

Life's Common Challenges

Reproduction

Life's Common Challenges

Introduction

The Purpose of Life!?*#?

- This unit that I call “common challenges” illustrates the many biological imperatives necessary for life.
- This unit will explore the last and perhaps most unique of all biological imperatives...Reproduction.
- 1. Reproduction is unique, in that, it is not an imperative for individuals to be alive or remain alive.
 - It is however imperative for the continuation of the species.
- 2. Many biologists feel that Reproduction is in fact “THE” biological imperative and that ultimately Reproduction drives all actions and adaptations of living organisms.
- **It could be said that the purpose of life from a biological perspective it pass your genes (or closely related genes) to the future generations.**

General Points Regarding

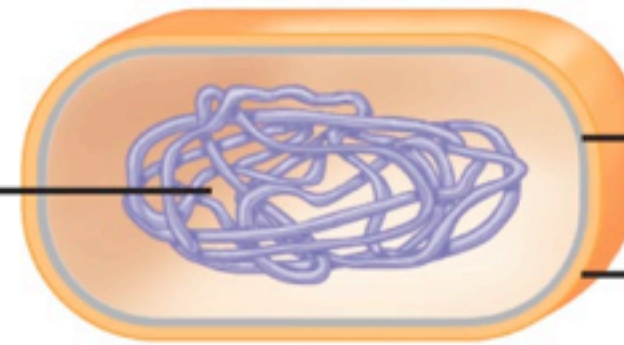
- “Life begets life”... more or less organisms reproduce their own kind.
- Oak trees give rise to Oak trees, euglenas produce euglenas, humans produce humans, etc
- some offspring are identical to their parent(s) while others are very similar to their parent(s)
- All cells arise from preexisting cells.
- Cell division underlies All reproduction.
- It is necessary for unicellular reproduction and multicellular reproduction, for asexual reproduction and sexual reproduction.

Cellular Division-Prokaryotes (Binary Fission)

