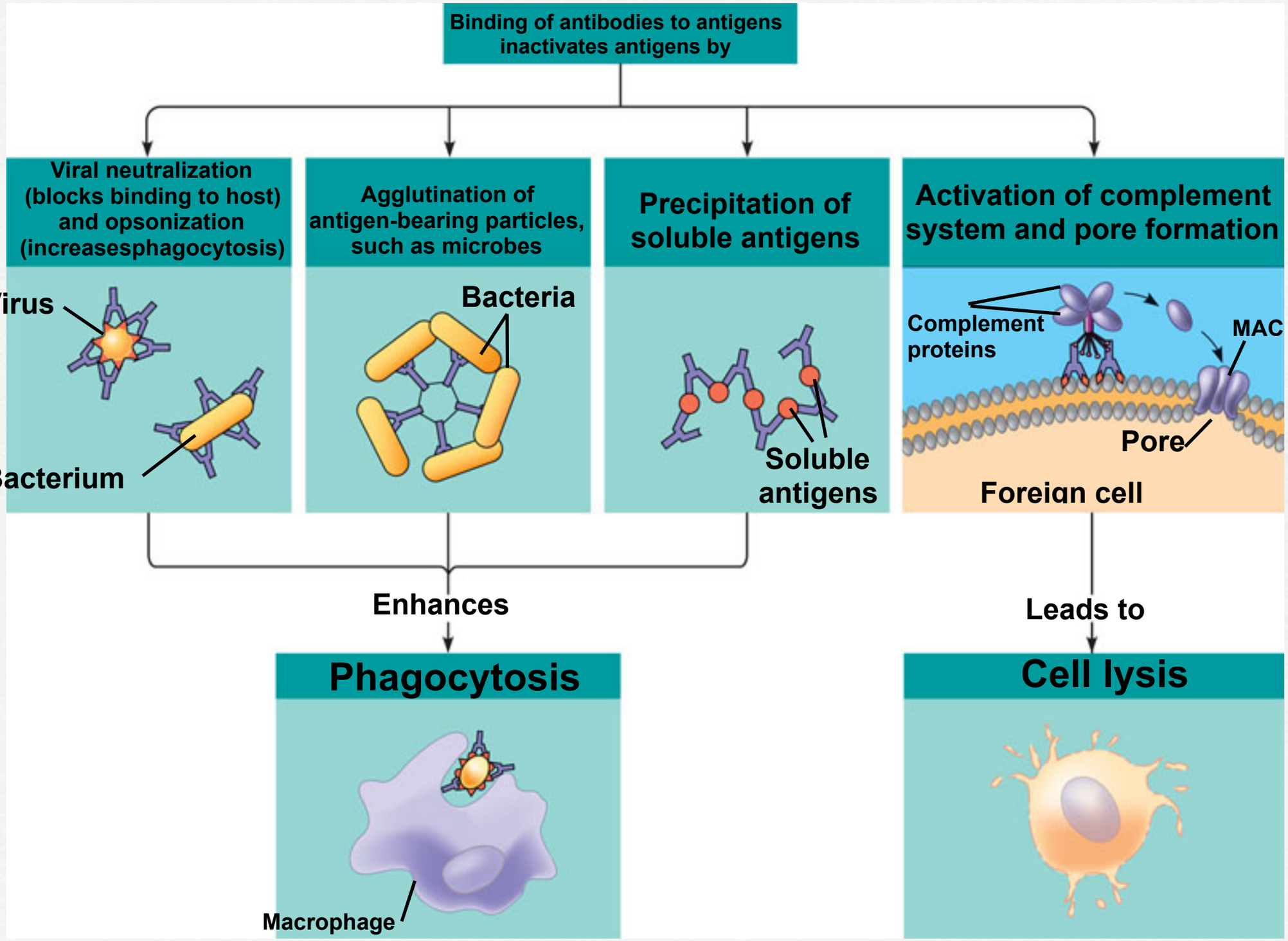


Humoral Immune Response

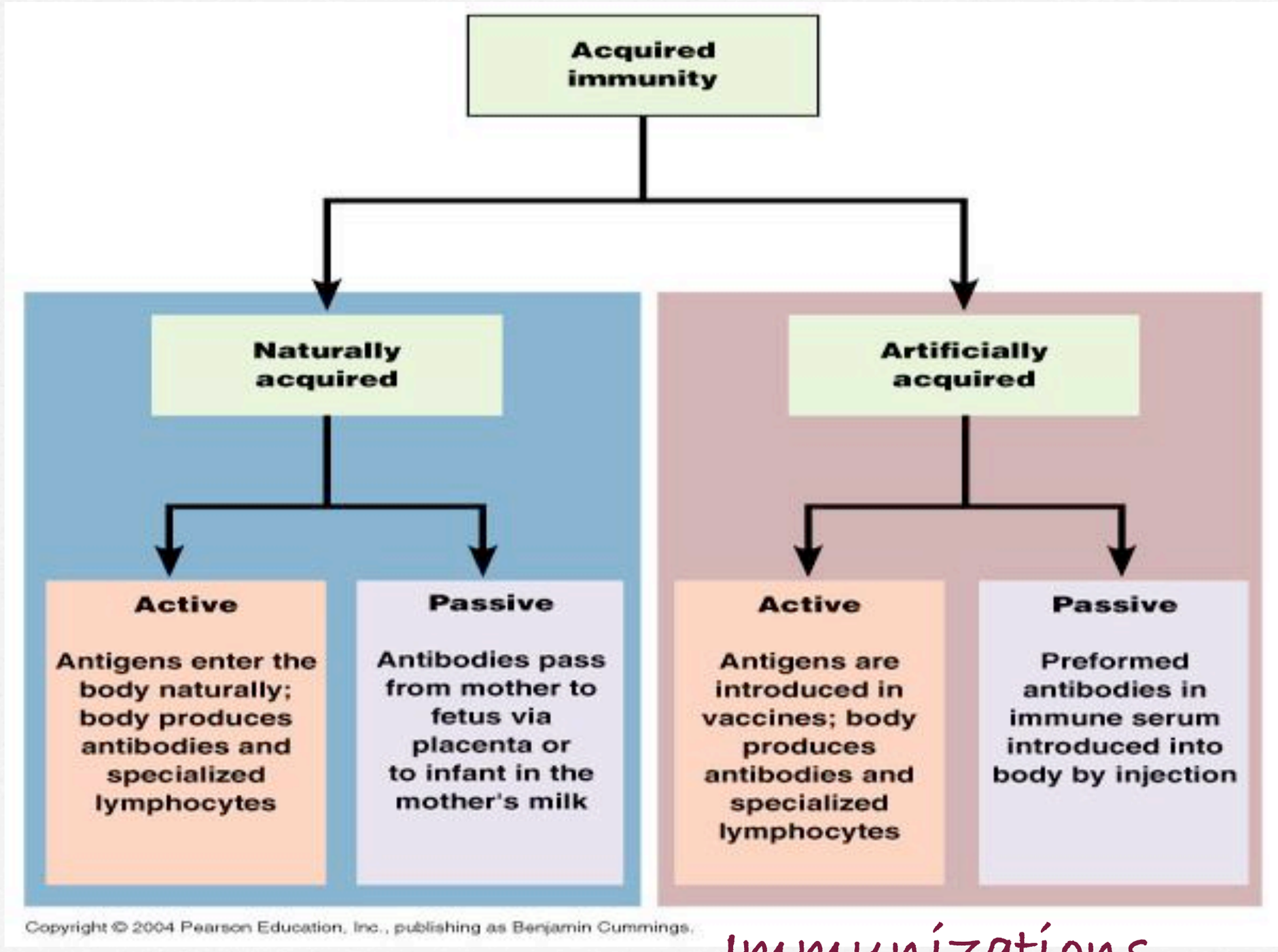


If macrophage presents antigen it is likely a secondary immune response

Antibody Mechanisms of Action



Active & Passive Immunity



Immunizations

Active & Passive Immunity

- **Active: Natural or Artificial**
  - slower but lasts much longer
  - involves T cells or B cells thus memory develops
- **Passive: Natural or Artificial**
  - immediate immunity but lasts only for a few weeks/months

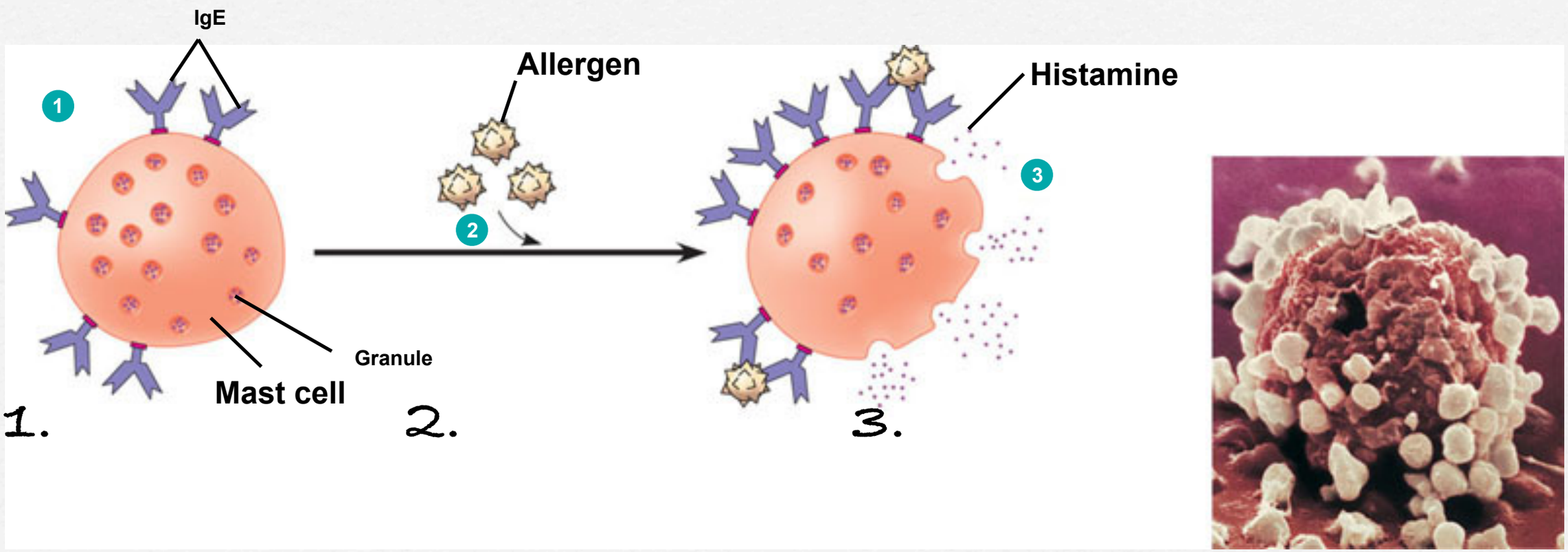
Immunizations / Vaccinations

- **Active or Passive Immunity: "Artificially"**
  - 1796 Edward Jenner noticed milkmaids were immune to severe and dangerous smallpox symptoms
  - Today's vaccines might include weakened toxins, killed pathogens, pathogen pieces or weakened pathogens

What can we deduce about the cowpox virus if it can serve as a smallpox vaccine?

Immune Disorders- Allergies

- **Allergies are hypersensitive responses to certain antigens called allergens.**



Disorders- Autoimmune Diseases

- **In some the immune system loses the ability to distinguish "self" and "non-self".**
  - *Lupus*
  - *Rheumatoid Arthritis*
  - *Type I Diabetes*
  - *Multiple Sclerosis*
  - Gender, genetics and environment all influence susceptibility to autoimmune disorders.

Life's Common Challenges

Reproduction

The Purpose of Life!?*#?

There are Two Types of Reproduction

- ASEXUAL REPRODUCTION.
  - one parent/cell
  - *clones*
    - any difference a result of a genetic mistake (mutation)
- SEXUAL REPRODUCTION.
  - two parents
  - unique

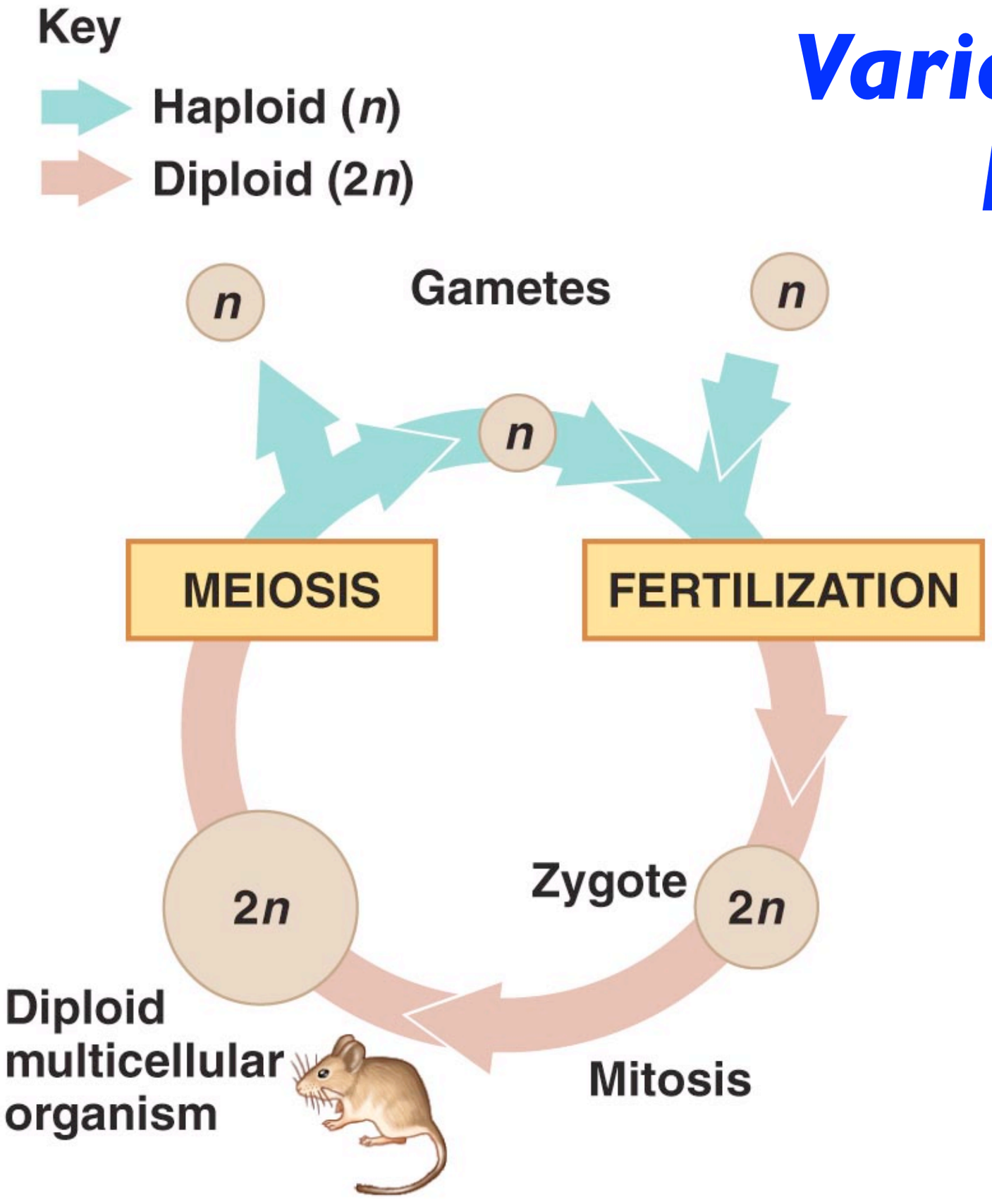
Reproductive Strategies have "TRADE-OFFS"

- ASEXUAL REPRODUCTION.
  - (+)Energetically Inexpensive
  - (+)Faster and more offspring produced
  - (-)Generates *No Variation

Reproductive Strategies have "TRADE-OFFS"

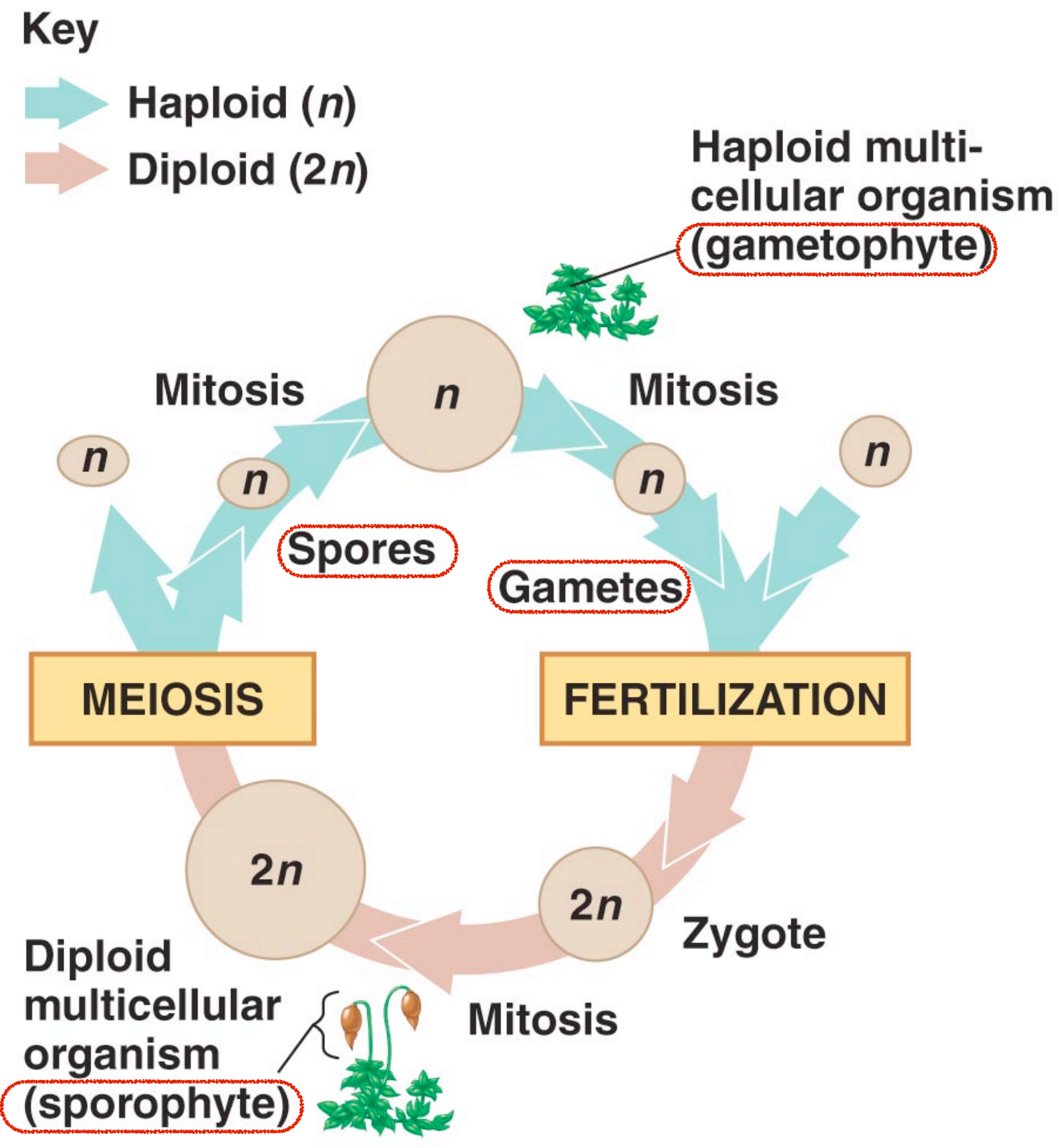
- SEXUAL REPRODUCTION.
  - (-)Energetically Expensive
  - (-)Slower and less offspring produced
  - (+)Generates Much Variation

Variation in Sexual Life Cycles



(a) Animals

Alternation of Generations



(b) Plants and some algae

Animals

Reproduction

Animal Reproduction Intro

- Most animals reproduce sexually.
- *Gametes* (sperm & eggs) are produce via meiosis
- In most species a small flagellated sperm swims to and fertilizes a large immobile egg
- The fusion of sperm and egg produces a single celled *zygote*
- The zygote proceeds to divide via mitosis and the new cells then grow and develop into a multicellular (*adult) organism

Animal Reproduction (Sexual)

Reproductive Cycles

- Most animals exhibit cycles in reproductive activity
- Cycles are often seasonal
  - reproduction when resources available & environmental conditions favorable
  - Cycles are controlled by hormones
  - Regulated by environmental cues: light, temp, rainfall, etc

Reproductive Cycles & Climate Change

- Danish scientists have shown a 75% decline in Caribou reproduction compared 1993
  - Caribou migrate to calving grounds using daylight length as their cue
  - Since 1993 the average spring temps have rise by 4 degrees C.