A single Circular chromosome that contains genetic instructions

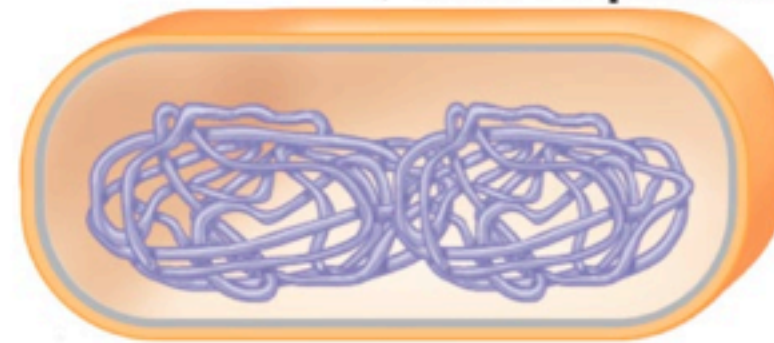
Prokaryotic chromosome

Plasma membrane
Cell wall



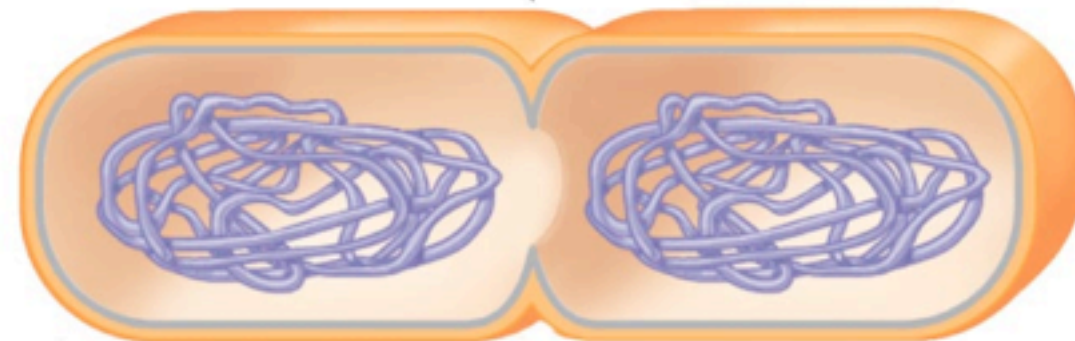
1

Duplication of chromosome and separation of copies



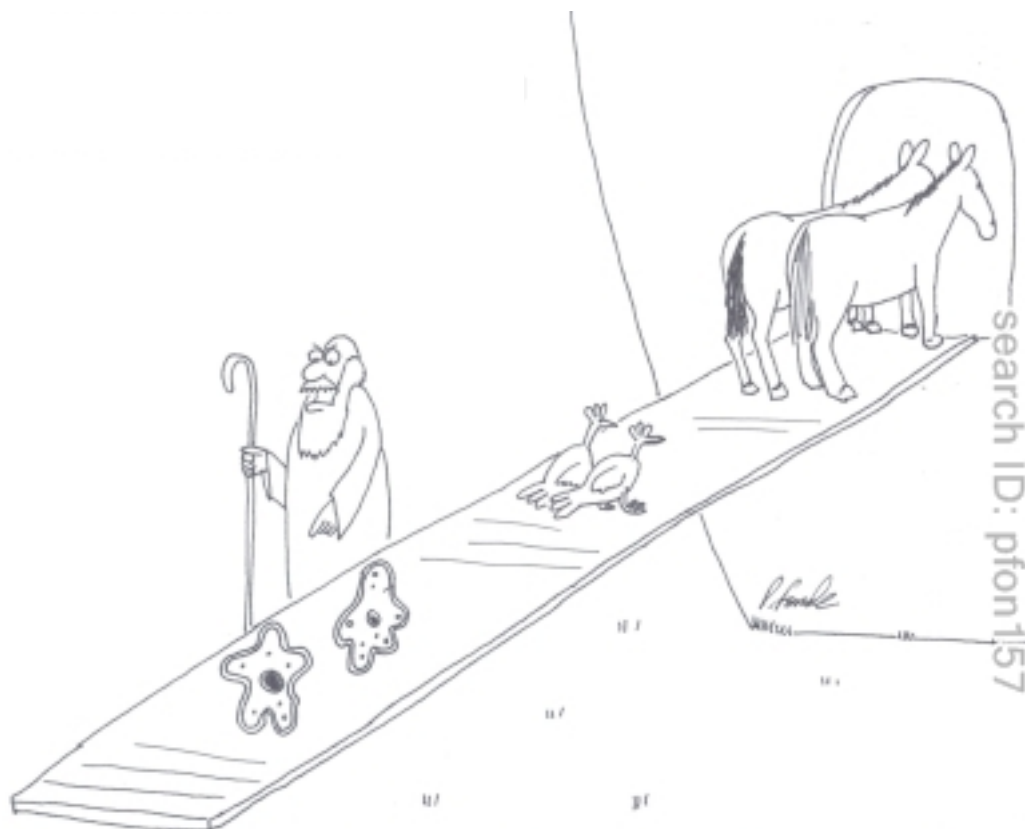
2

Continued elongation of the cell and movement of copies



3

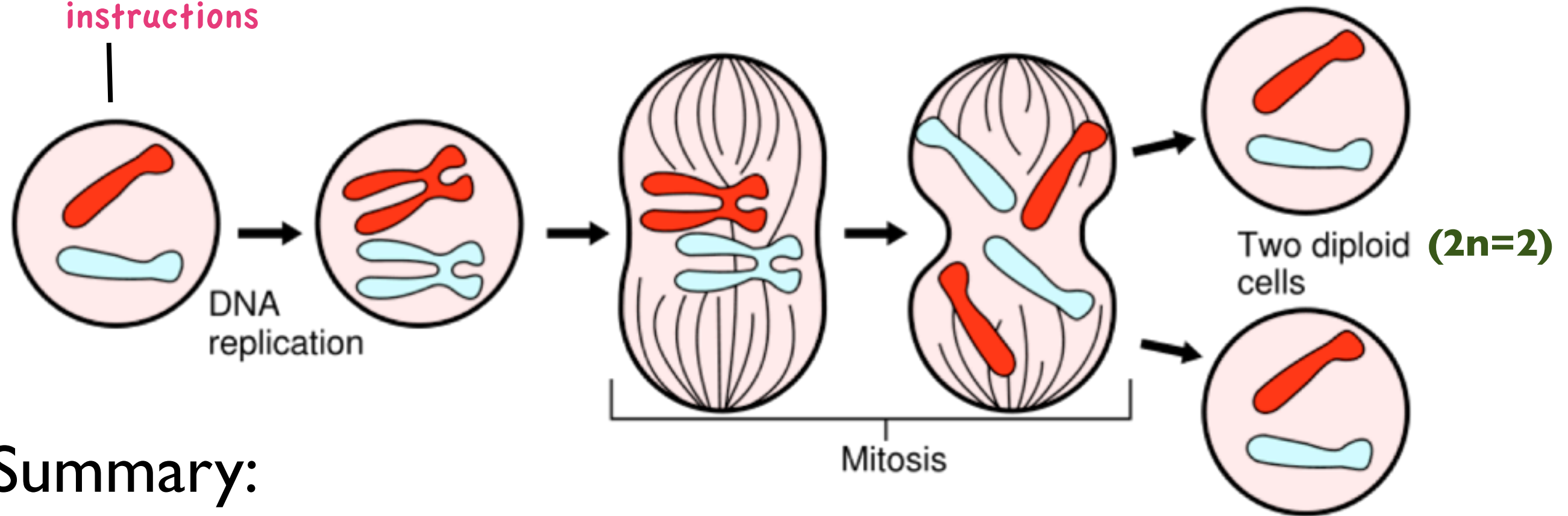
Division into two daughter cells



"Nice try! We only need *one* of you. You can just turn around and be on your way, buddy."