Reproductive Cycles & Climate Change

- **Australia**

Higher temperatures & Drier conditions

Reproductive Cycles & Climate Change

- **South America**

Sea levels rise & Nest-warming trend

Fertilization Depends on Mechanisms that Bring Together Sperm and Eggs of the Same Species

- *Fertilization*- the union of sperm and egg, it can occur internally or externally.
- *Internal Fertilization*- sperm are deposited in or near female's reproductive tract and fertilization occurs inside this tract.
- *External Fertilization*- females release eggs into the environment and males then fertilize them.

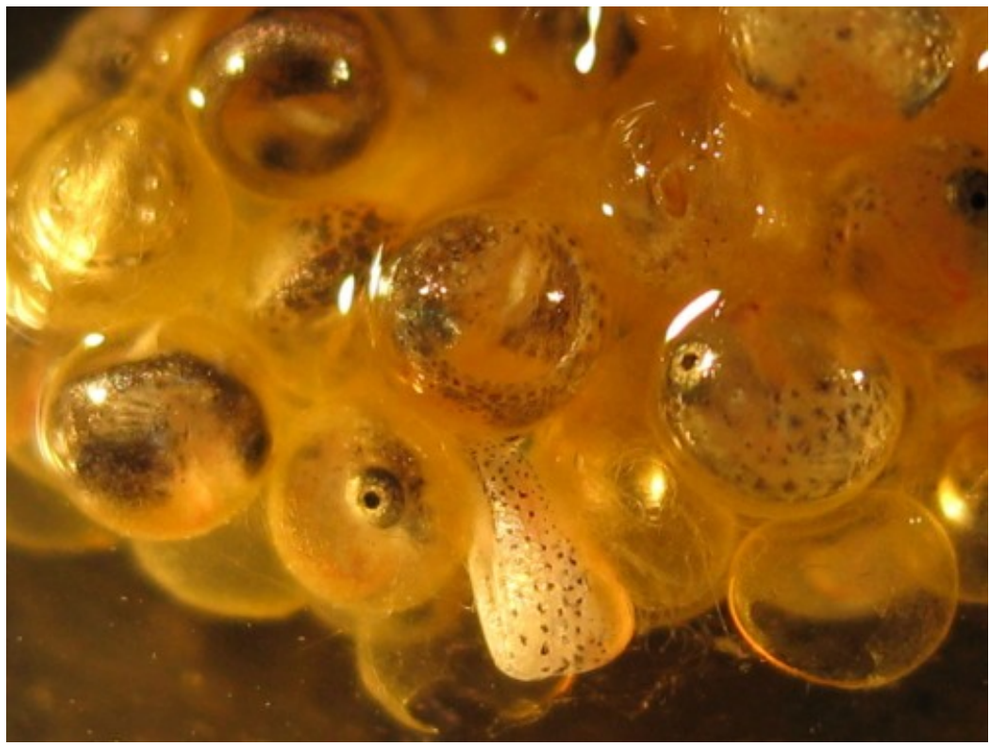
TRADE-OFFS!

- External Fertilization typically produces far more gametes but a lower fraction of zygotes survive
- Internal Fertilization typically produces far less gametes but a higher fraction of zygote survival

TRADE-OFFS!

Internally Fertilized Bird Eggs

Which egg type provides greater protection?



Externally Fertilized Fish Eggs

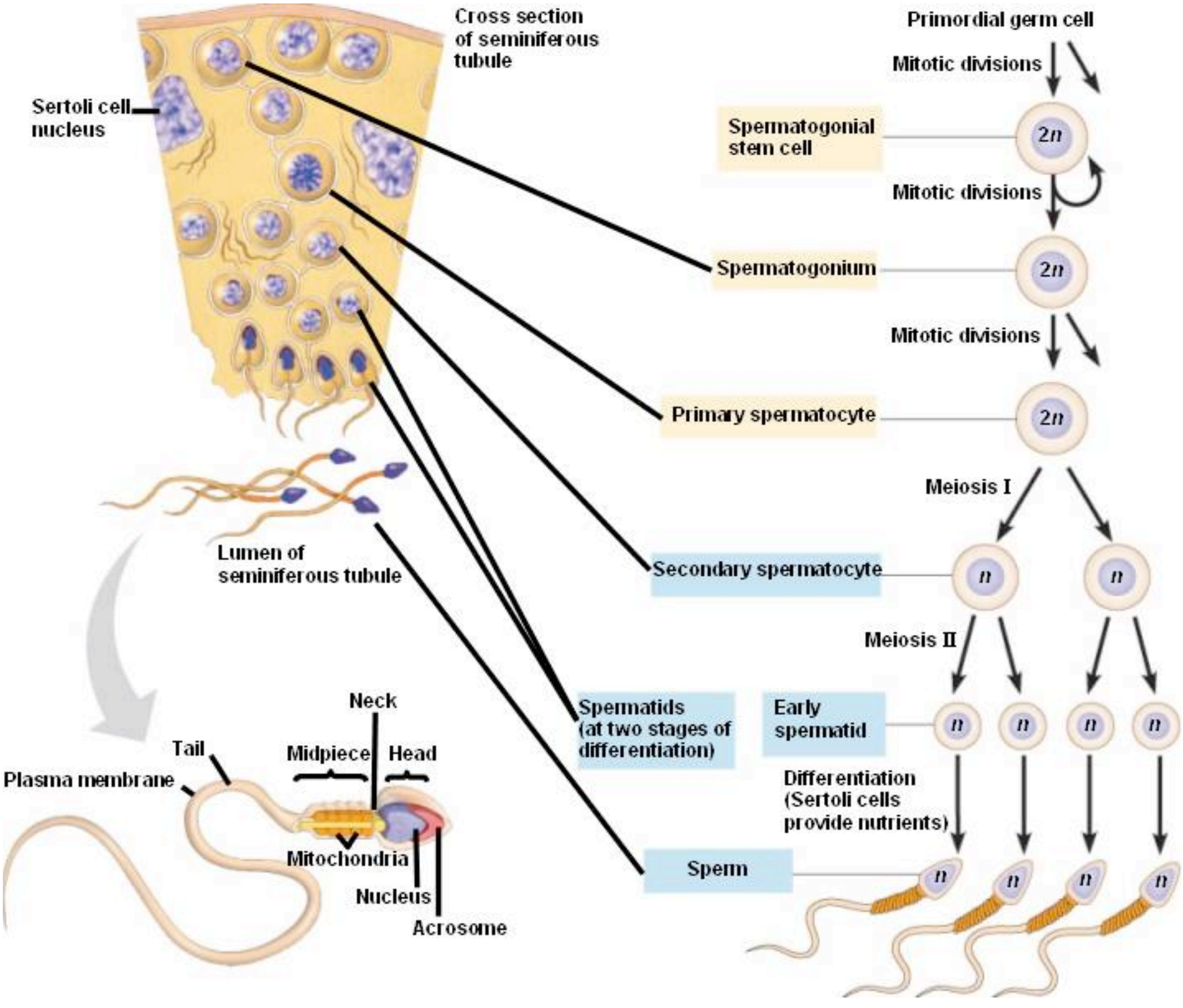
- No matter how fertilization occurs, the mating organisms make use of *pheromones*.
- *Pheromones*- are chemicals released by one organism that can influence the the physiology and behavior of others of the same species
  - small volatile or water soluble,tiny amounts exert their effects, many act as male attractants

External Fertilization in Frogs

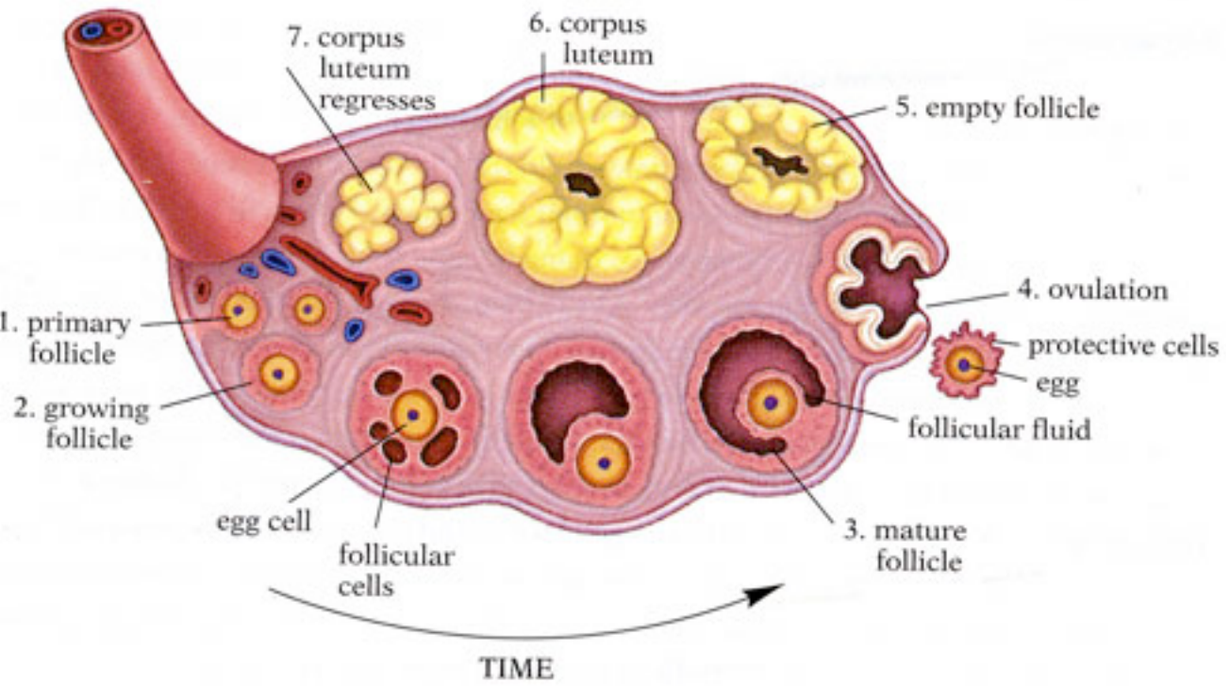
Gamete Production

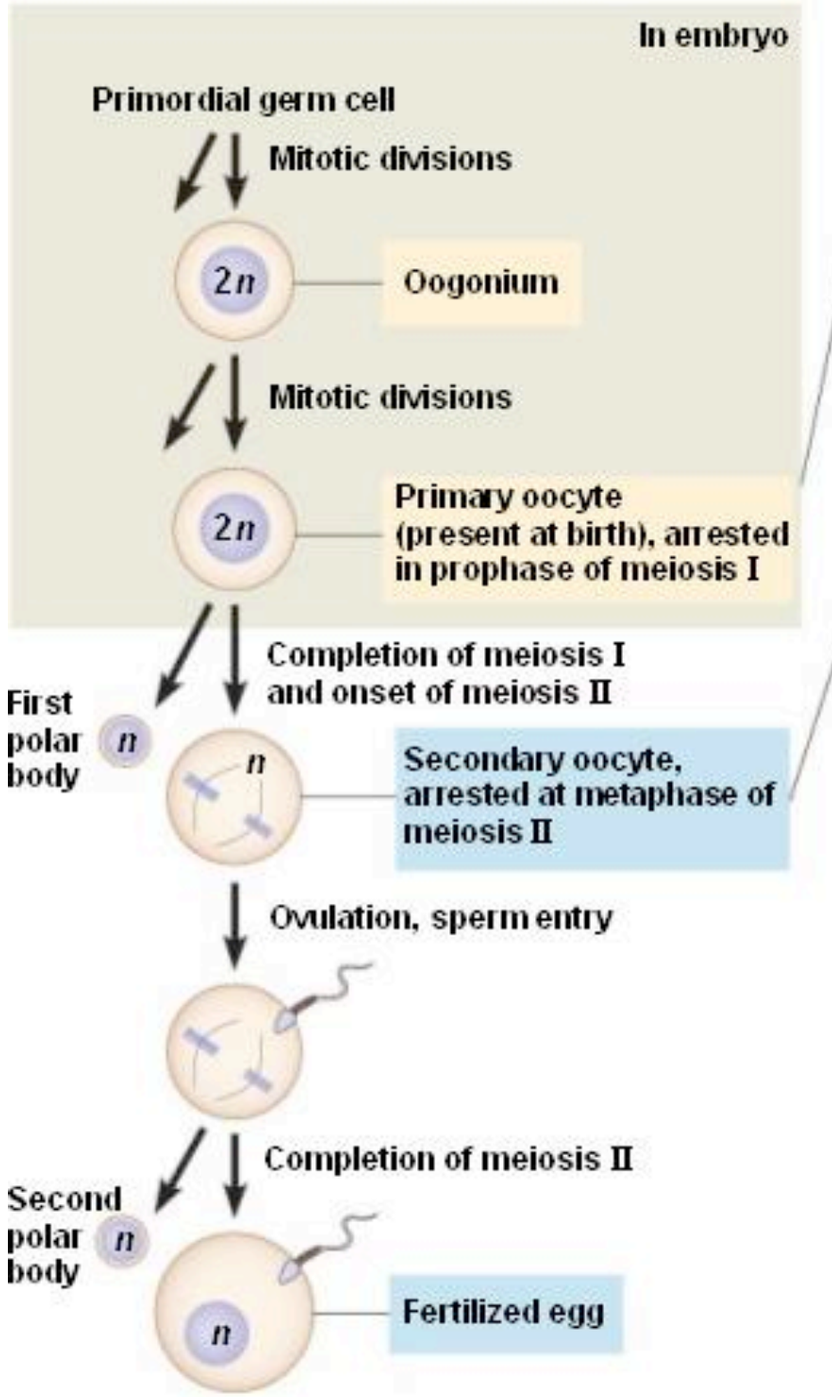
- Sexual reproduction in animals relies on special cells (germ cells) that give rise to sperm and eggs
- In most and more elaborate reproductive systems special organs are used to produce gametes, *gonads*
  - *Male Gonads are Testes*
  - *Female Gonads are Ovaries*

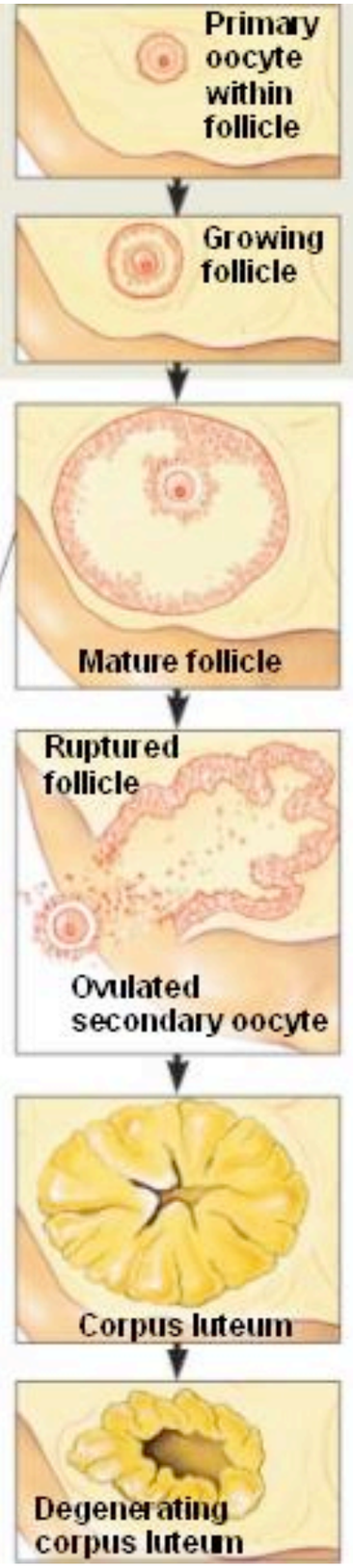
Spermatogenesis



Oogenesis


7. corpus luteum regresses
6. corpus luteum
5. empty follicle
4. ovulation
protective cells
egg
follicular fluid
1. primary follicle
2. growing follicle
egg cell
follicular cells
3. mature follicle
TIME


In embryo
Primordial germ cell
Mitotic divisions
2n
Oogonium
Mitotic divisions
2n
Primary oocyte (present at birth), arrested in prophase of meiosis I
Completion of meiosis I and onset of meiosis II
First polar body
n
n
Secondary oocyte, arrested at metaphase of meiosis II
Ovulation, sperm entry
Completion of meiosis II
Second polar body
n
n
Fertilized egg


Primary oocyte within follicle
Growing follicle
Mature follicle
Ruptured follicle
Ovulated secondary oocyte
Corpus luteum
Degenerating corpus luteum

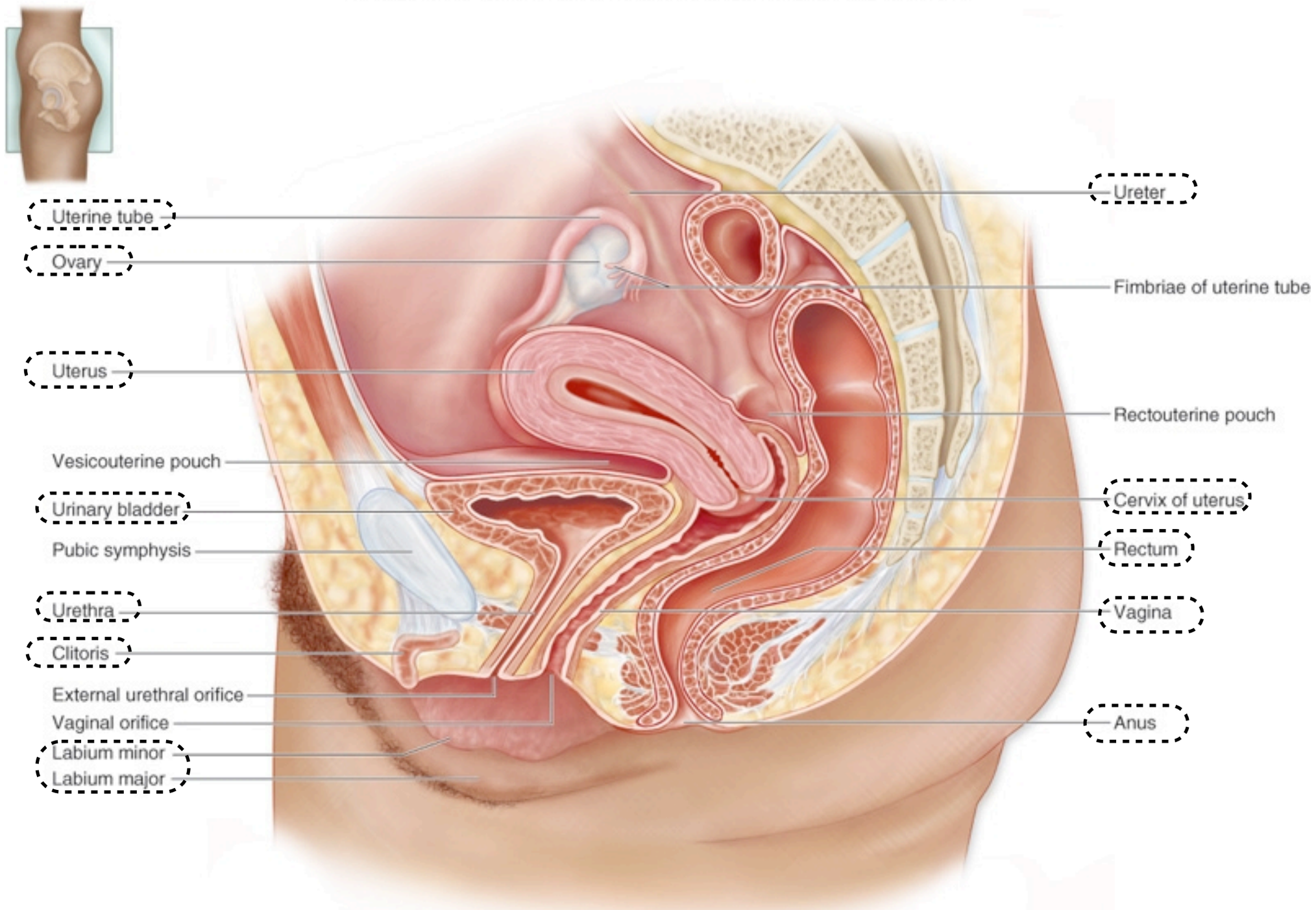
Comparison of Gamete Production

3 Significant Differences

- First; Spermatogenesis-4 gametes, oogenesis- 1 gamete
- Second; Spermatogenesis occurs throughout, Oogenesis begins before birth to menopause
- Third; Spermatogenesis-continuous, oogenesis-interruptions

Human Reproductive System

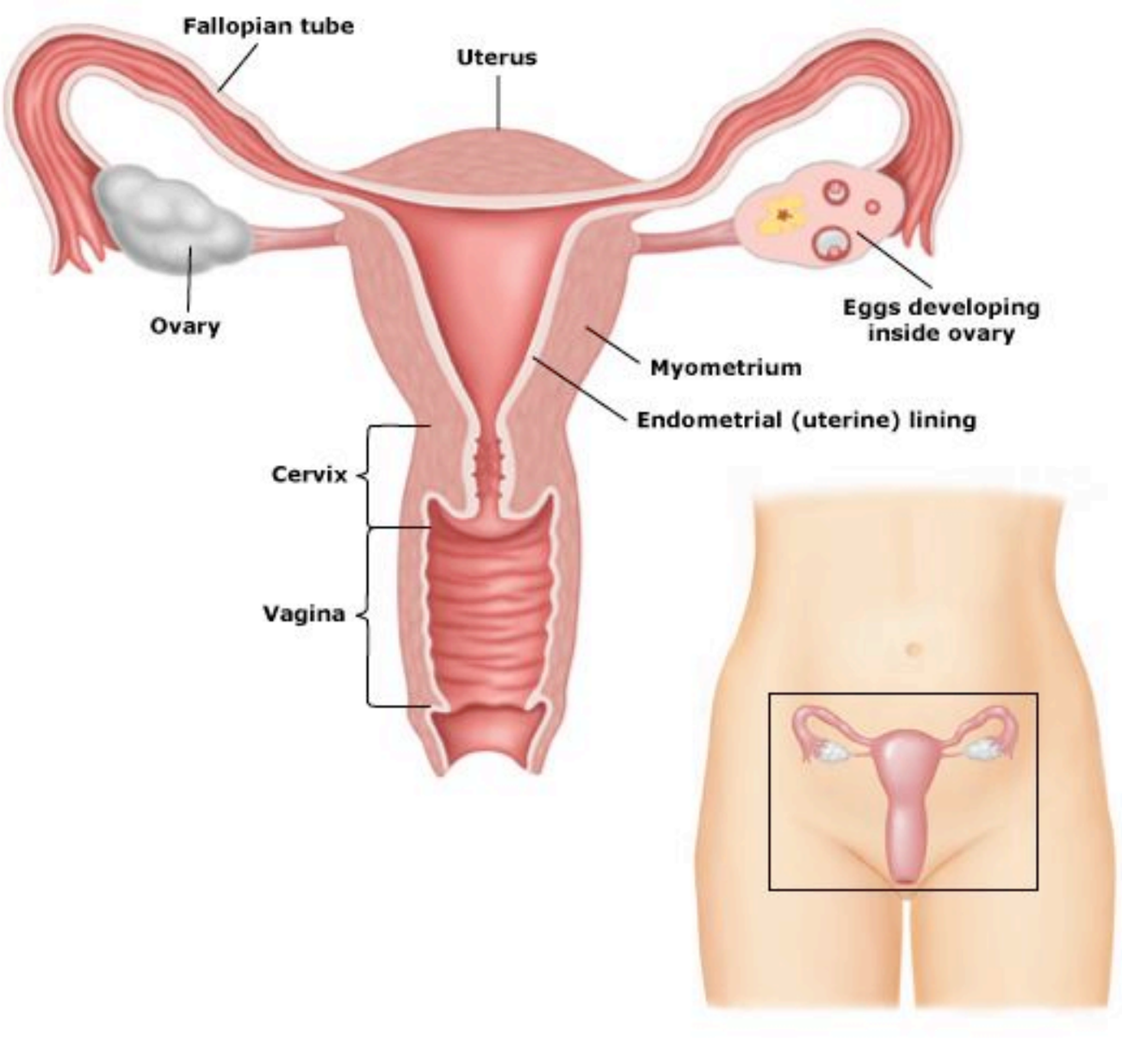
Female Anatomy

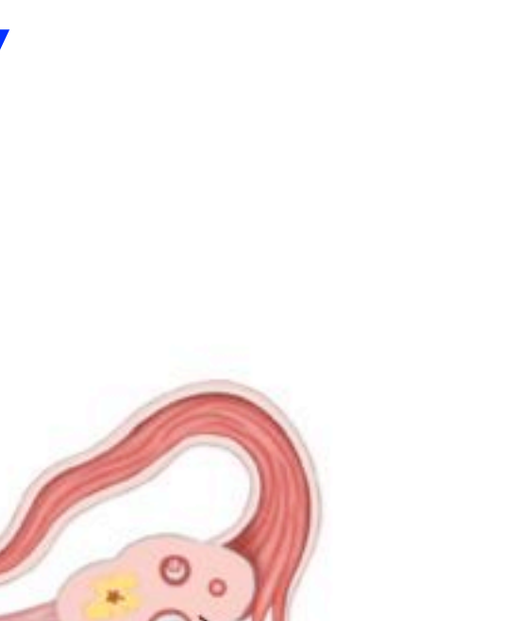


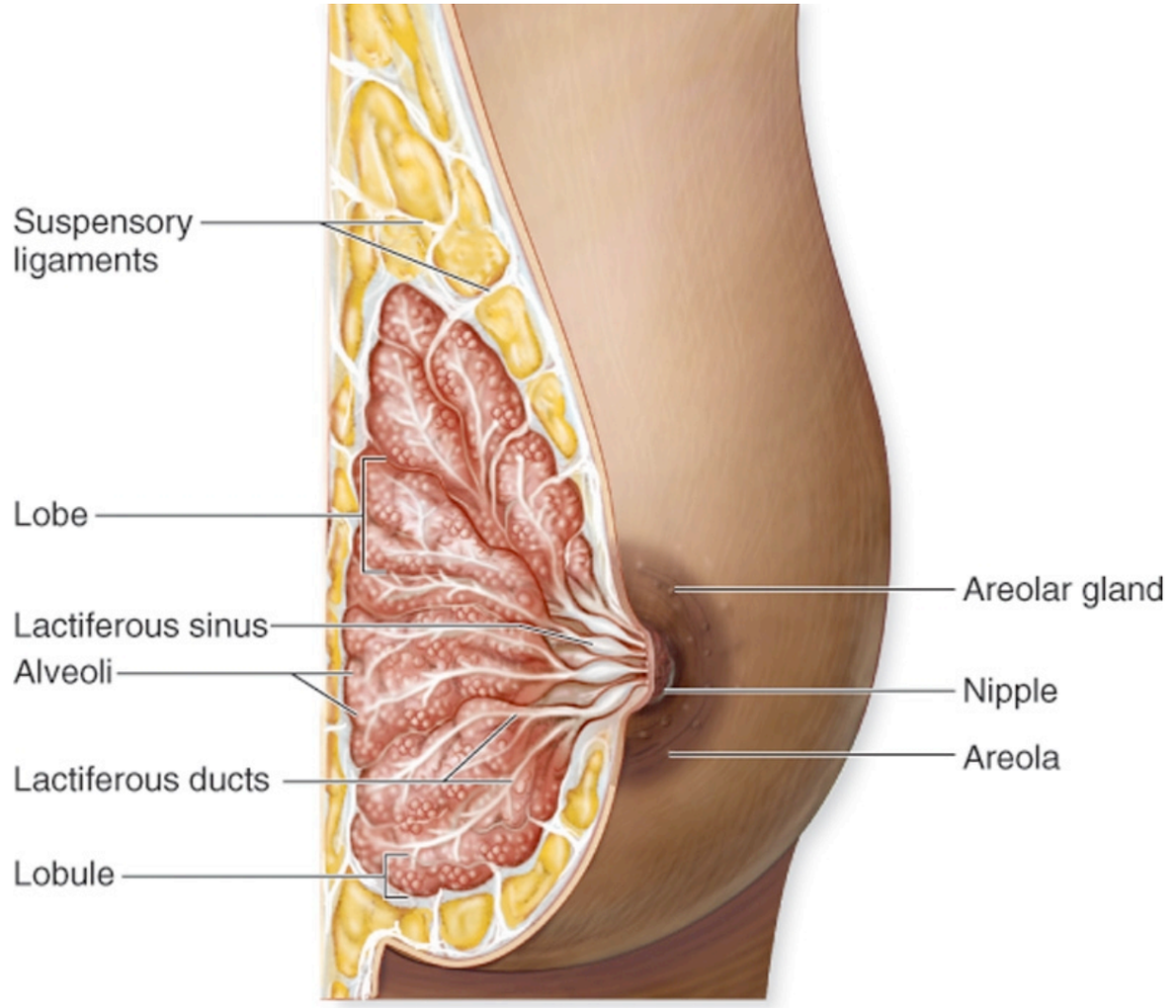
Vagina & Vulva (external genitalia)

- The vagina is a thin-walled chamber
  - repository for sperm during copulation
  - serves as the birth canal
- The vagina opens to the outside at the vulva
  - includes the hymen, vestibule, labia minora, labia majora, and clitoris

Female Anatomy







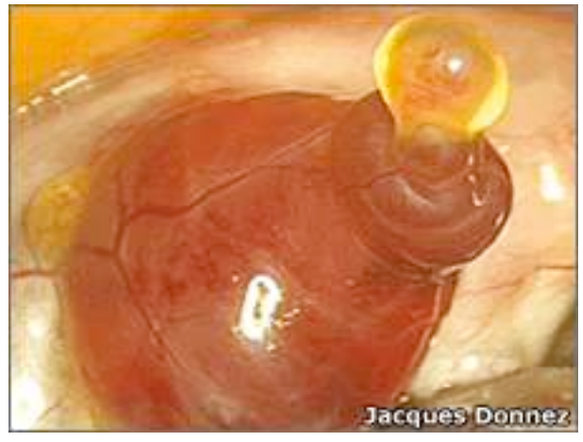
Mammary Glands

- The mammary glands are not part of the reproductive system
  - But are important to mammalian reproduction
- Within the glands
  - Small sacs of epithelial tissue secrete milk

Ovaries

- The female gonads, ovaries
  - in the abdominal cavity
- A **follicle** consists of one egg cell surrounded by one or more layers of follicle cells
  - Cells of the follicle produce estrogen
  - *(400,00 + follicles formed before birth)*

Ovulation

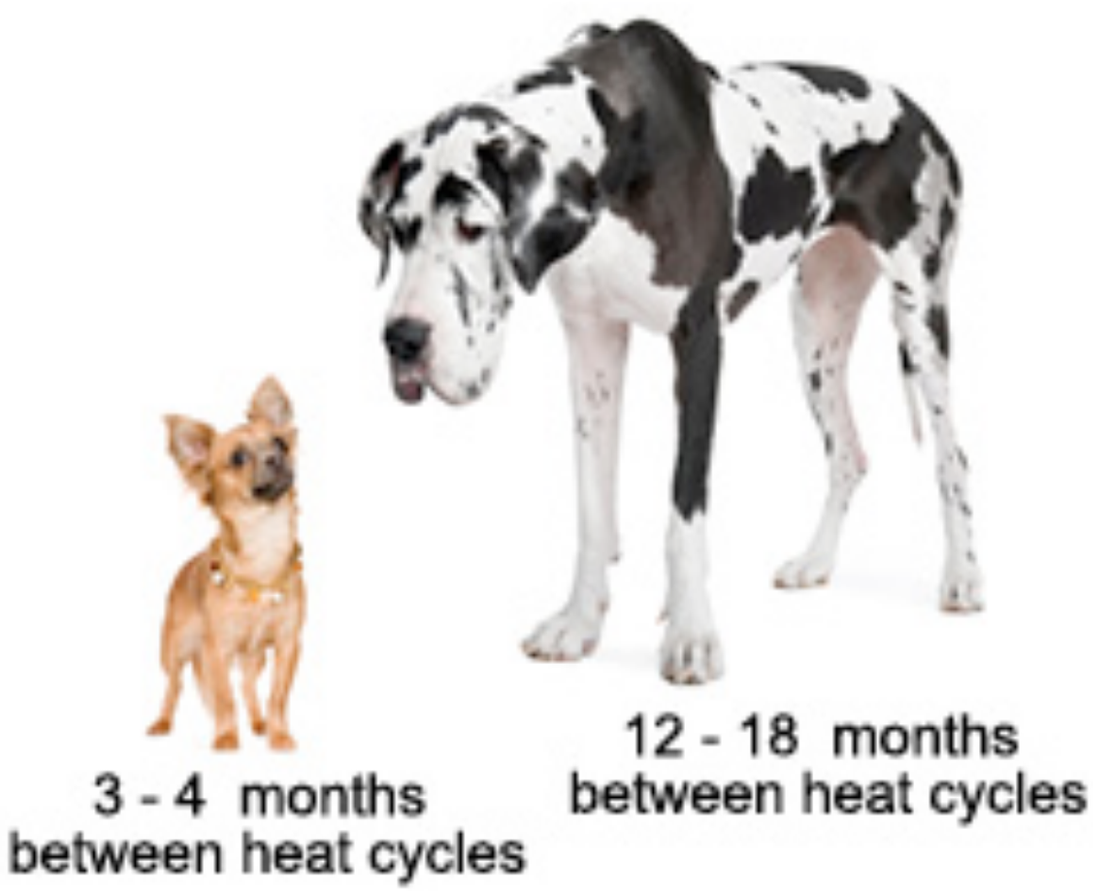


- The process of ovulation
  - Expels an egg cell from the follicle
    - occasionally more than egg is ovulated (fraternal twins!)
  - Starting at puberty and ending at menopause
  - A ripened egg lives for ~ 24 hours

- The remaining follicular tissue then grows within the ovary
  - To form a solid mass called the corpus luteum, which secretes estrogen and progesterone, depending on whether or not pregnancy occurs

Estrous Cycles

- Season /climate has strong effect on these cycles
- Vaginal changes permit mating ("in heat")
- Rat cycle is 5 days, some like bears and dogs have only one cycle per year (others a few)
- Reabsorb endometrium



Menstrual Cycles

- Two organs are most directly involved: ovaries & uterus

I. Menstrual Cycle

A. Ovarian Cycle

1. Luteal Phase

2. Follicular Phase

B. Uterine Cycle

1. Menstrual Phase

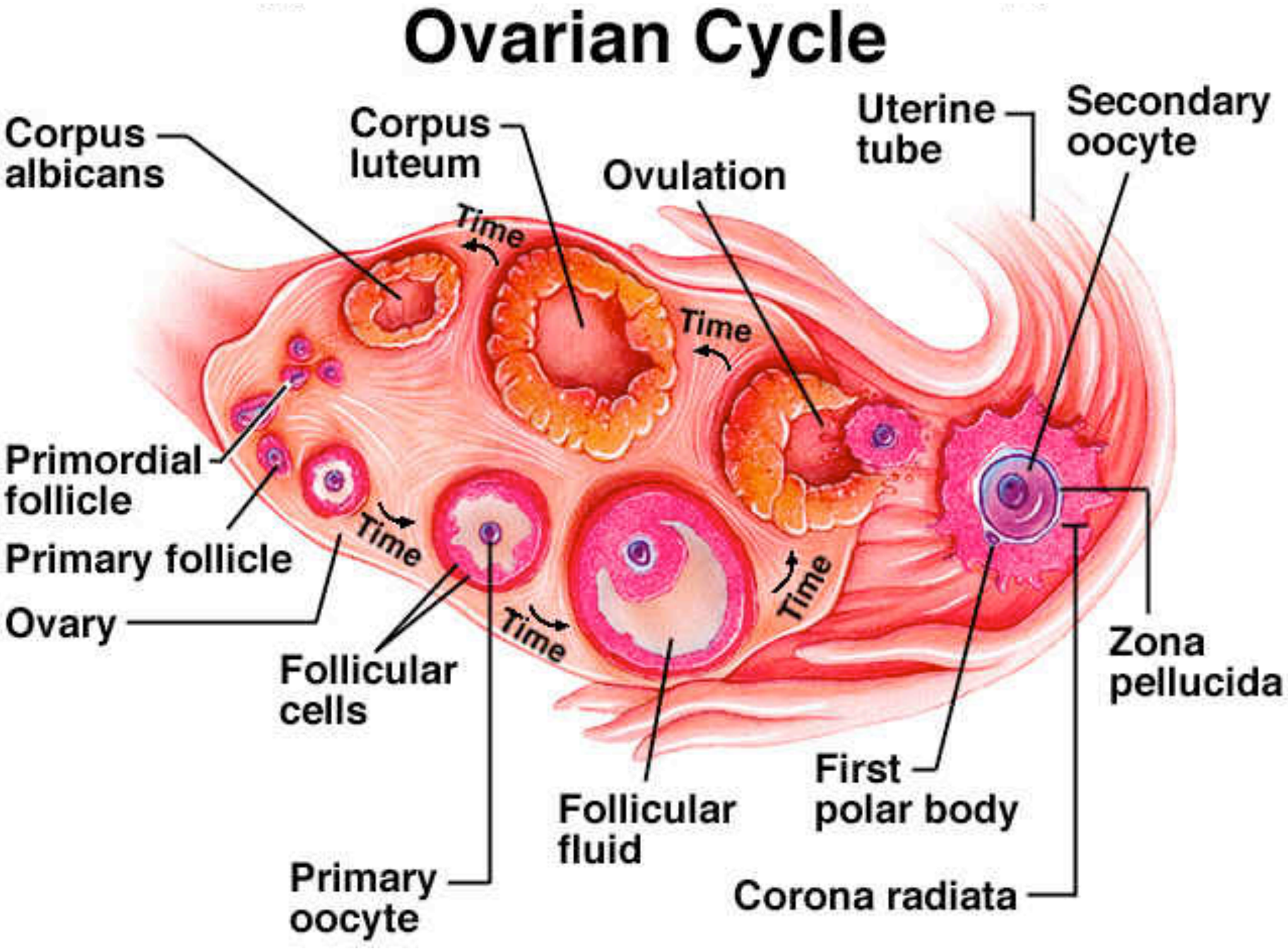
2. Proliferation Phase

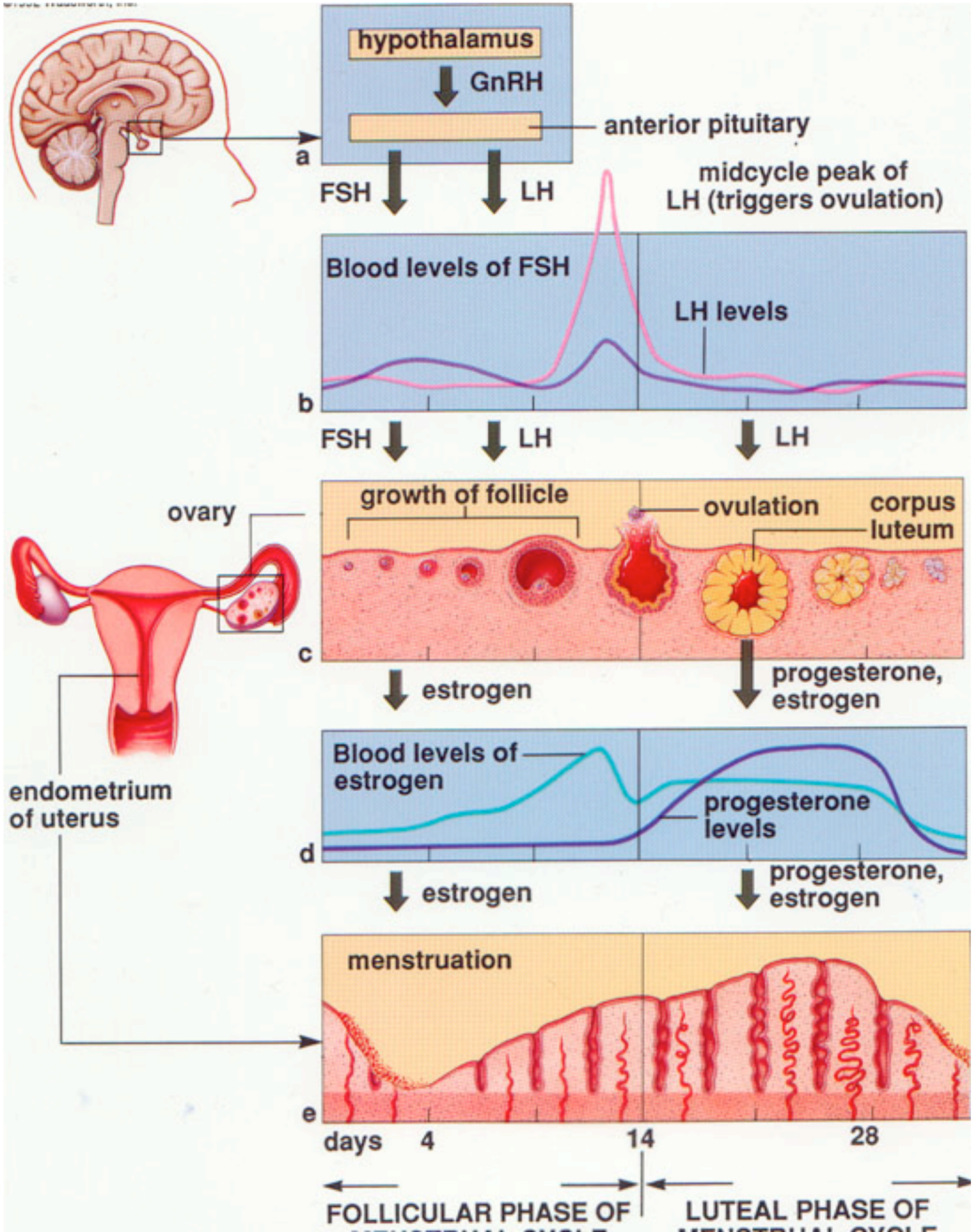
3. Secretory Phase

Menstrual Cycles

- Range from 20-40 days (28 on average)(regular or irregular)
- 5 different hormones are involved
- 3 uterine phases: menstrual, proliferation, secretory
- 2 ovarian phases: follicular, luteul
- Negative and positive feedback loops
- Two organs: ovaries & uterus