Cellular Division- Eukaryotes (Mitosis)

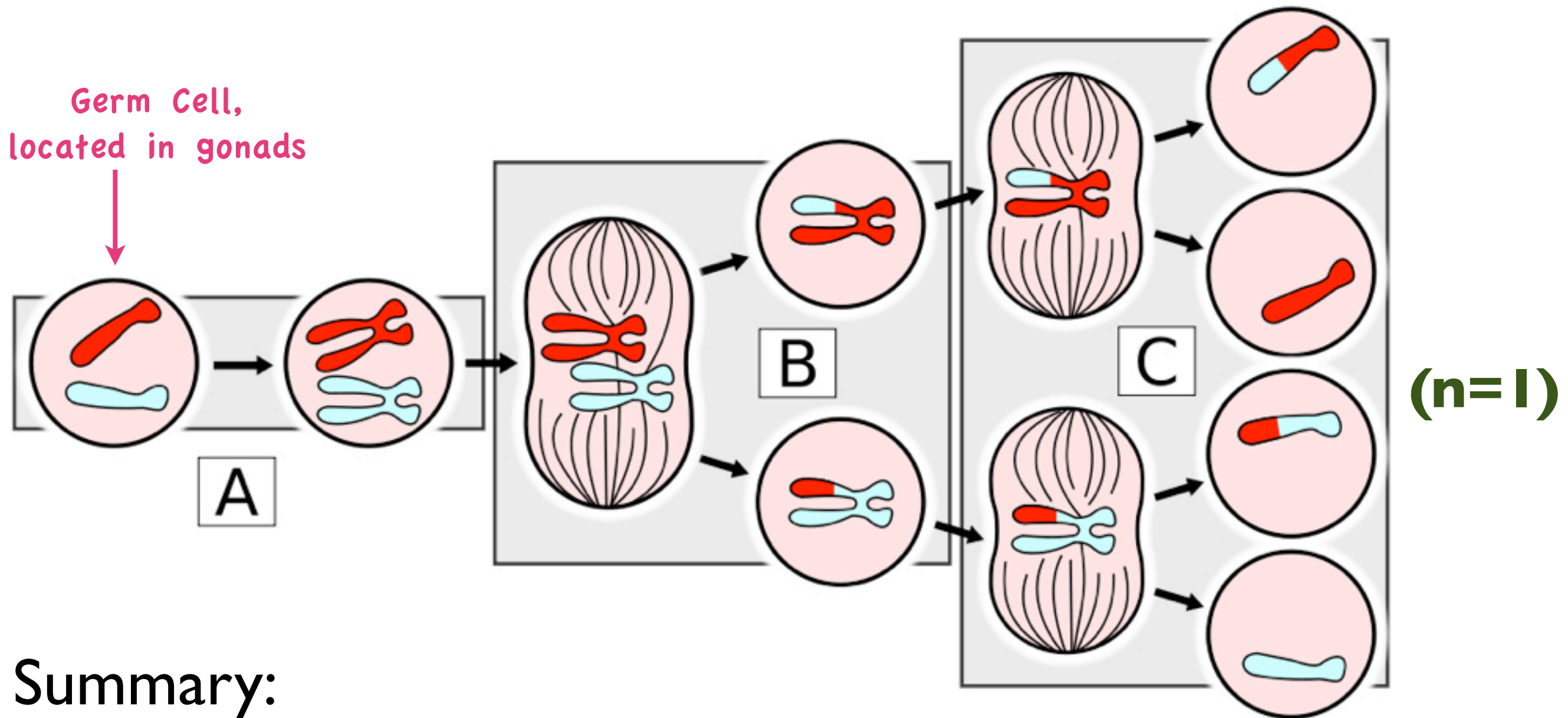
Two or more linear
chromosomes that
contain genetic
instructions



Summary:

- 2 diploid cells produced
- identical to parent & each other
- same # of chromosomes as parent cell
- used in growth, repair and development of a multicellular organism

Cellular Division- Eukaryotes (Meiosis)



Summary:

- 4 haploid cells produced
- unique to parent & each other
- half the # of chromosomes as parent cell
- produces sperm and eggs (gametes)