Another Perspective-

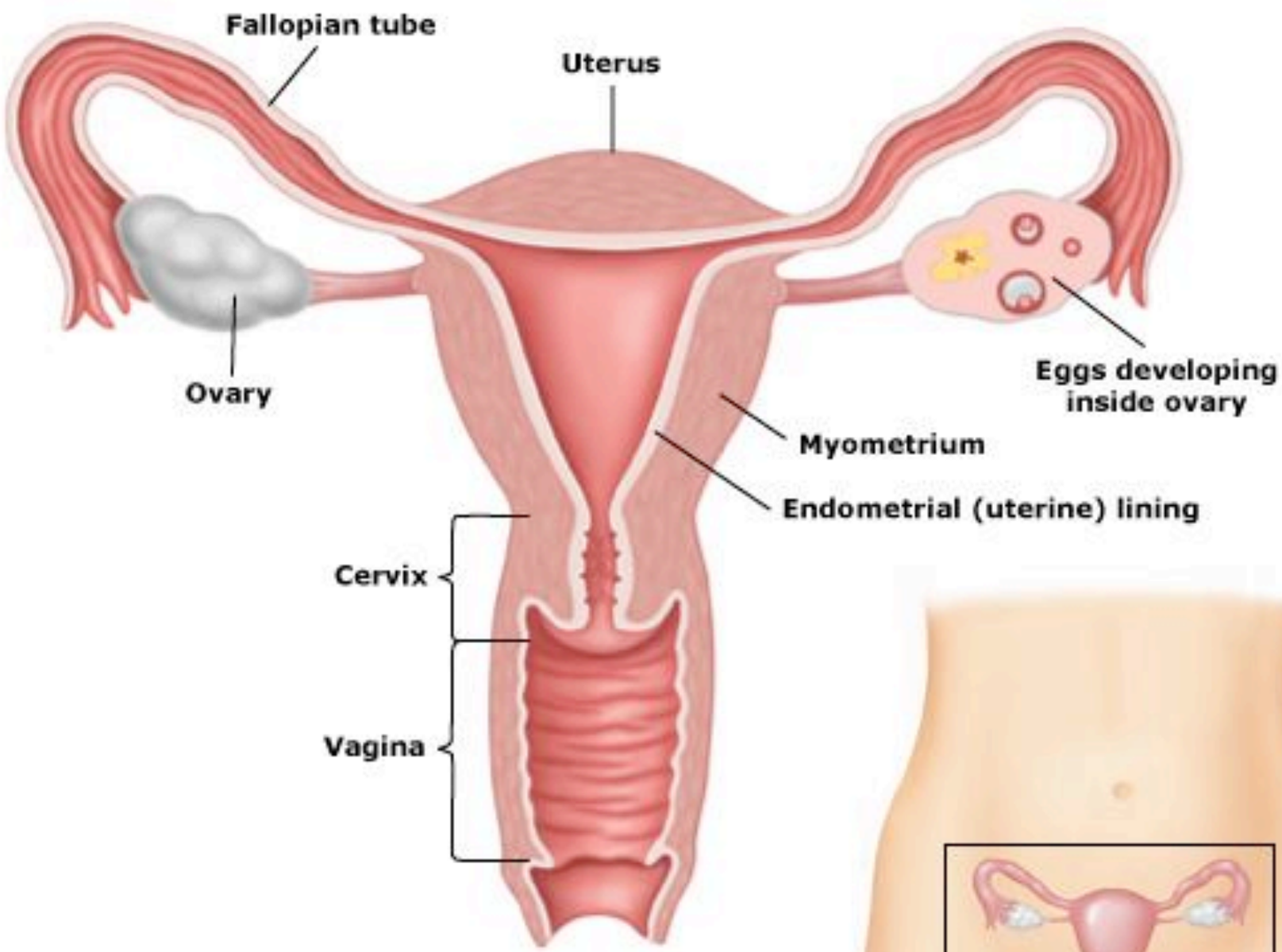


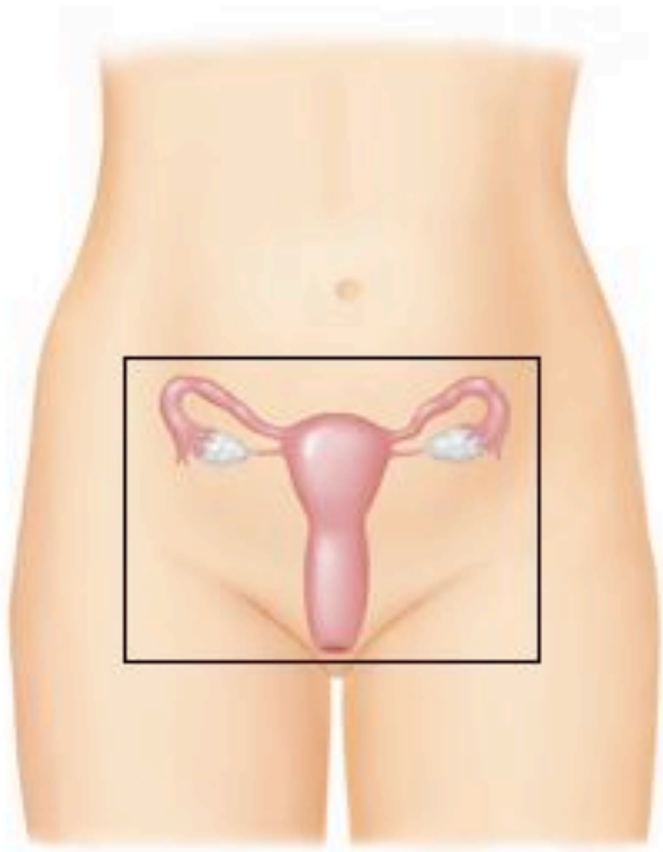

hypothalamus
GnRH
anterior pituitary
a
FSH
LH
midcycle peak of
LH (triggers ovulation)
Blood levels of FSH
LH levels
b
FSH
LH
LH
ovary
growth of follicle
ovulation
corpus
luteum
c
estrogen
progesterone,
estrogen
Blood levels of
estrogen
progesterone
levels
d
estrogen
progesterone,
estrogen
endometrium
of uterus
menstruation
e
days
4
14
28
FOLLICULAR PHASE OF
LUTEAL PHASE OF

Oviducts

- The egg cell is released into the abdominal cavity
  - Near the opening of the oviduct, or fallopian tube
- Cilia in the tube draw in the egg

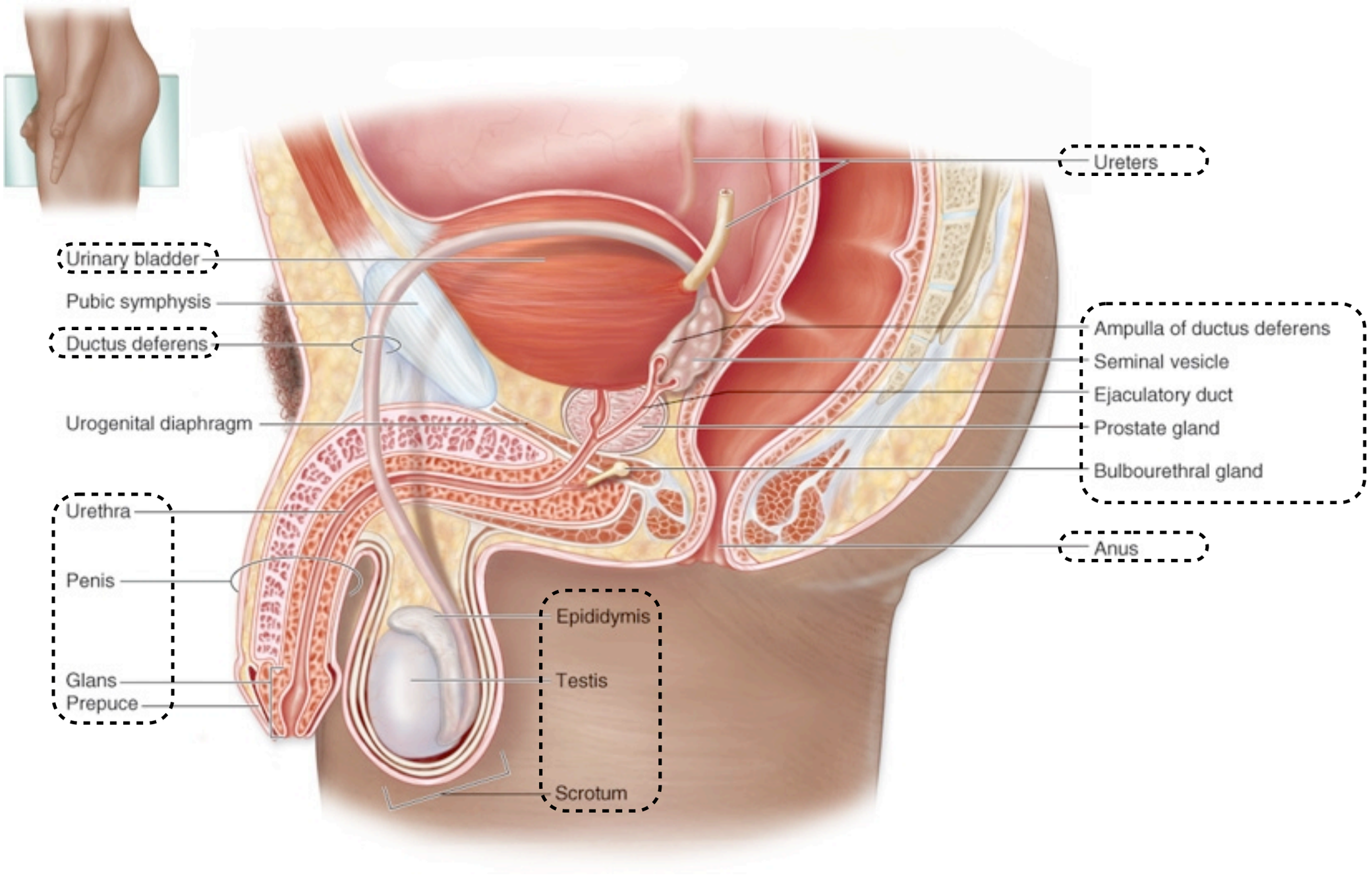
Uterus


Fallopian tube
Uterus
Ovary
Eggs developing inside ovary
Myometrium
Endometrial (uterine) lining
Cervix
Vagina

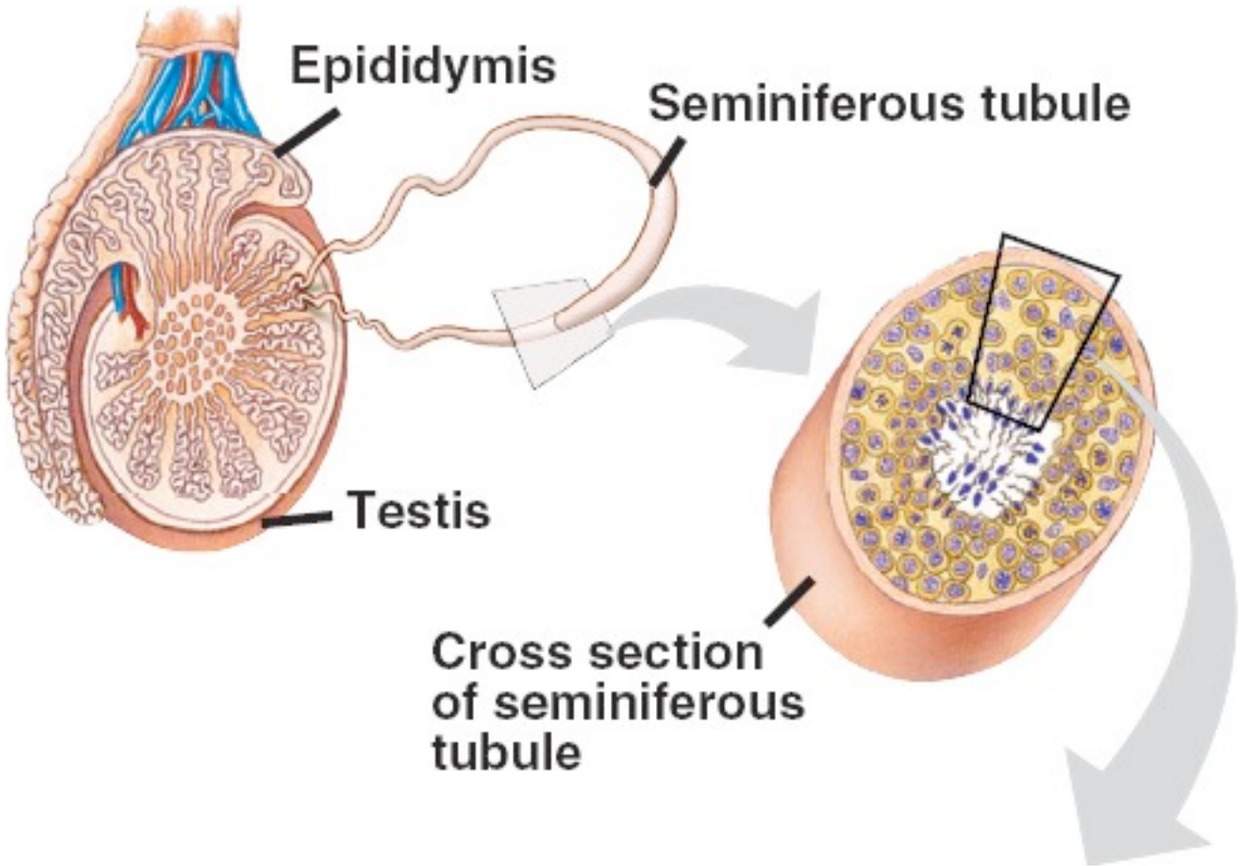


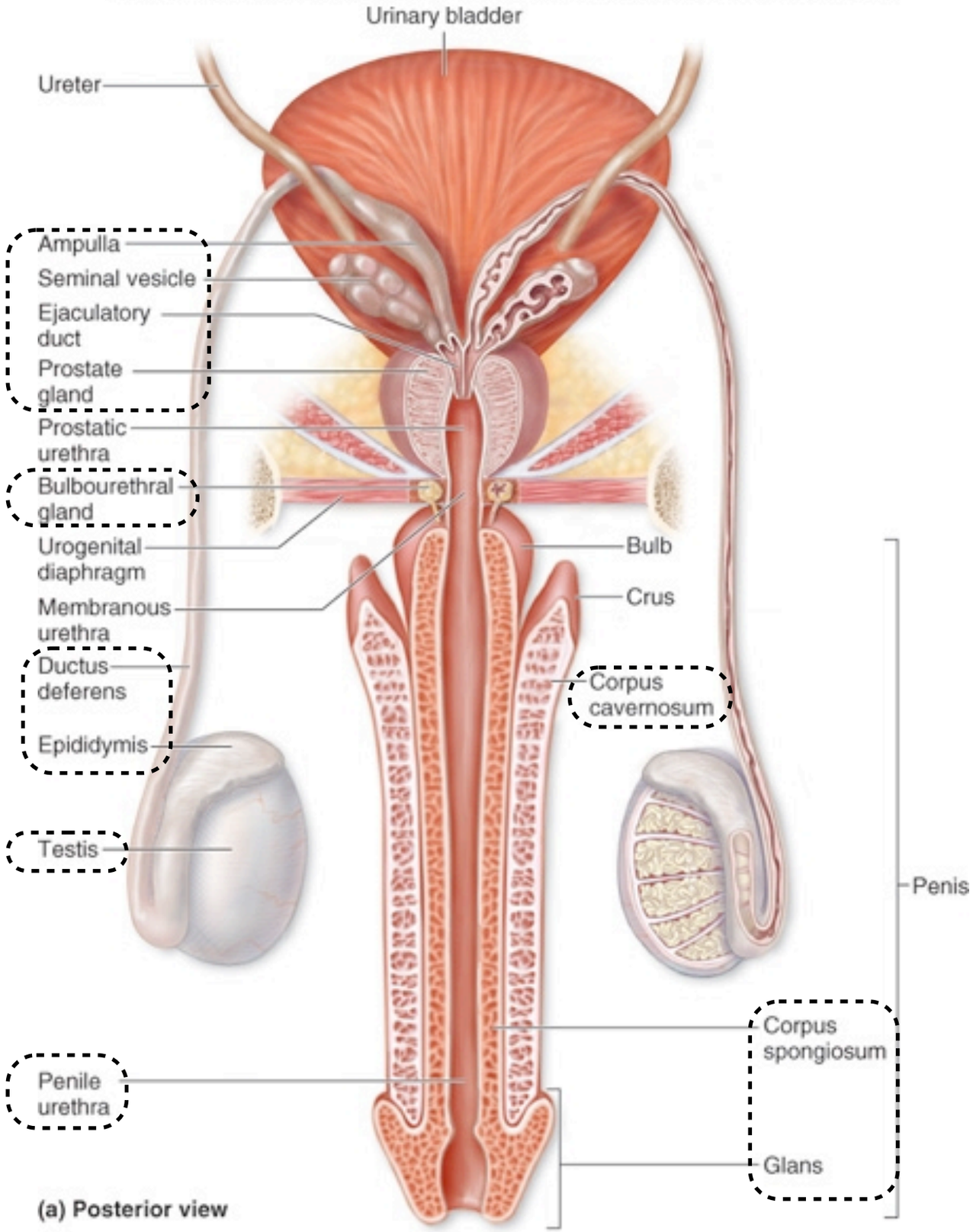
Human Reproductive System

Male Anatomy



Male Anatomy





Testes

- The male gonads, testes
  - Consist of many highly coiled tubes
- The tubes are seminiferous tubules
  - Where sperm form
  - Leydig cells scattered between tubes produce testosterone and other androgens (male steroid hormone)

Testes/Sperm Production

- Production of normal sperm
  - Cannot occur at the body temperatures of most mammals
- The lifespan of human sperm
  - Outside the body on the order of minutes to hours and inside female reproductive tract 5 days or more

Testes/Sperm Production

- The testes of humans and many mammals
  - Are held outside the abdominal cavity in the scrotum, where the temperature is lower than in the abdominal cavity
  - Rodents move them in and out accordingly and whales and elephants retain theirs

Ducts

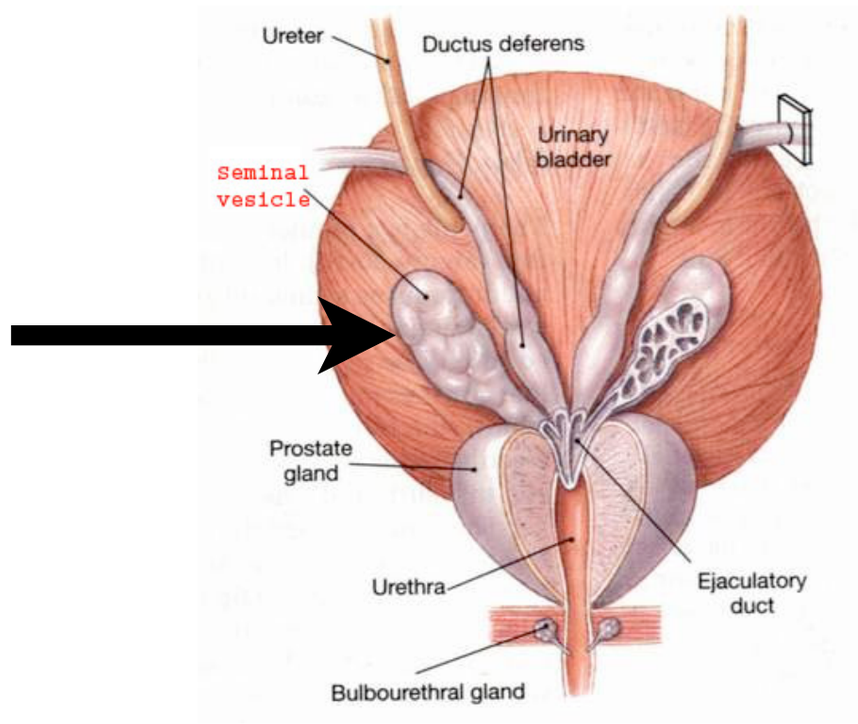
- From the seminiferous tubules of a testis
  - The sperm mature as they pass into the coiled tubules of the epididymis (6 meters in length-takes about 20 days for sperm to get through)

Ducts

- During ejaculation
  - Sperm pathway
  - Urethra serves both excretory and reproductive functions in males
  - Human copulation transfers 2-5ml of sperm with 70-130 million sperm per ml
  - semen coagulates until it reaches the cervix

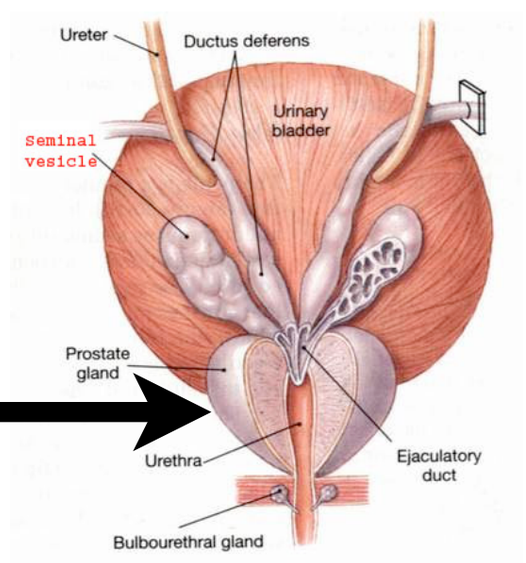
Glands

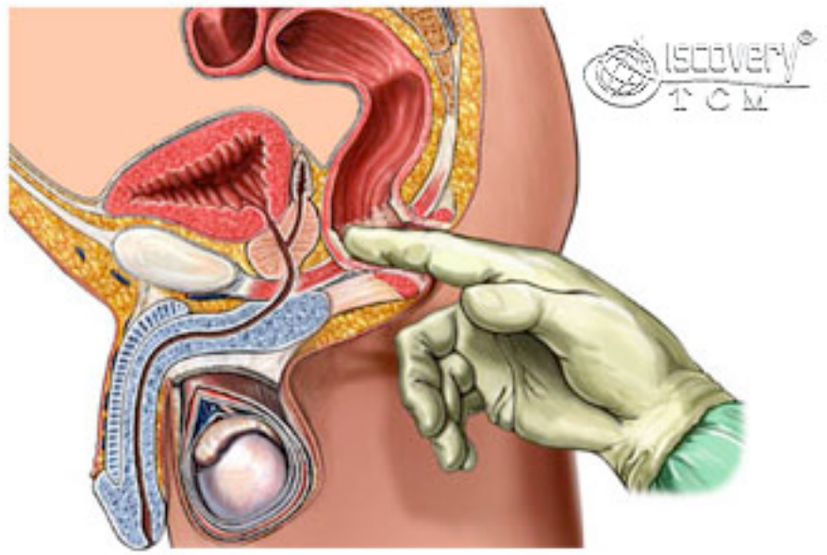
- Three sets of accessory glands
  - Add secretions to the semen, the fluid that is ejaculated
- A pair of seminal vesicles
  - Contributes about 60% of the total volume of semen
  - Thick, yellowish, alkaline fluid
- Contains: mucus, sugar, coagulating enzymes, ascorbic acid and prostaglandins (local regulators)



Glands

- The prostate gland
  - Largest of three, it secretes its products directly into the urethra through several small ducts
  - Thin and milky fluid
  - Contains: anticoagulant enzymes and citrate

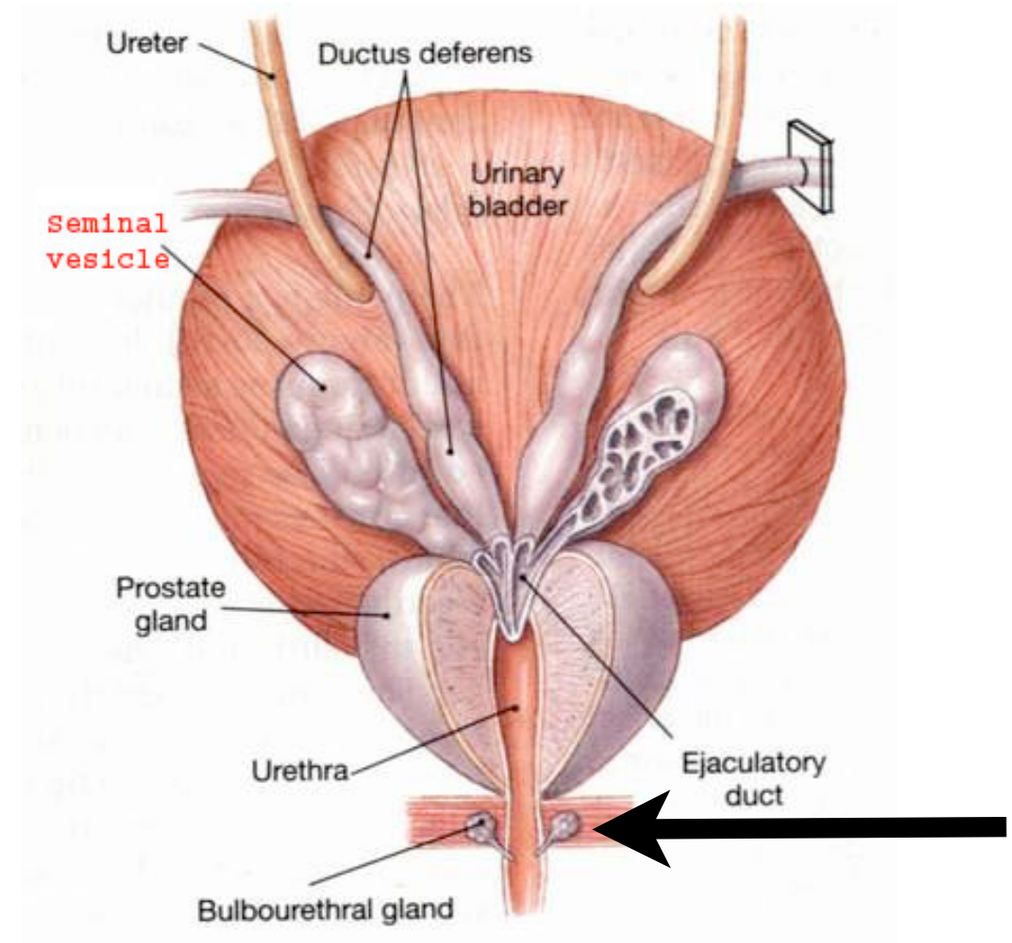




- The prostate gland
  - One of the most common cancers in men
  - 50% of males over the age of 40 have an enlarged prostrate

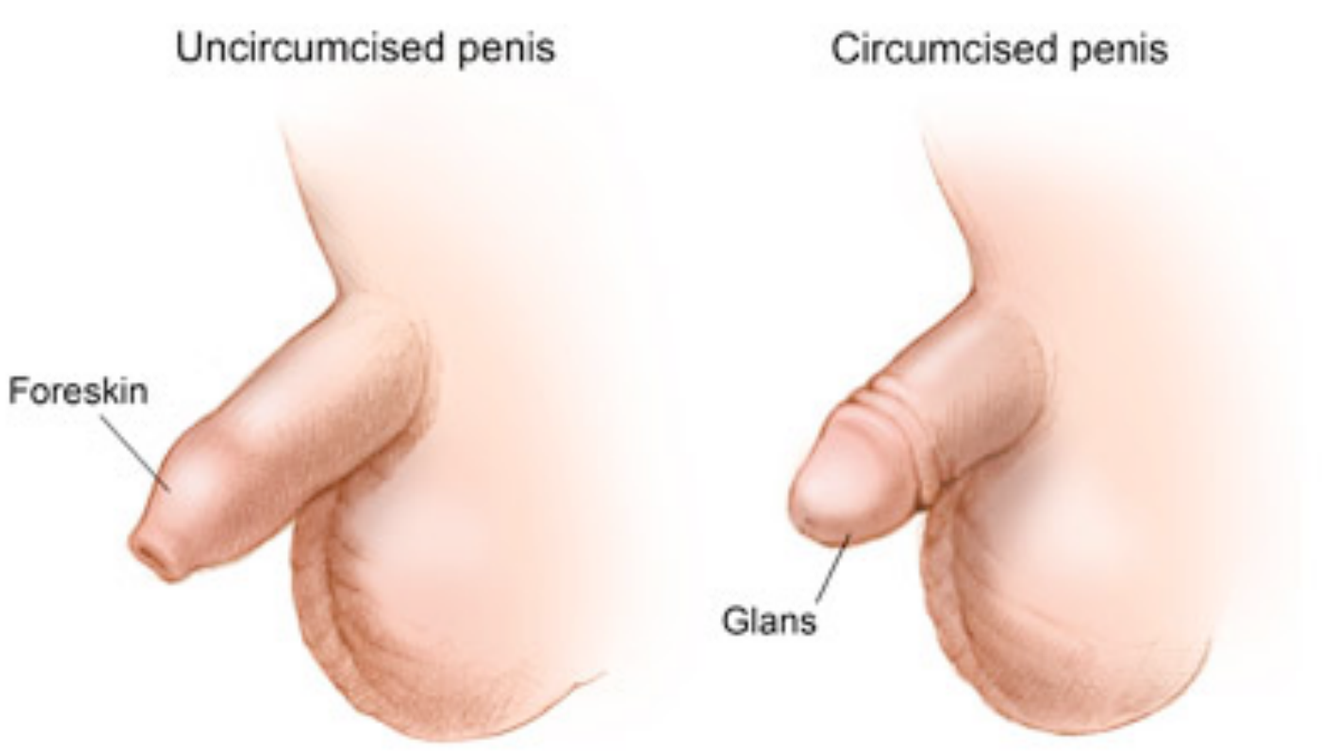
Glands

- The bulbourethral gland
  - Secretes a clear mucus neutralizes acidic urine remaining in the urethra
  - carries some sperm prior to ejaculation

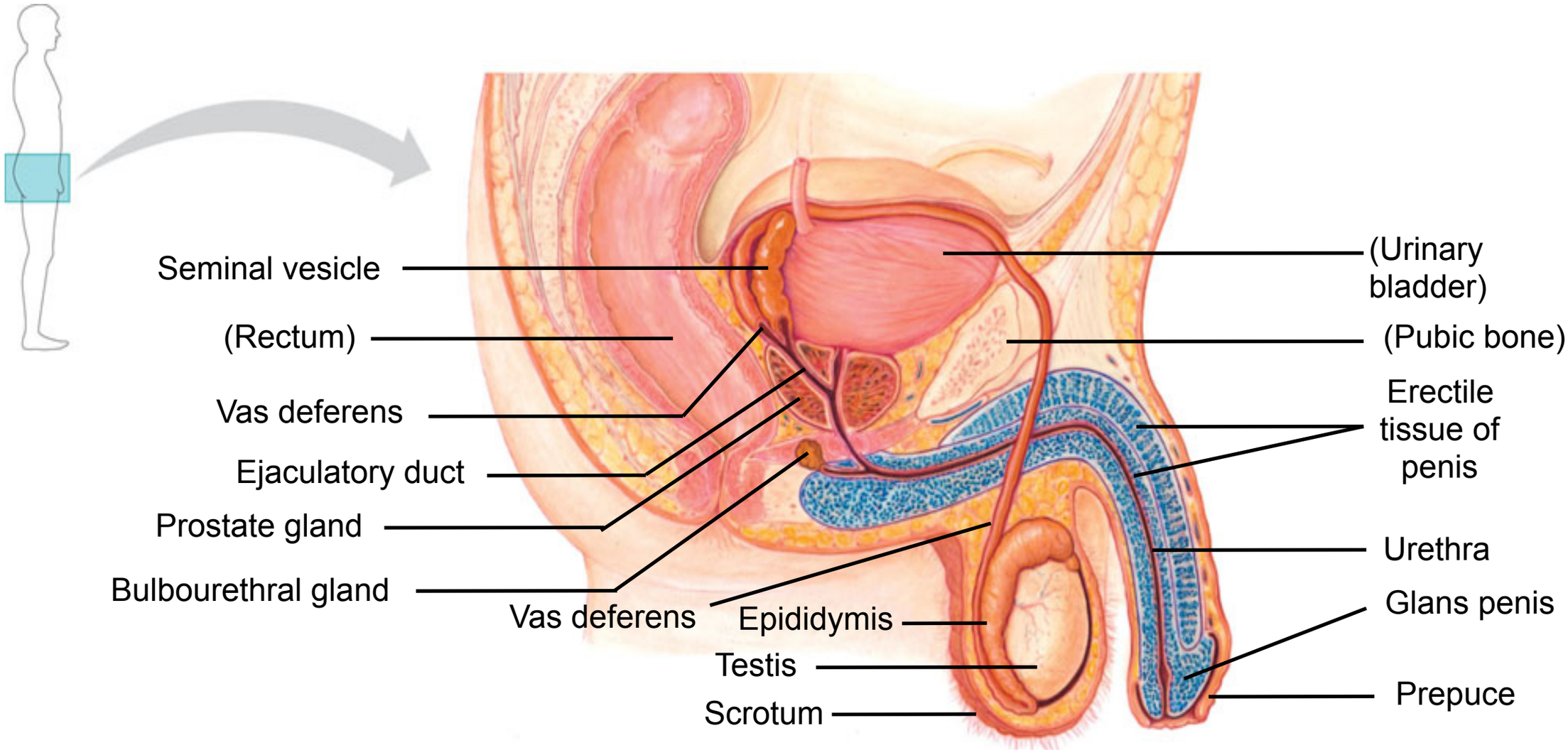


Penis

- The human penis
  - Is composed of three cylinders of spongy erectile tissue
  - Glans penis thin skin and dense nerve endings
  - Prepuce (foreskin) is a fold of skin that covers the Glans penis



Pathway of Sperm in Ejaculation



Semen in the Female Reproductive Tract

- Once in the female reproductive tract
  - A number of processes, including contractions of the uterus, help move the sperm up the uterus
- Secretions in the female reproductive tract bring about "changes" in sperm motility and structure
  - These "changes" (called ***capacitation***) take place about 6 hours after sperm enters female and they are required for sperm to fertilize the egg

Conception & Fetal Development

- Conception = Fertilization & Gestation = Pregnancy

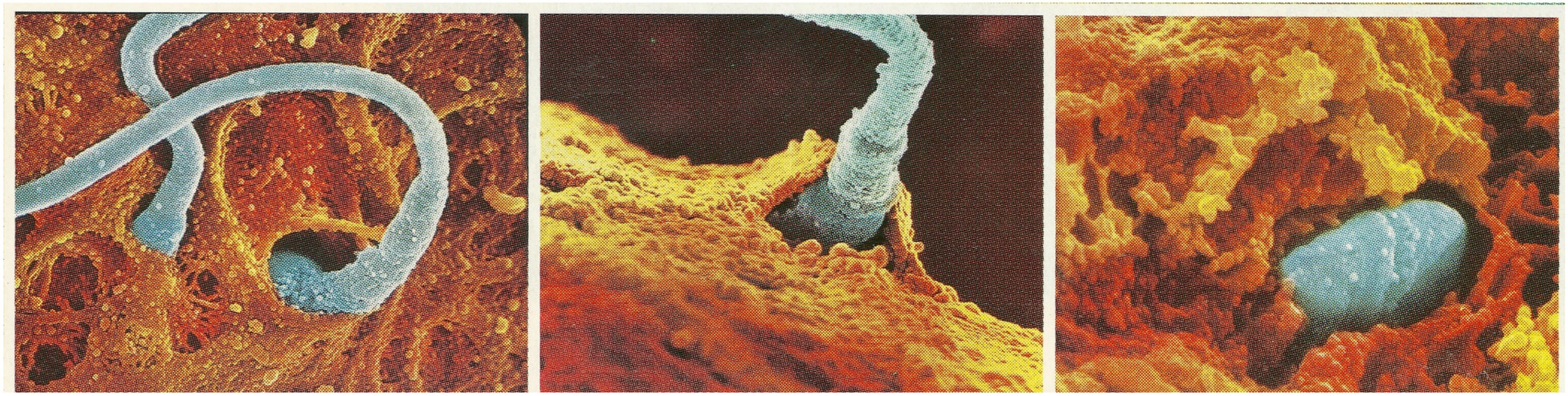
- Human gestation is 40 weeks (countdown begins from your first day of your last menstrual period)

- Divided into three trimesters

- Gestation period directly correlates with animal size.