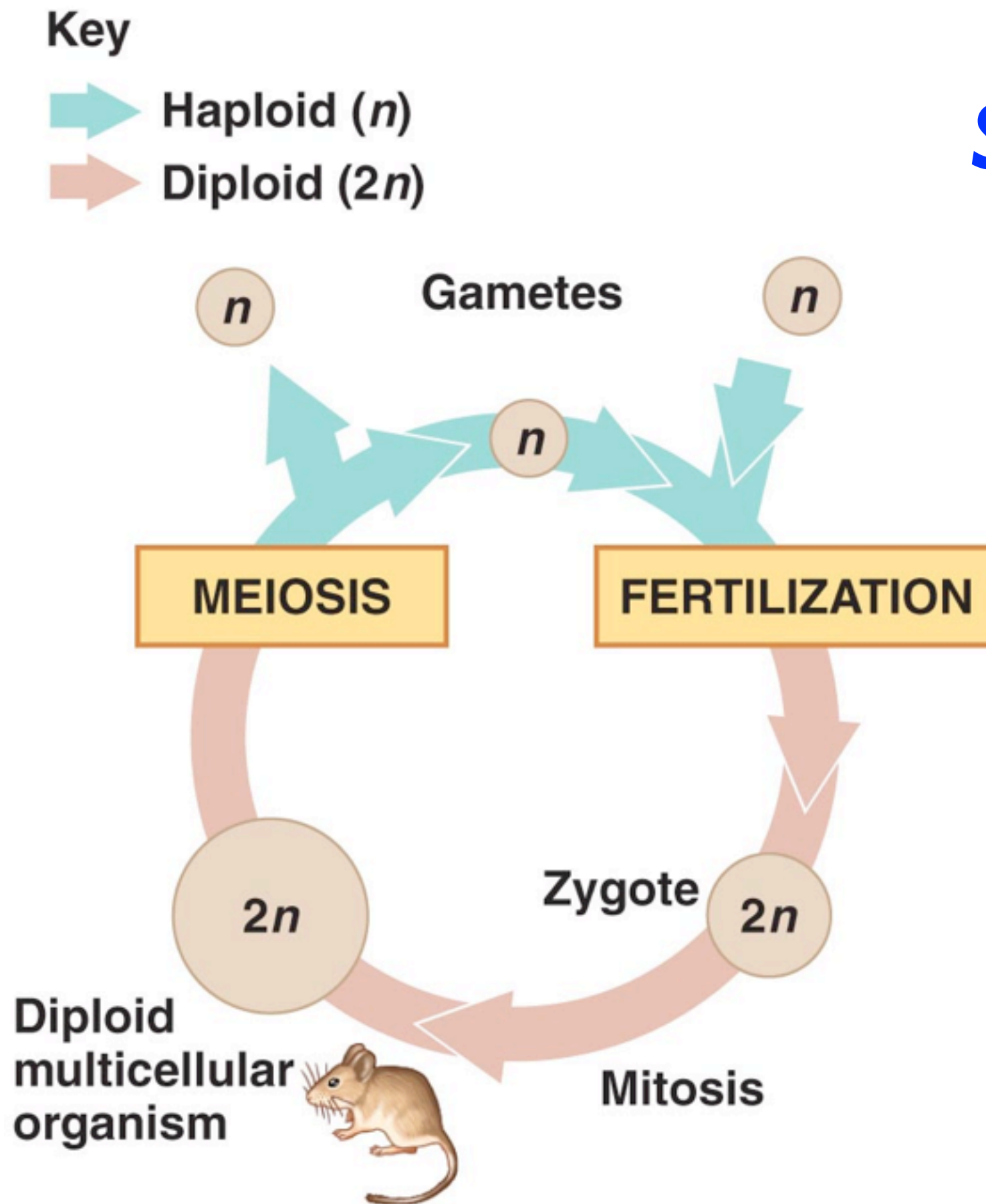
There are Two Types of Reproduction

- ASEXUAL REPRODUCTION.
 - the parent/cell passes exact copies of its genetic instructions to its offspring/daughter cells
 - the offspring or daughter cells are called *clones*
 - any difference that does happen to show up in the offspring is a result of a genetic mistake (mutation)
- SEXUAL REPRODUCTION.
 - two parents give rise to offspring that have unique combinations of genetic instructions inherited from the two parents
 - in contrast sexually produced offspring are vary from parents and siblings, they are not exact replicas

Reproductive Strategies have

- **ASEXUAL REPRODUCTION.**
 - (+)Energetically Inexpensive
 - (+)Faster and more offspring produced
 - (-)Generates *No Variation
- **SEXUAL REPRODUCTION.**
 - (-)Energetically Expensive
 - (-)Slower and less offspring produced
 - (+)Generates Much Variation

Sexual Life Cycle



(a) Animals

Animals

Reproduction

Animal Reproduction Intro

- Most animals reproduce sexually.
- The diploid stage dominates the life cycle
- *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 over and over again and the new cells then grow and develop into a multicellular (*adult) organism

Animal Reproduction Intro

- Some animals develop directly into adults, like humans.
- Most animal life cycles include at least one larval stage.
- *Larva*- is a sexually immature form of an animal
 - Larva have: 1. distinct morphology 2. eats different food 3. may live in different habitats
- Animal larva will eventually undergo metamorphosis
- *Metamorphosis*- a developmental transformation that turns the animal in a juvenile which resembles the adult but is still sexually immature

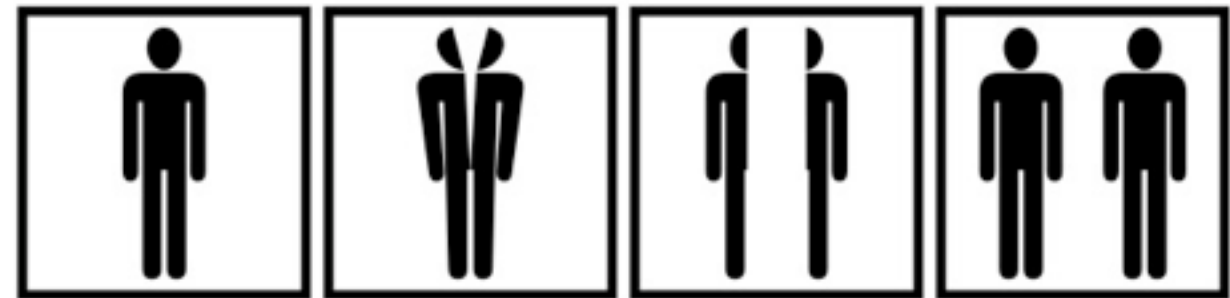


Newt Larva

Animal Reproduction (Asexual)