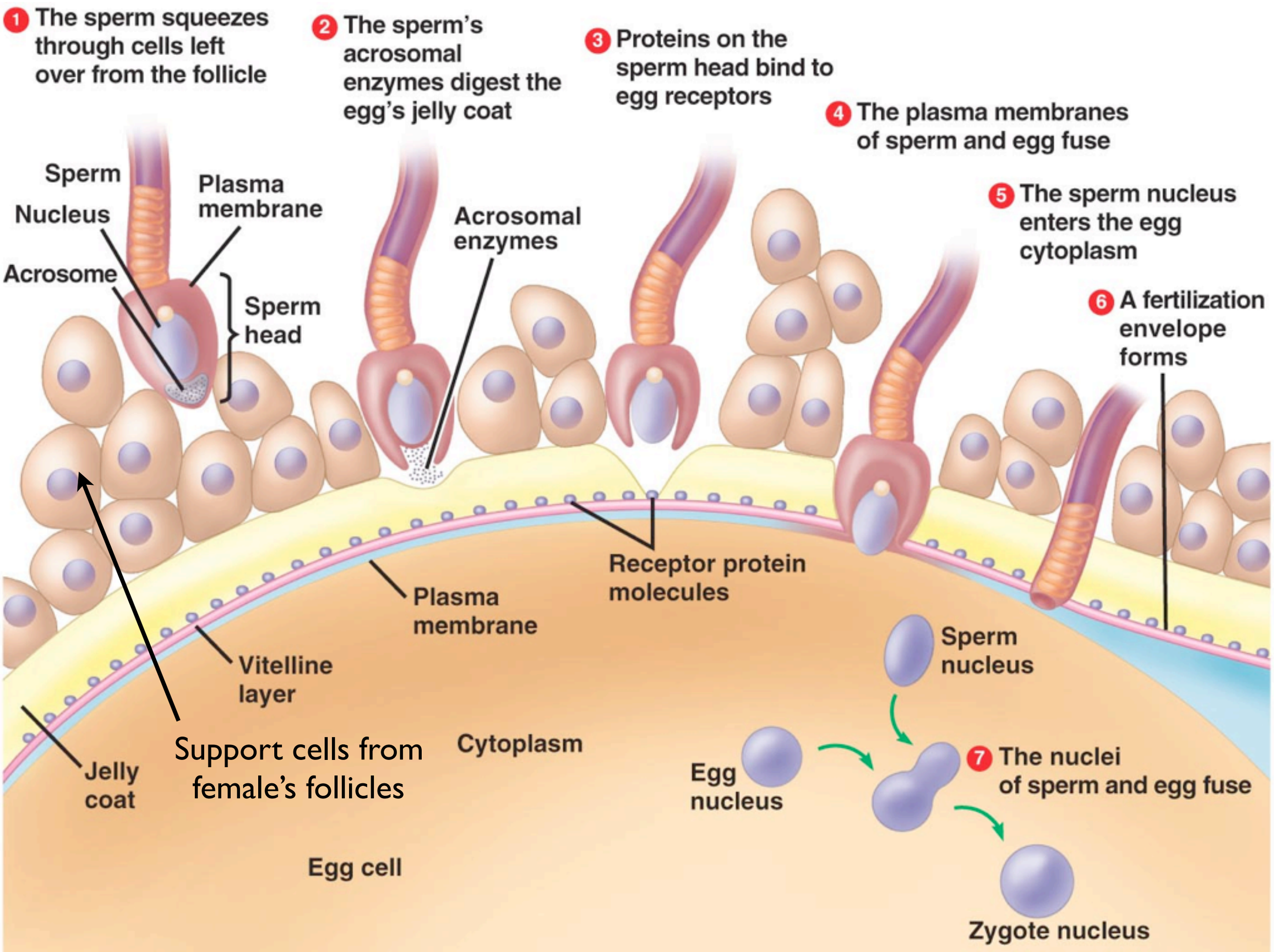
  Example rats (21 days), dogs (60 days), cows (270 days), giraffes (420 days), elephants (600 days)

Fertilization/Conception



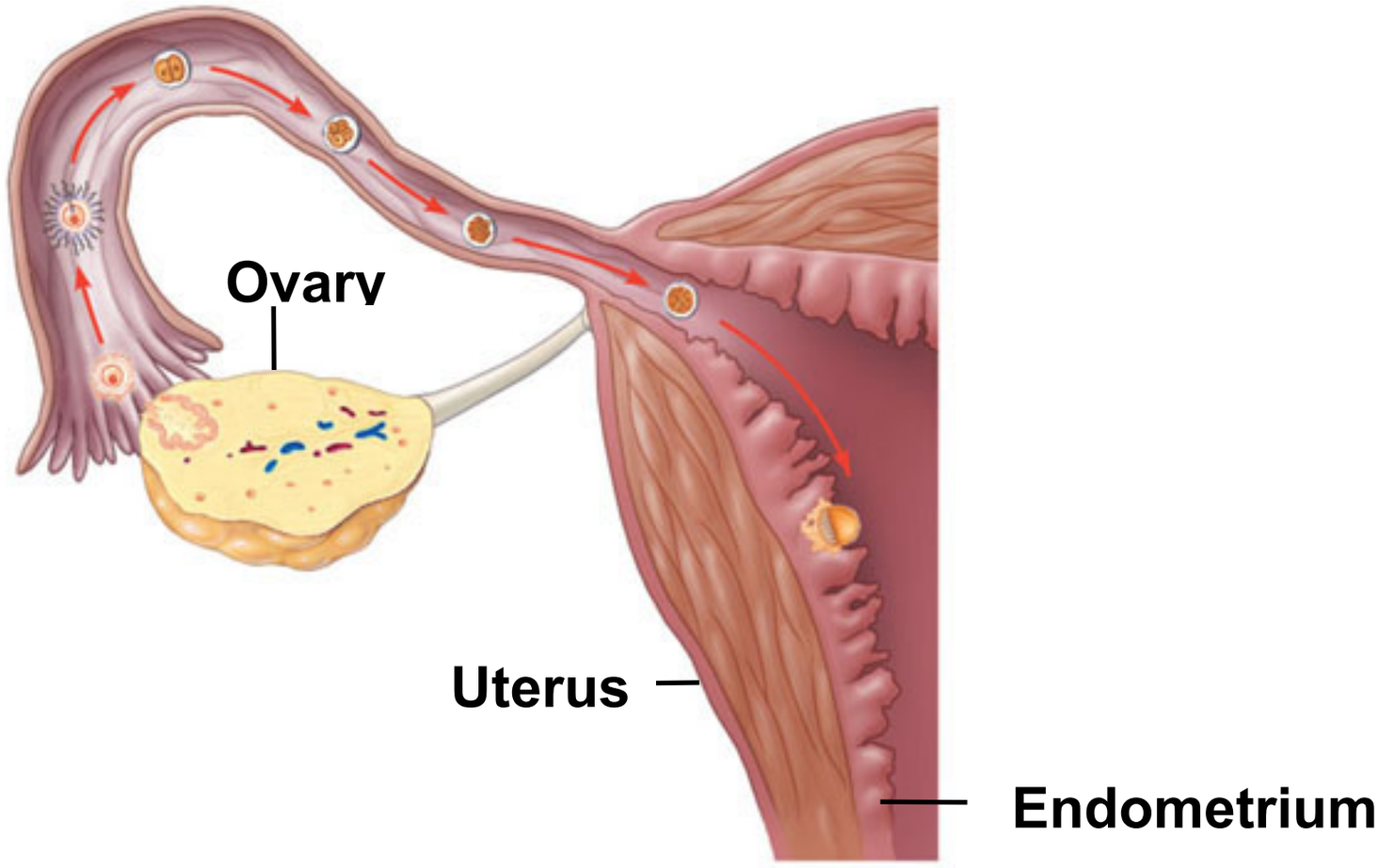
- Fertilization of an egg by a sperm, conception
  - Occurs in the oviduct

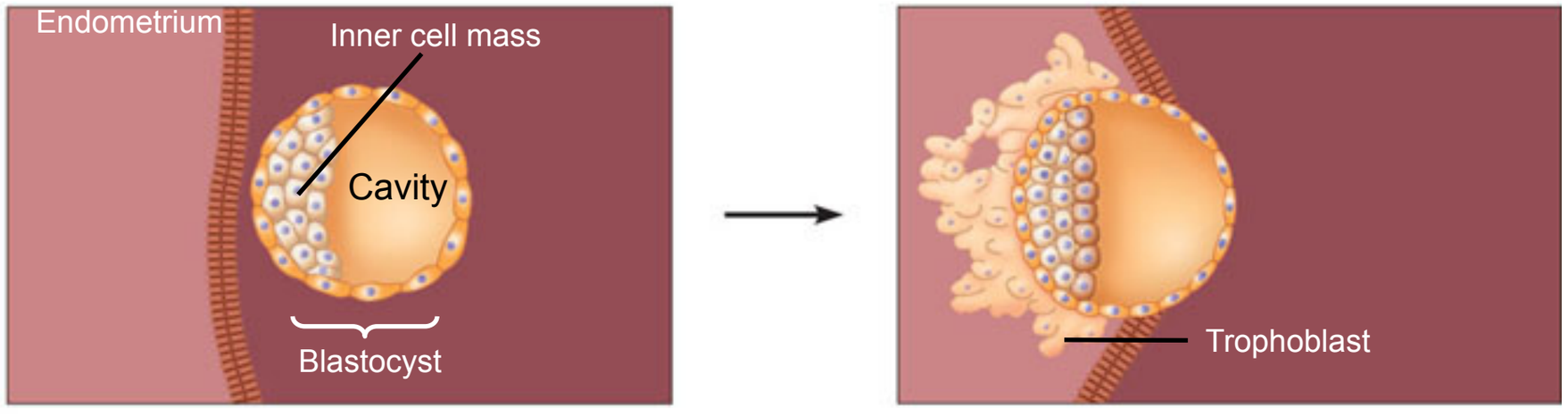
Fertilization/Conception



A Closer Look-Fertilization

From ovulation to implantation

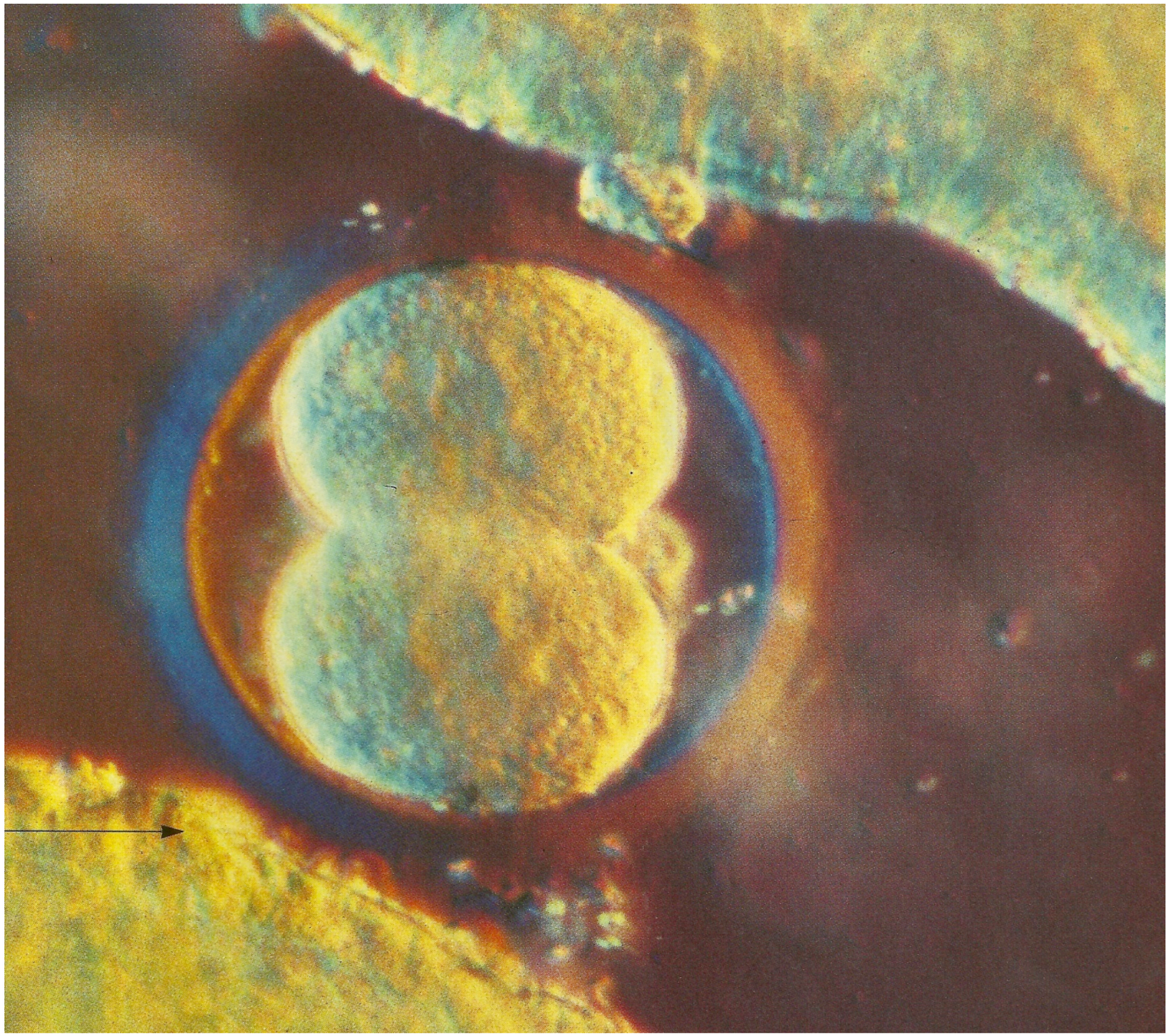




Implantation of blastocyst

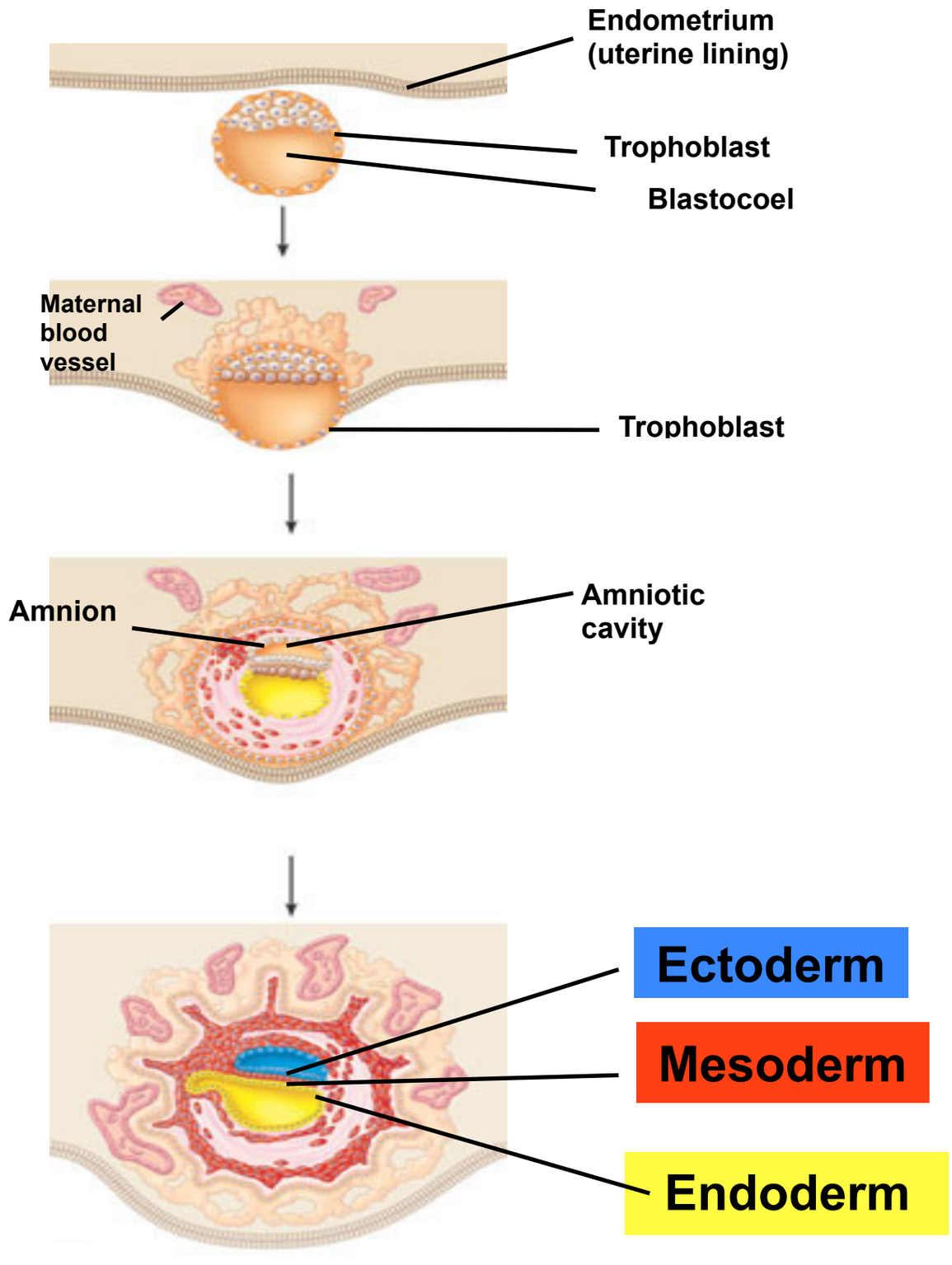
Conception

12-36 hours after sperm binds to egg



Embryonic Development

- Early embryonic development in a human
  - Occurs in 4 stages...



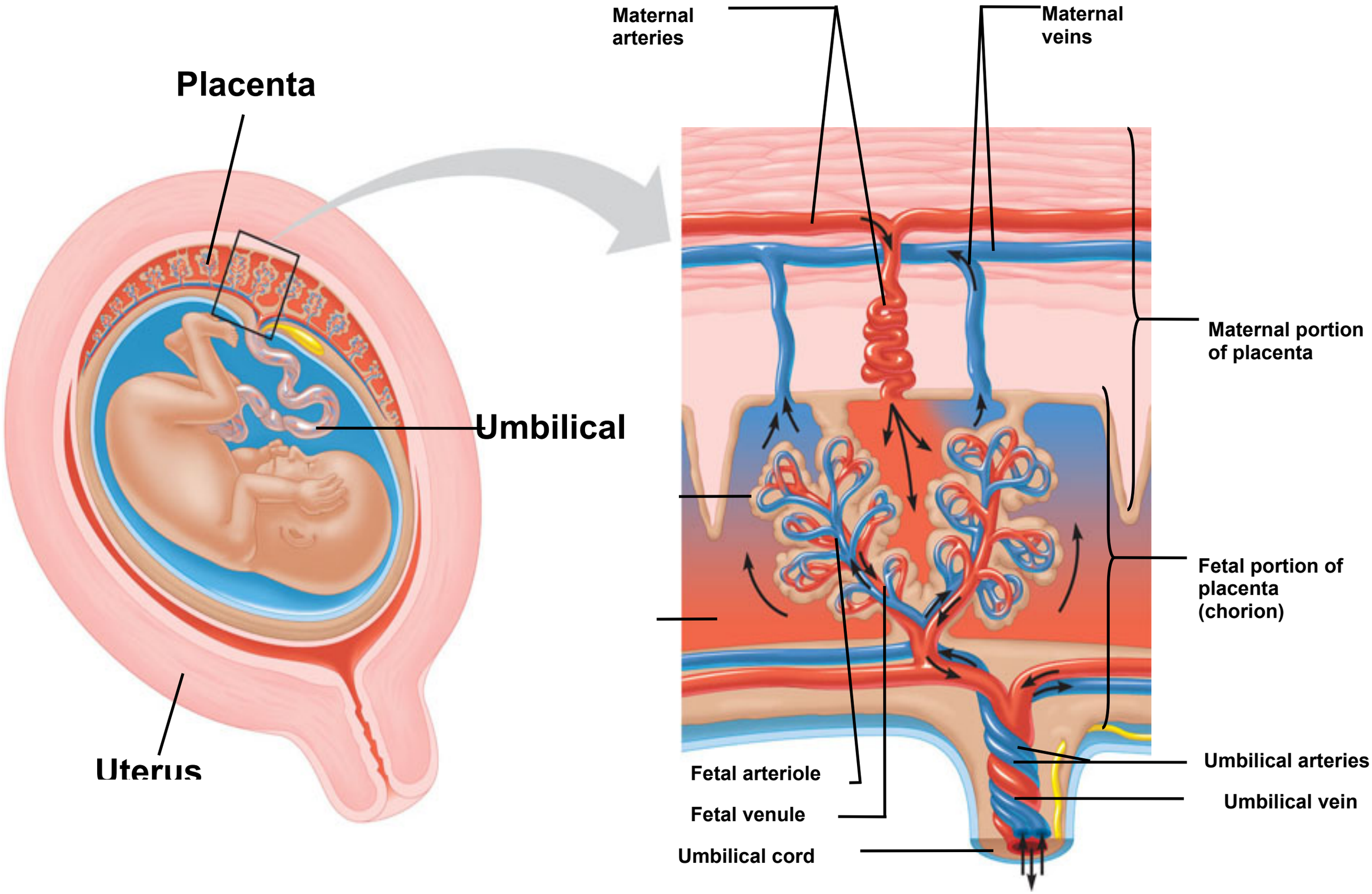
Embryonic Development

ECTODERM	MESODERM	ENDODERM
• Epidermis of skin and its derivatives (including sweat glands, hair follicles) • Epithelial lining of mouth and rectum • Sense receptors in epidermis • Cornea and lens of eye • Nervous system • Adrenal medulla • Tooth enamel • Epithelium or pineal and pituitary glands	• Notochord • Skeletal system • Muscular system • Muscular layer of stomach, intestine, etc. • Excretory system • Circulatory and lymphatic systems • Reproductive system (except germ cells) • Dermis of skin • Lining of body cavity • Adrenal cortex	• Epithelial lining of digestive tract • Epithelial lining of respiratory system • Lining of urethra, urinary bladder, and reproductive system • Liver • Pancreas • Thymus • Thyroid and parathyroid glands

Development (First Trimester)

- Embryo obtains nutrients from endometrium for the first 2-4 weeks
  - Tissues grow out from embryo and mingle with endometrium-forming the disc shaped placenta
    - Placenta- maternal and embryonic blood vessels
      - gas, nutrient and waste exchange occur
      - The umbilical cord connects embryo to placenta

First Trimester



First Trimester

- Human gestation
  - Can be divided into three trimesters of about three months each
- The first trimester
  - Is the time of most radical change for both the mother and the embryo

- Embryo secretes HCG (acts like LH) to maintain corpus luteum for the first 3 months
- No HCG would result in menstruation and a spontaneous abortion
- Home pregnancy tests detect HCG in Urine
- Other Changes include: cessation of ovulation and menstruation, enlargement of breasts and uterus and development of protective cervical plug

- The first trimester is the main period of organogenesis

5 weeks. Limb buds, eyes, the heart, the liver, and rudiments of all other organs have started to develop in the embryo, which is only about 1 cm long.

14 weeks. Growth and development of the offspring, now called a fetus, continue during the second trimester. This fetus is about 6 cm long.

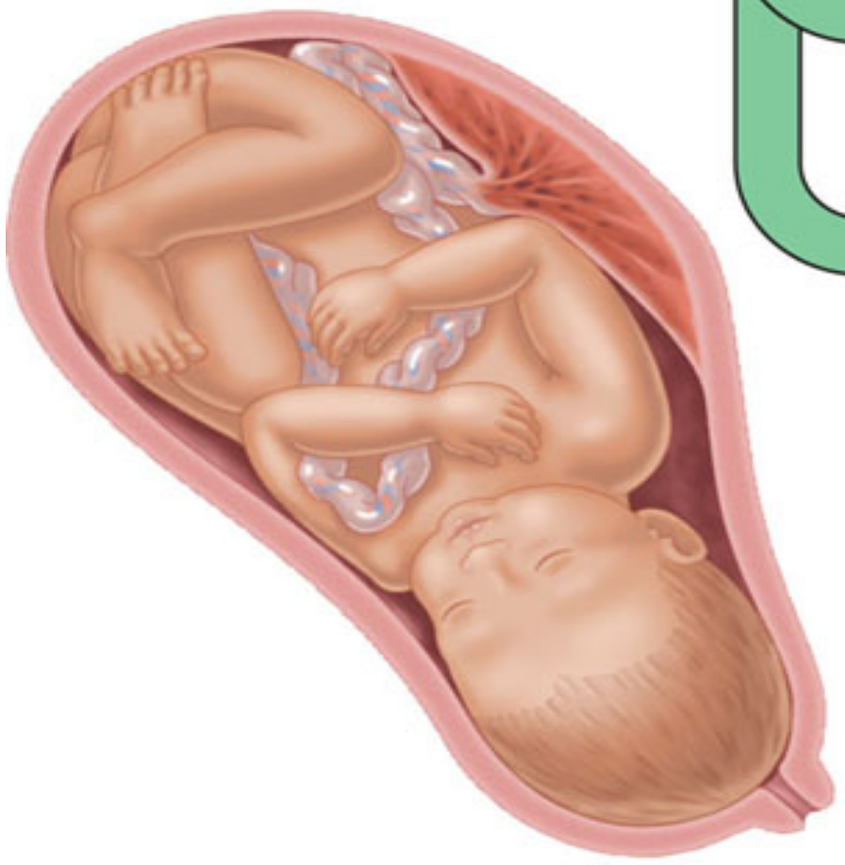
20 weeks. By the end of the second trimester (at 24 weeks), the fetus grows to about 30 cm in length.

Second Trimester

- During the second trimester
  - The fetus grows and is very active
  - HCG declines, corpus luteum deteriorates, and placenta secretes its own progesterone, which maintains pregnancy through birth

Third Trimester

- During the third trimester
  - The fetus continues to grow rapidly
  - Fetus expands compressing maternal organs resulting in shortness of breath, frequent urination, constipation and lower back aches
  - Complex interplay of hormones begin

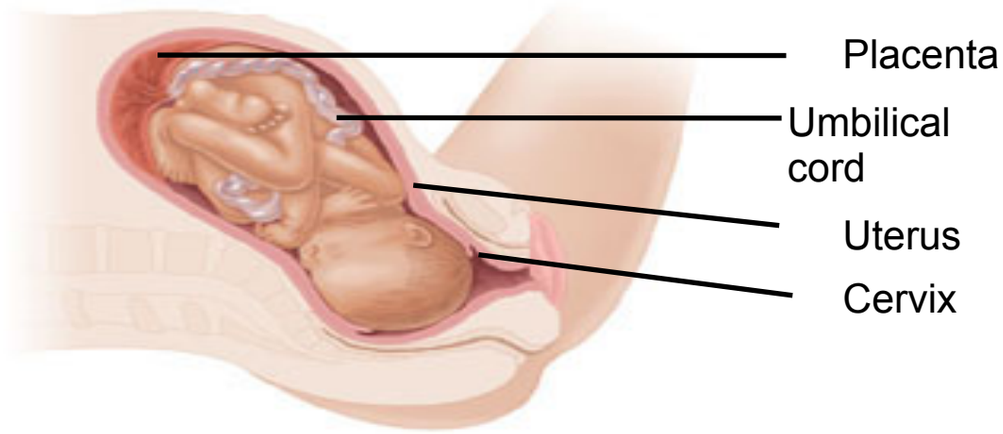


Estrogen
Oxytocin
from ovaries
from fetus and mother's posterior pituitary
Positive feedback
Induces oxytocin receptors on uterus
Stimulates uterus to contract
Stimulates placenta to make
Prostaglandins
Stimulate more contractions of uterus

Labor/Birth

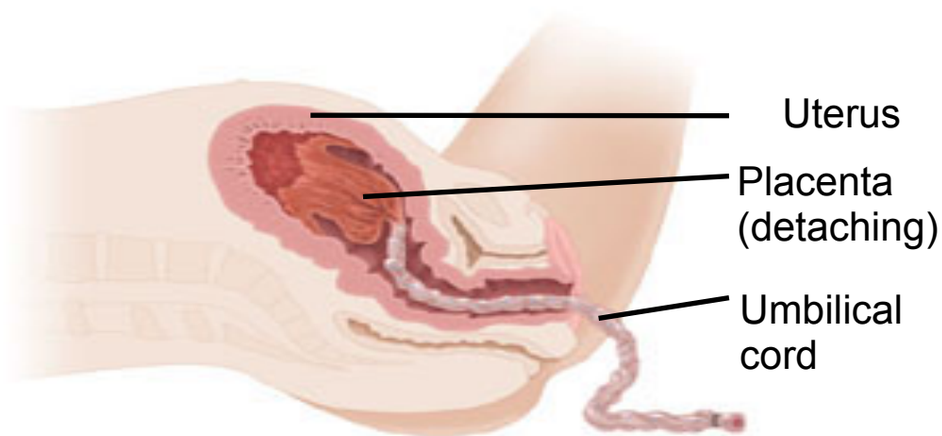
Birth (parturition)

- The process of labor has three stages:



1 Dilation of the cervix

2 Expulsion: delivery of the infant



3 Delivery of the placenta

REVIEW

Plants

Reproduction

Plant Reproduction Intro

- ALL *Plants can be placed into one of four main groups.*
  - 1. Bryophytes:
  - 2. Pterophytes & Lycophytes:
  - 3. Gymnosperms
  - 4. Angiosperms

BRYOPHYTES

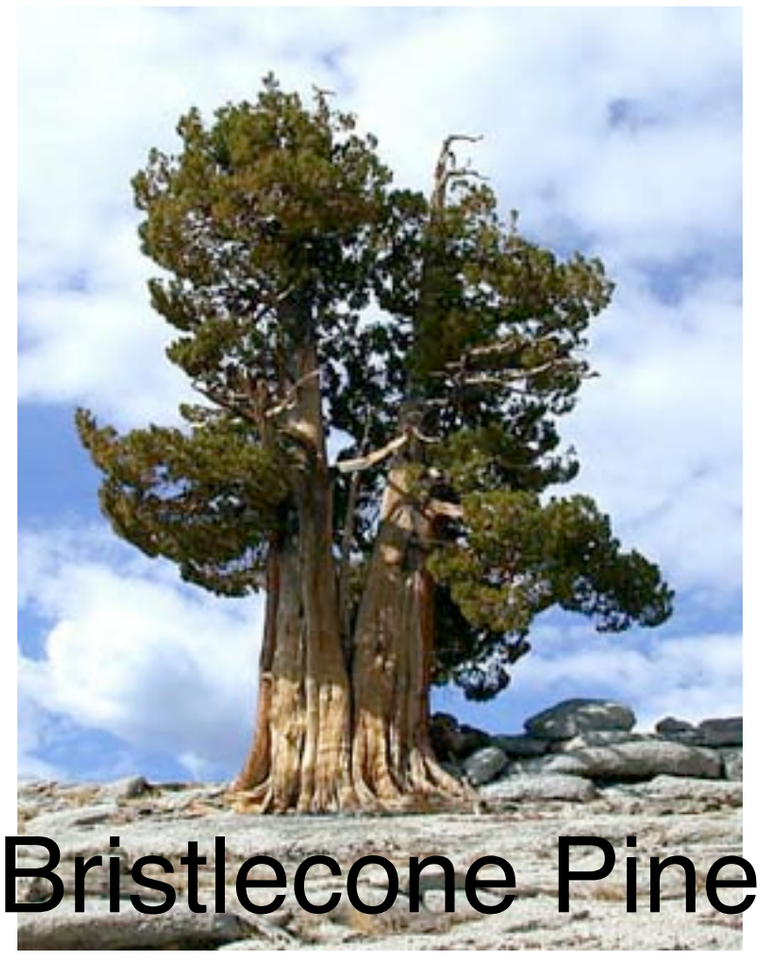
PTEROPHYTES & LYCOPHYTES

Horsetails

Ferns

Whisk Ferns

GYMNOSPERMS



Plant Reproduction Intro

- *Gametes* (sperm & eggs) are produce via meiosis
- The fusion of sperm and egg (fertilization) produces a single celled *zygote*
- The zygote proceeds to divide via mitosis over and over again and the new cells then grow and develop into a multicellular (*adult) organism

Plant Reproduction Intro

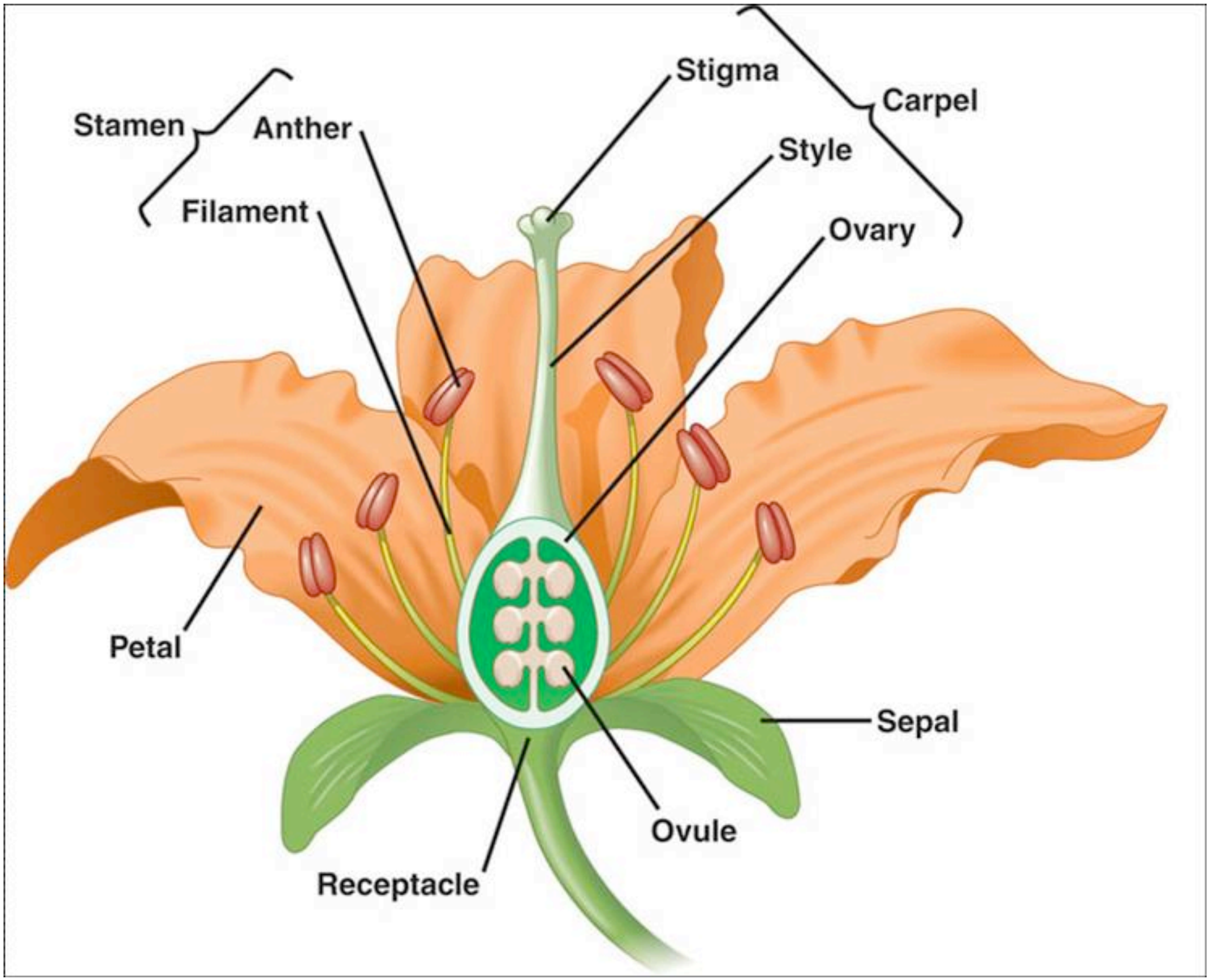
- The life cycle of ALL plants is characterized by an Alteration of Generations.
    - The gametophyte (multi-cell, haploid generation) and the sporophyte (multi-cell, diploid generation) take turns producing each other
- The diploid stage (sporophyte) dominates (larger, lives longer and more conspicuous) the life cycle in most plants

Plant Reproduction Intro

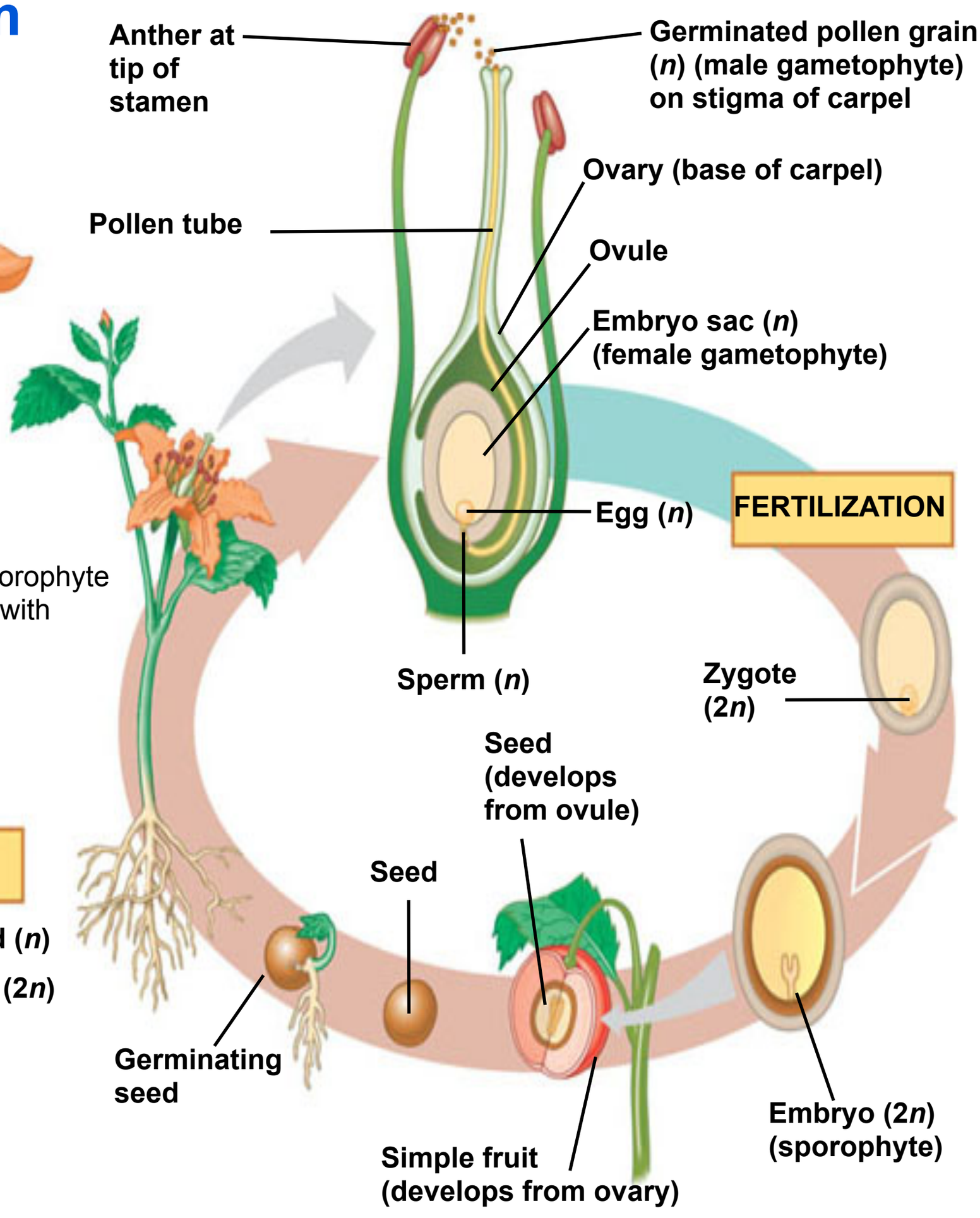
- The key traits of angiosperm (flowering plants) reproduction are the "3F's"- ***Flowers, Fertilization, Fruits, Seeds***

- A knowledge of ***Seed*** structure and function will also be helpful to fully understand (most) plant life cycles

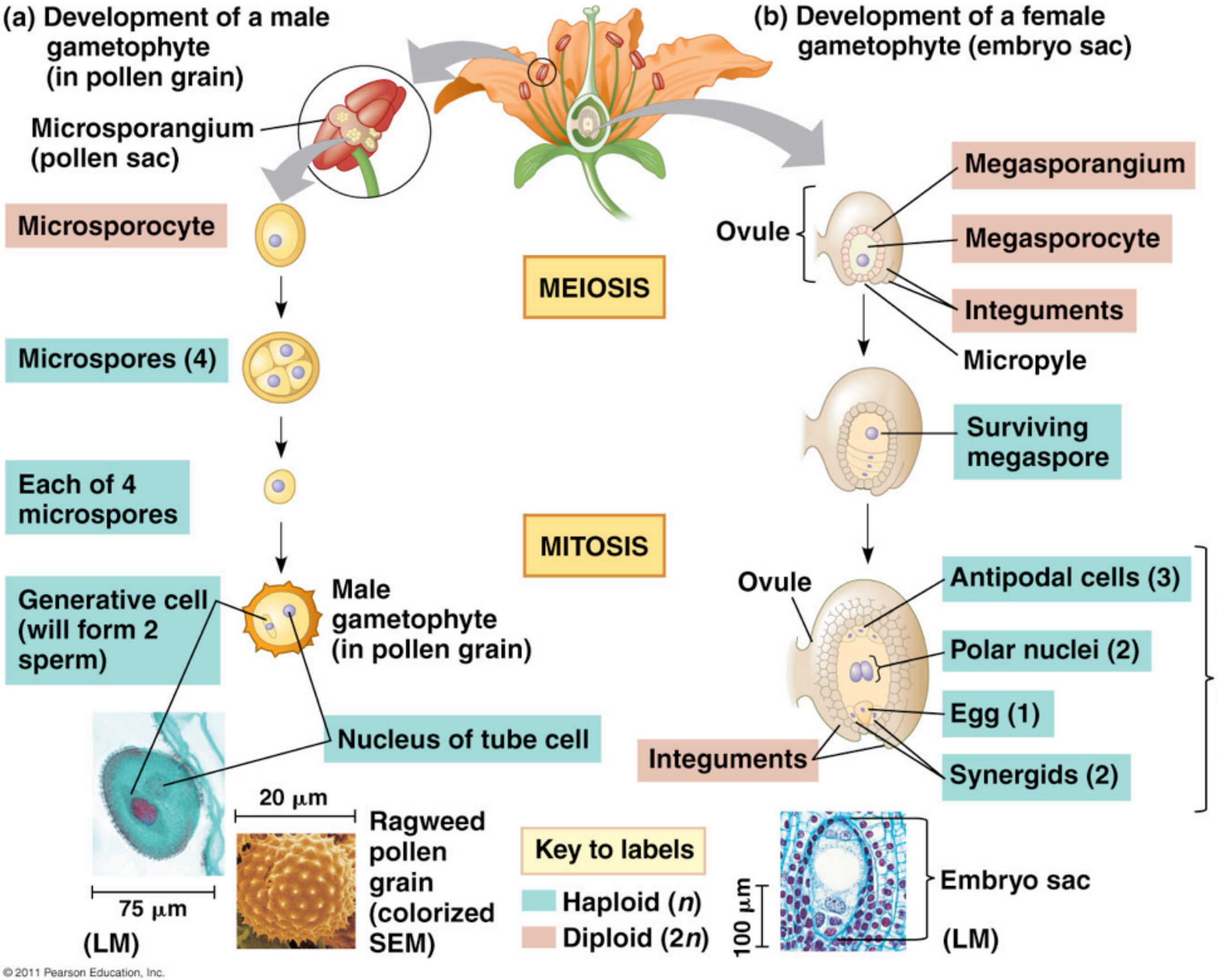
FLOWERS: Structure & Function



Simplified Angiosperm Life Cycle.