- Most animals reproduce primarily or exclusively sexually.
- Some animals reproduce primarily asexually.
- There are several forms of asexual reproduction

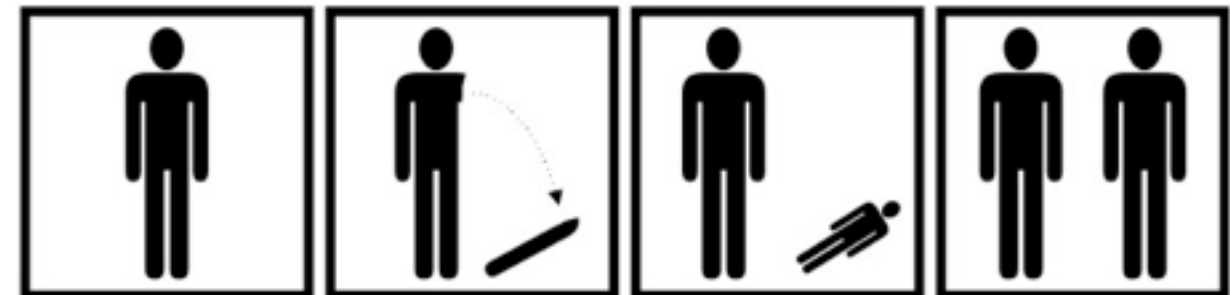
- Fission



- Budding



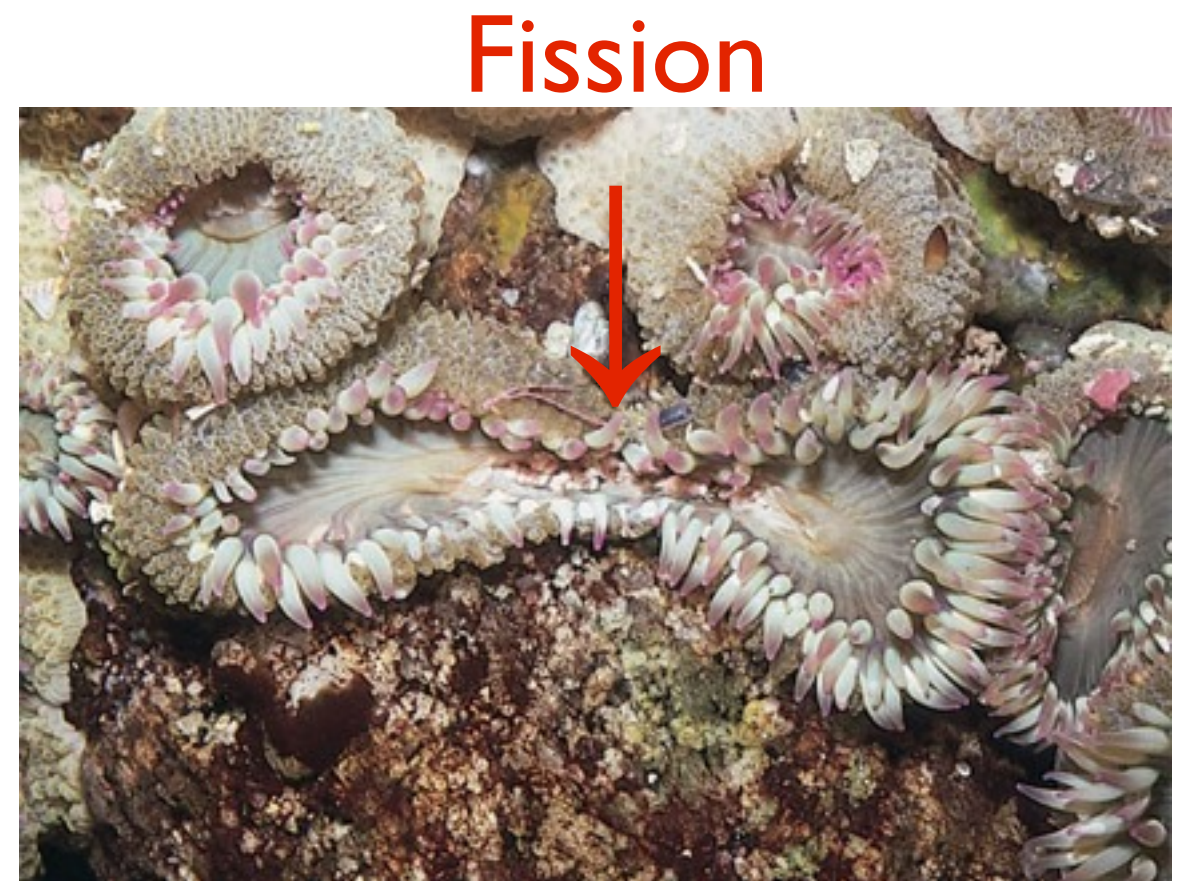
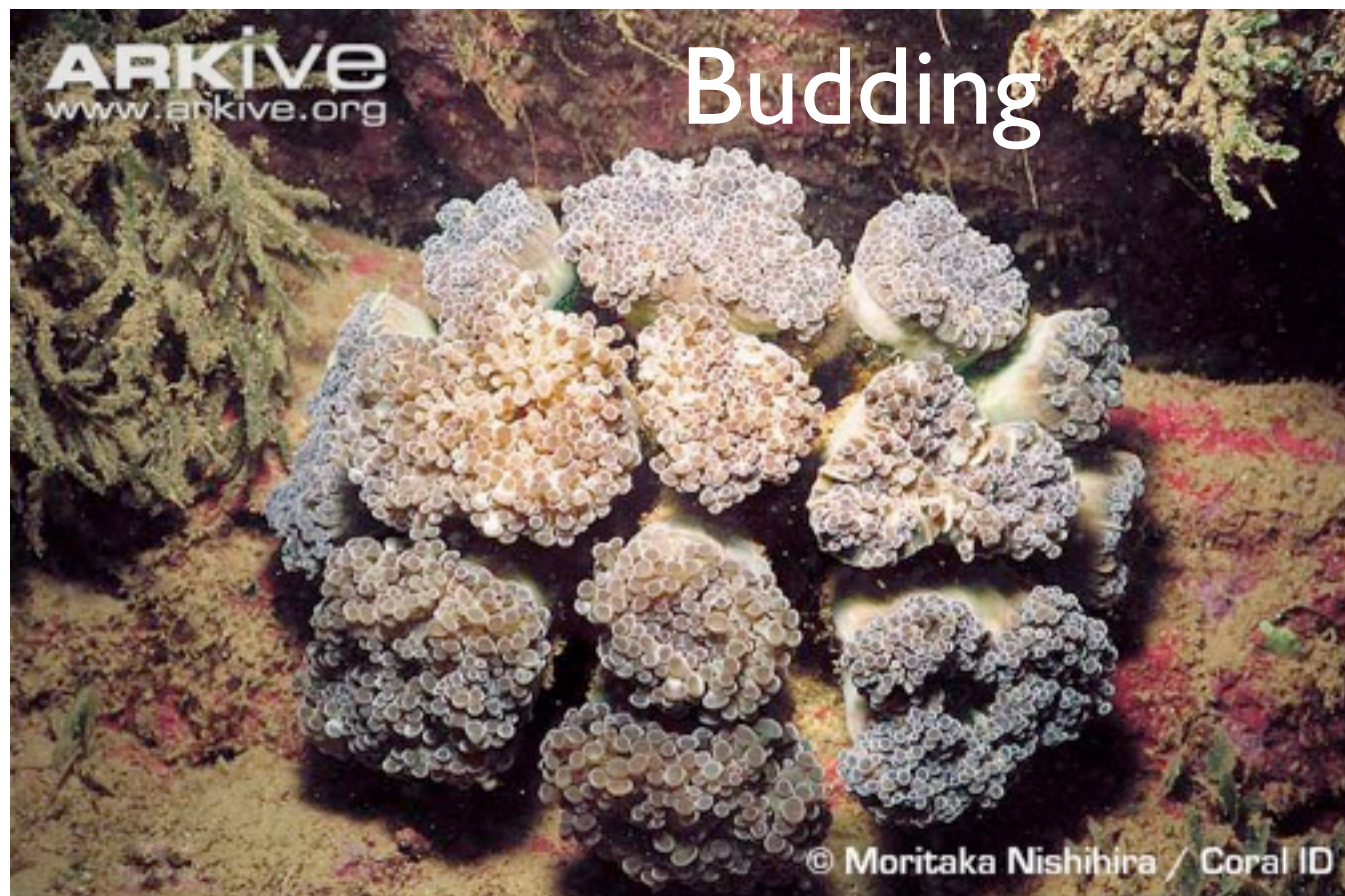
- Fragmentation, Regeneration



- Parthenogenesis

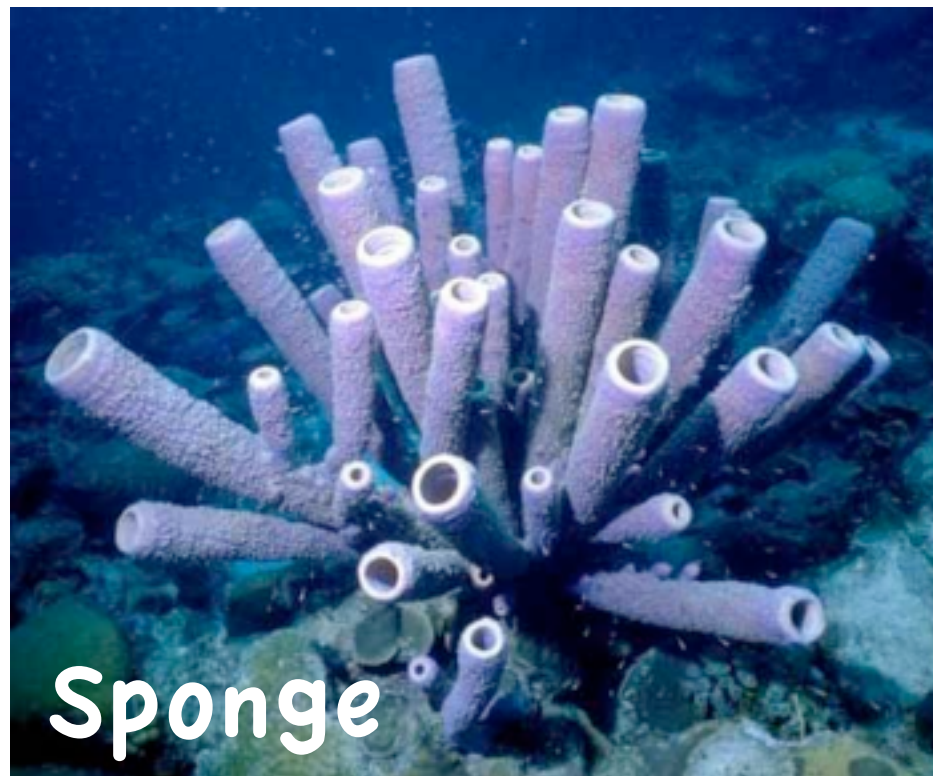
Fission & Budding

- *Fission*- separation of parent organism into two individuals of equal size.
- ex. Sea Anemones
- *Budding*- new individuals arise from outgrowths of existing ones
- ex. stony corals



Fragmentation-Regeneration

- This mode of reproduction involves two steps.
- *Fragmentation*- the breaking of the body into several pieces
- *Regeneration*- regrowth of the lost body parts
- If one piece regrows into a complete organism then it is considered reproduction



Sponge



Sea Squirt



Bristle Worm

Parthenogenesis

- *Parthenogenesis*- an egg develops into organism without being fertilized.
- *ex. bees, wasps, ants, recently discovered Komodo Dragon and certain species of hammerhead sharks!*
- The progeny can be haploid or diploid
- Male honeybees (drones) are fertile haploid adults, they produce sperm and eggs without meiosis
- Female honeybees are sterile diploid adults (except queen is fertile diploid adult) that develop from fertilized eggs

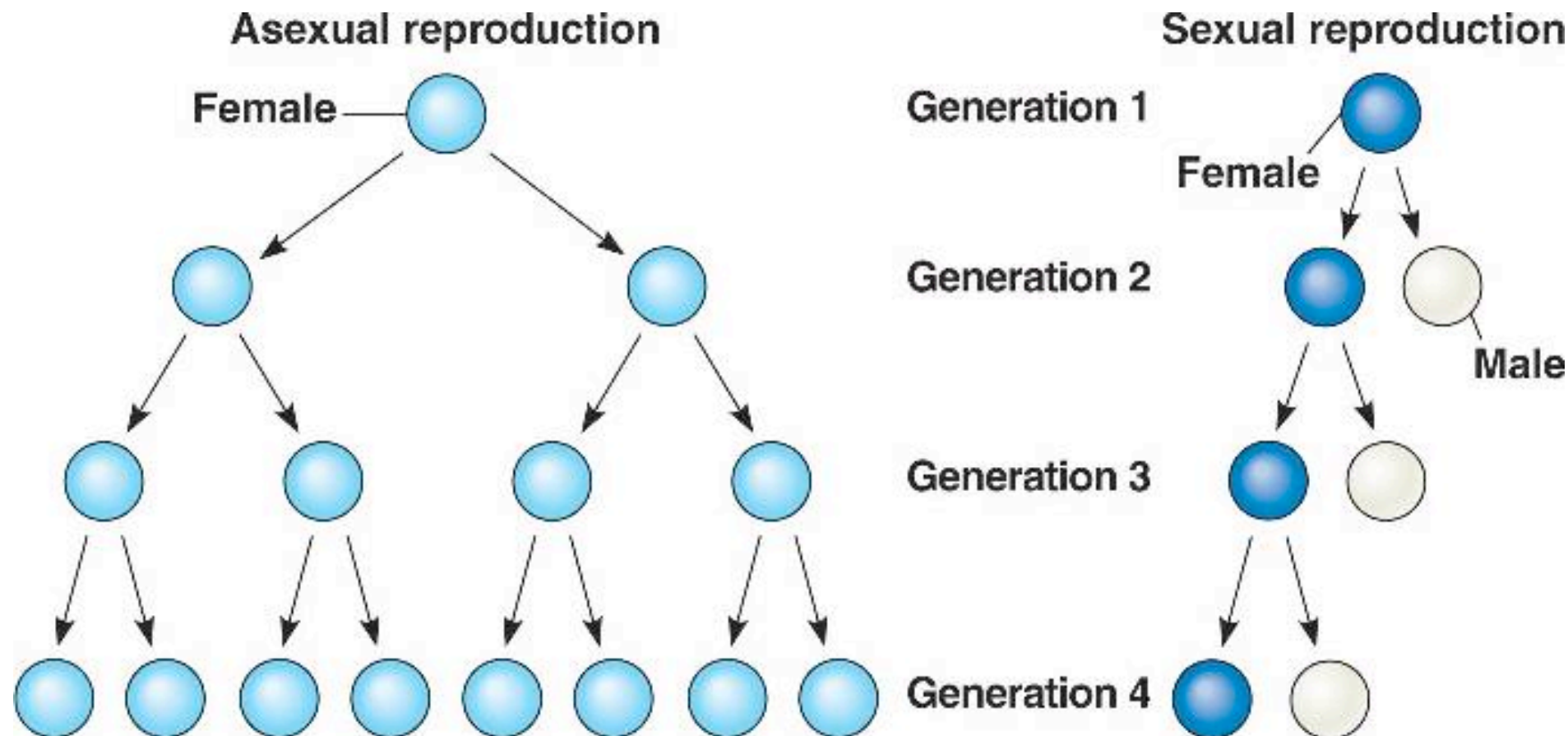


Animal Reproduction (Sexual)