Development of Male & Female Gametophytes



Pollination

- Pollination the transfer of pollen from an anther to stigma.
  - Most angiosperms rely on biotic and abiotic pollinating agents. (the others self fertilize)
  - 80% of all pollination is biotic
  - most abiotic pollination relies on wind(98%) or water(2%)

Wind Pollination

trees and grasses

inefficient so lots of pollen is produced

usually small, lack color and scent

appear early in spring before leaves get in the way

Bee Pollination

bees are the most important pollinators

bees use flower nectar for food

flowers have UV markings called “nectar guides”

bee populations are declining, this concerns scientists because bees pollinate most of our food crops

Bird Pollination

birds use flower nectar for food

these flowers have little to no scent

usually large bright yellow or red flowers

petals often fuse to produce long tubes

Fly Pollination

these flowers
smell like dead,
rotting corpses

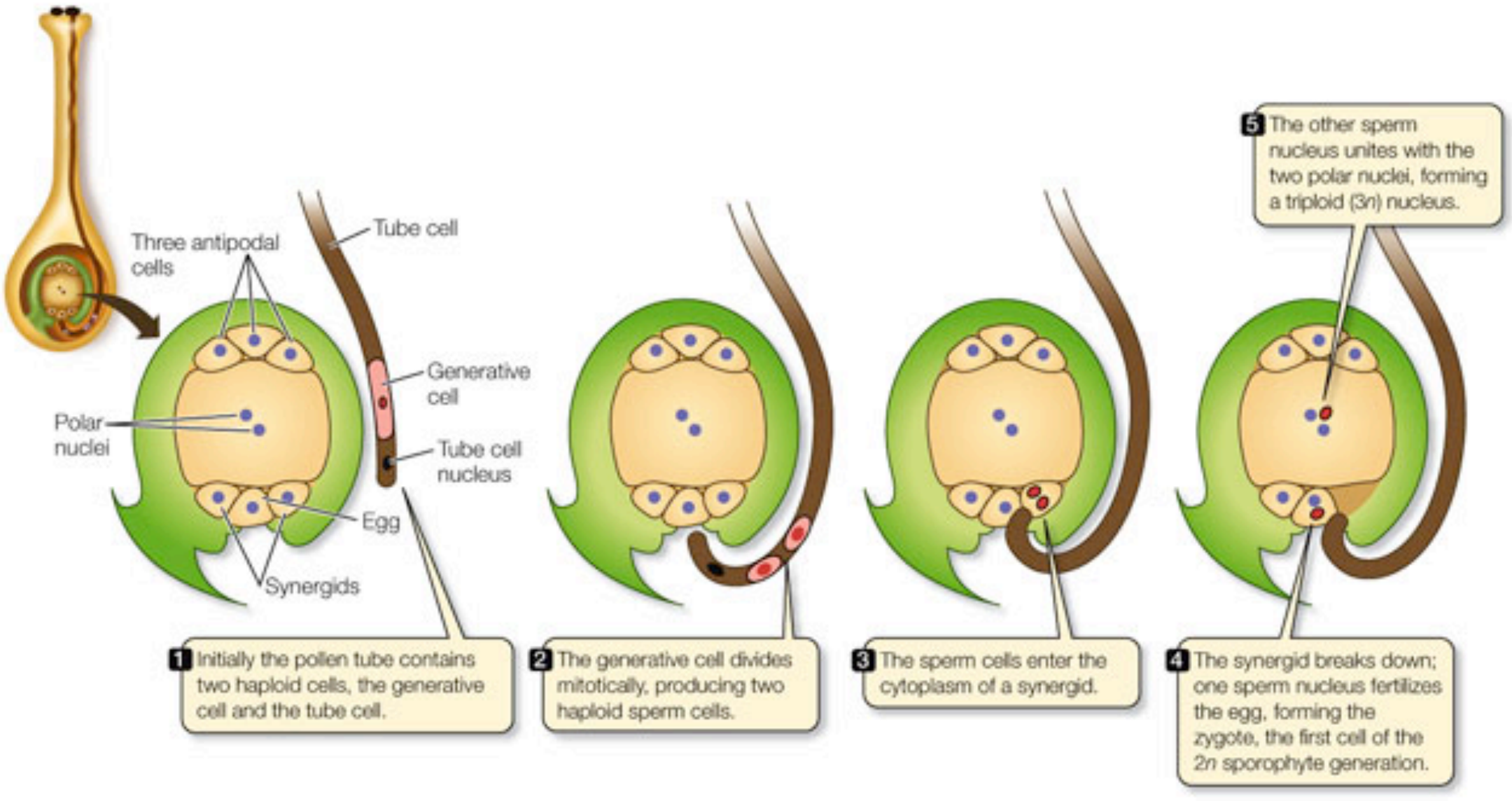
usually red
fleshy flowers

fly’s lay their
eggs on it and
get dusted with
pollen doing so

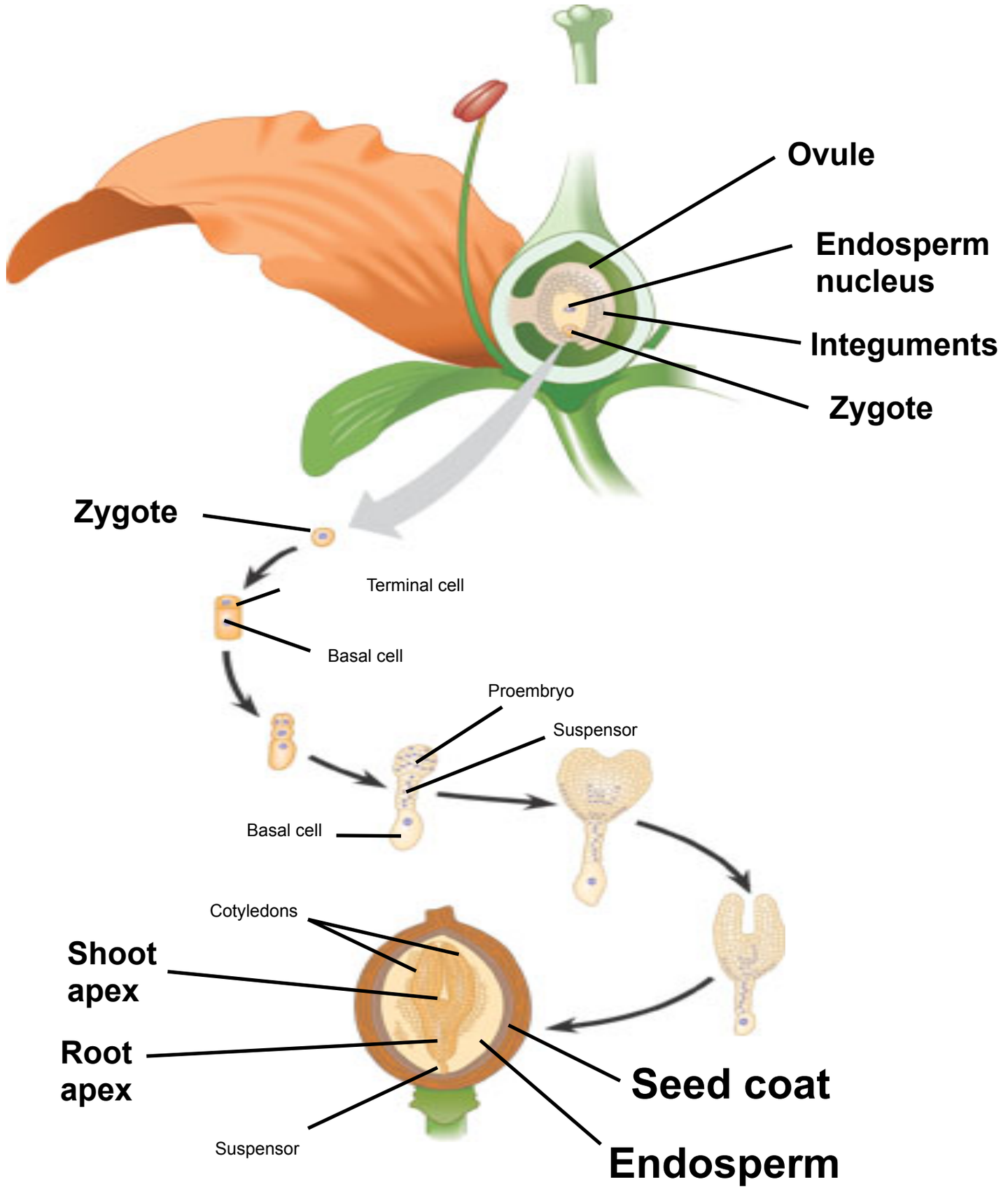
Moth & Bat Pollination

usually white or light colored flowers
because pollinators are often nocturnal

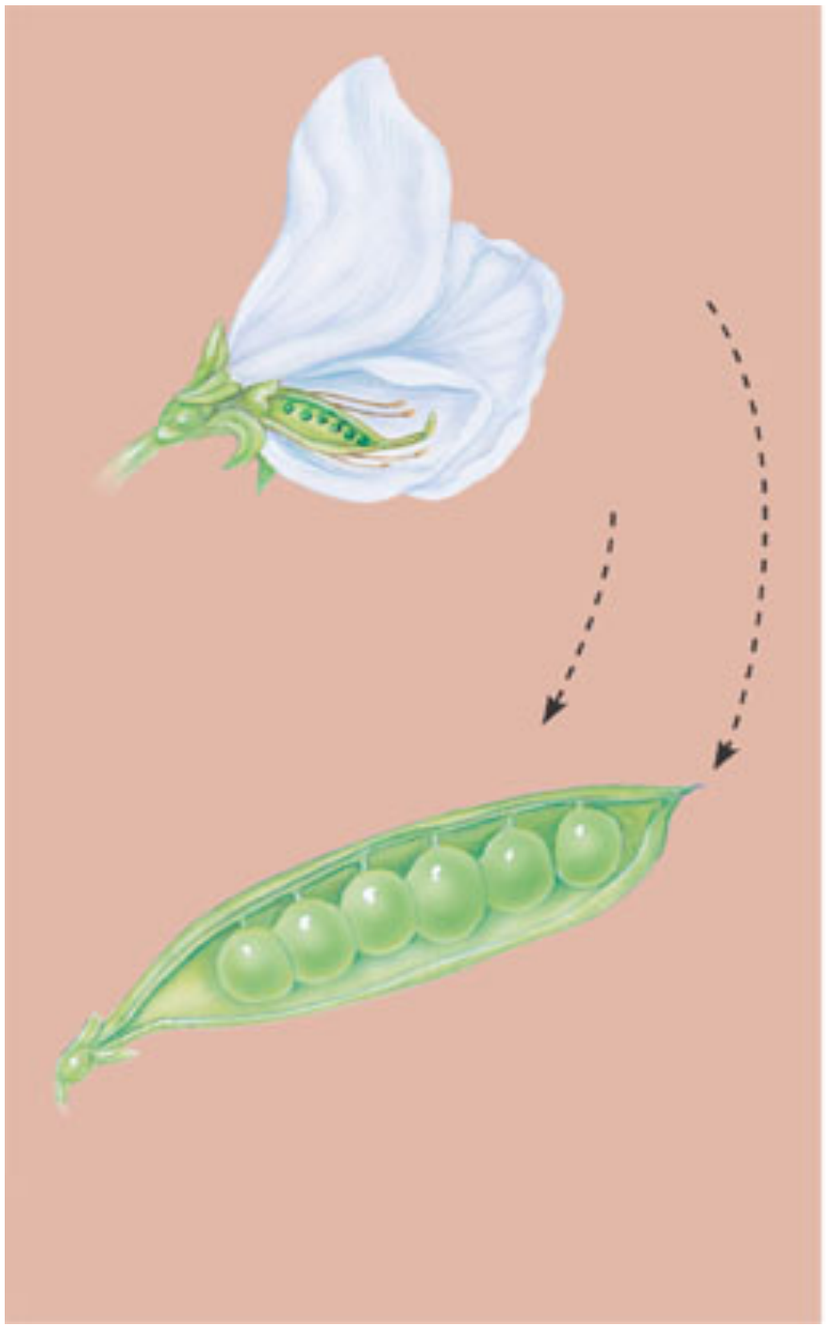
Double Fertilization



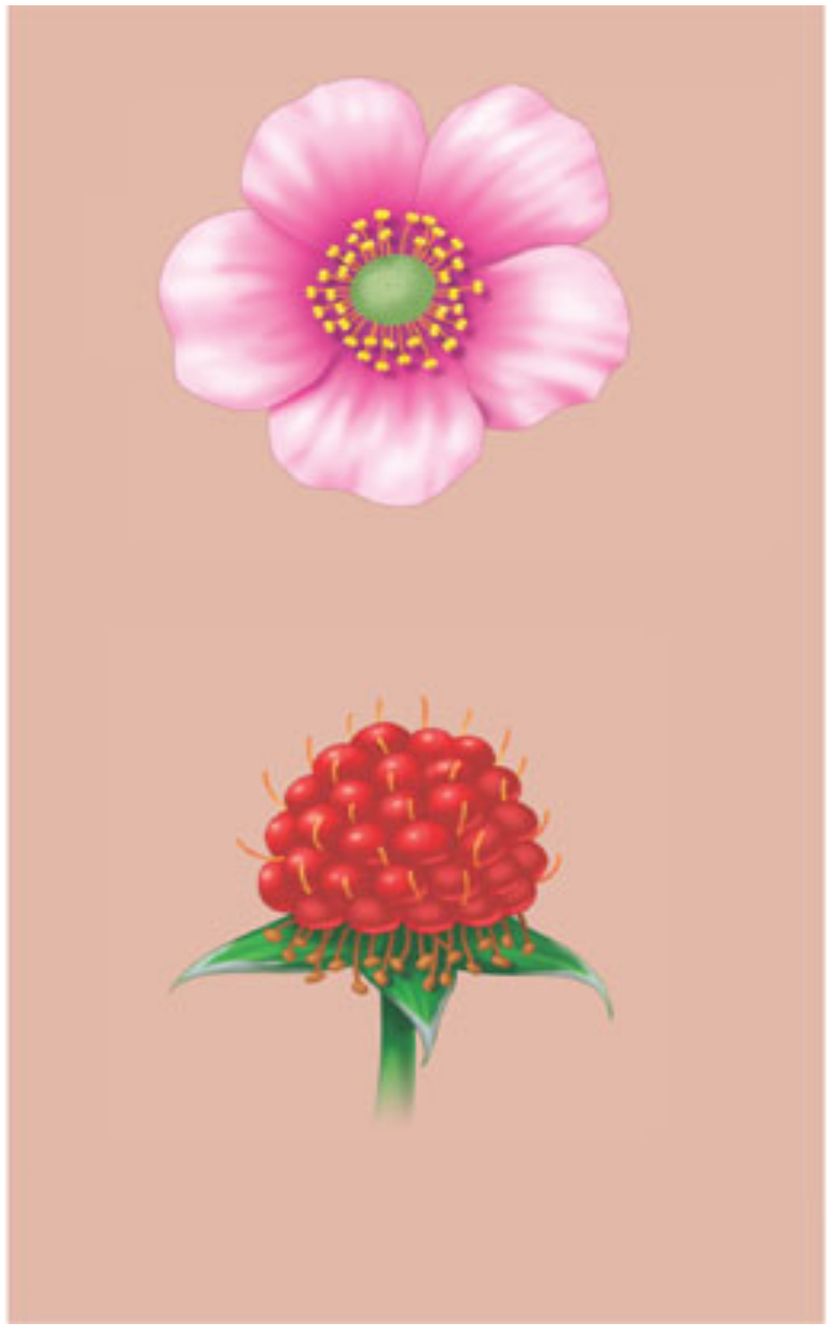
Embryo & Seeds



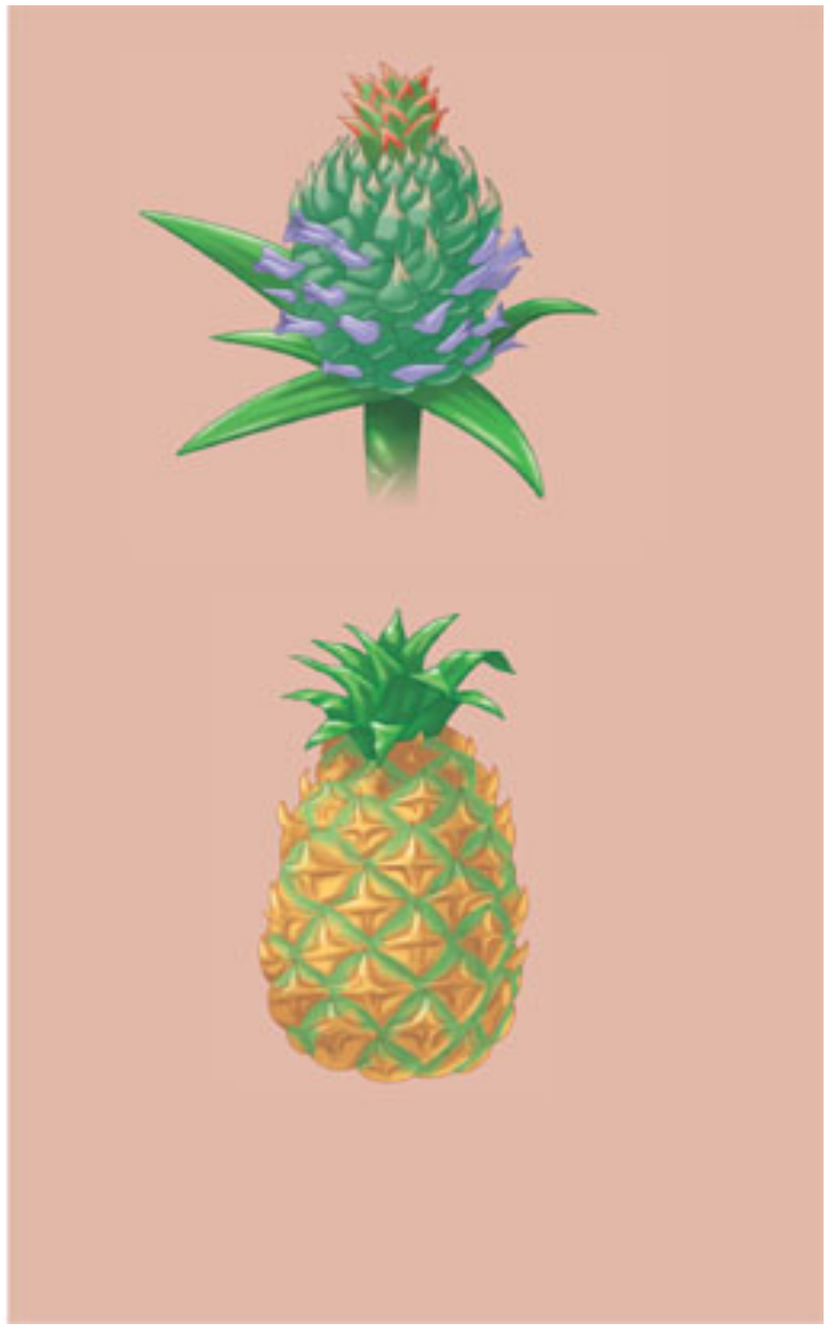
Fruits



Simple fruit. A simple fruit develops from a single carpel (or several fused carpels) of one flower (examples: pea, lemon, peanut).



Aggregate fruit. An aggregate fruit develops from many separate carpels of one flower (examples: raspberry, blackberry, strawberry).



Multiple fruit. A multiple fruit develops from many carpels of many flowers (examples: pineapple, fig).

Seed & Fruit Dispersal