Sex...An Evolutionary Enigma

- Sex must enhance reproductive success or survival because it would otherwise disappear...but HOW

Clearly asexual reproduction can produce far more offspring and sexual organisms only pass 50% of their genes into the future



Sex...An Evolutionary Enigma

...possible explanations

- Sexual reproduction may enhance the reproductive success of parents when environmental factors change rapidly.
- Variation generated through sex might speed up the rate of adaptations.
- Another idea is that shuffling genes helps a population to get rid of harmful genes
- Asexual reproduction is expected to be most advantageous in stable, favorable environments because it perpetuates successful genes faithfully and precisely

Animal Reproduction (Sexual)

Reproductive Cycles

- Most animals exhibit cycles in reproductive activity
- Cycles are often seasonal
 - reproduction takes place when resources are most available and environmental conditions most favorable
- Ex. Sheep
 - Ewes (females) are fertile for two weeks in the fall
 - sheep gestation period is 5 months
 - lambs are born in the spring
- Cycles are controlled by hormones
- Regulated by environmental cues: light, temp, rainfall, etc

Reproductive Cycles & Climate Change

- Because reproductive cycles are often seasonal, climate change can decrease reproductive success
- 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.
- As a result tundra thaws earlier, plants sprout earlier and the timing has resulted in less nutrition for nursing females and a higher mortality rate among calfs

Reproductive Cycles & Climate Change

- **Australia**

Climate change is affecting home range, abundance and breeding cycles of many of Australia's **frog** species. Since frogs rely on water to breed, any reduction or change in rainfall could reduce frog reproduction. Higher temperatures contribute to the drying out of breeding pools, and as a result, to the deaths of tadpoles and eggs. Drier conditions also cause adult frogs to die, due to increased rates of internal water loss through their permeable skin



Reproductive Cycles & Climate Change

- **South America**

Sea turtles lay their eggs on Brazilian beaches, many of which are threatened by rising sea levels. Climate change also threatens the offspring of sea turtles, as nest temperature strongly determines the sex: the coldest sites produce male offspring, while the warmer sites produce female offspring. This nest-warming trend is reducing the number of male offspring and seriously threatens turtle populations.



A Very Different Reproductive Cycle

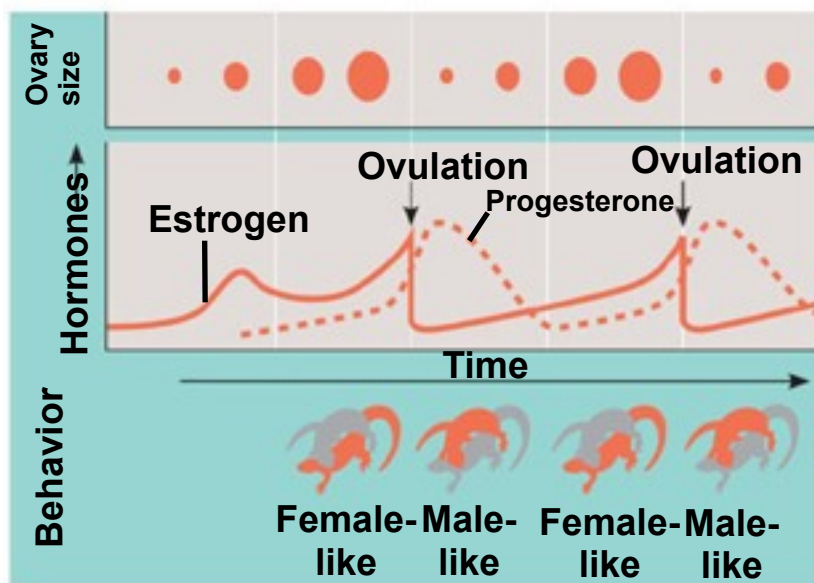
- Whiptail lizard video clip...

Parthenogenesis

- Among vertebrates, several genera of fishes, amphibians, and lizards, including whiptail lizards
- Reproduce exclusively by a complex form of parthenogenesis.



Both lizards in this photograph are *C. uniparens* females. The one on top is playing the role of a male. Every two or three weeks during the breeding season, individuals switch sex roles.



The sexual behavior of *C. uniparens* is correlated with the cycle of ovulation mediated by sex hormones. As blood levels of estrogen rise, the ovaries grow, and the lizard behaves like a female. After ovulation, the estrogen level drops abruptly, and the progesterone level rises; these hormone levels correlate with male behavior.

Variation in Patterns of Sexual Reproduction

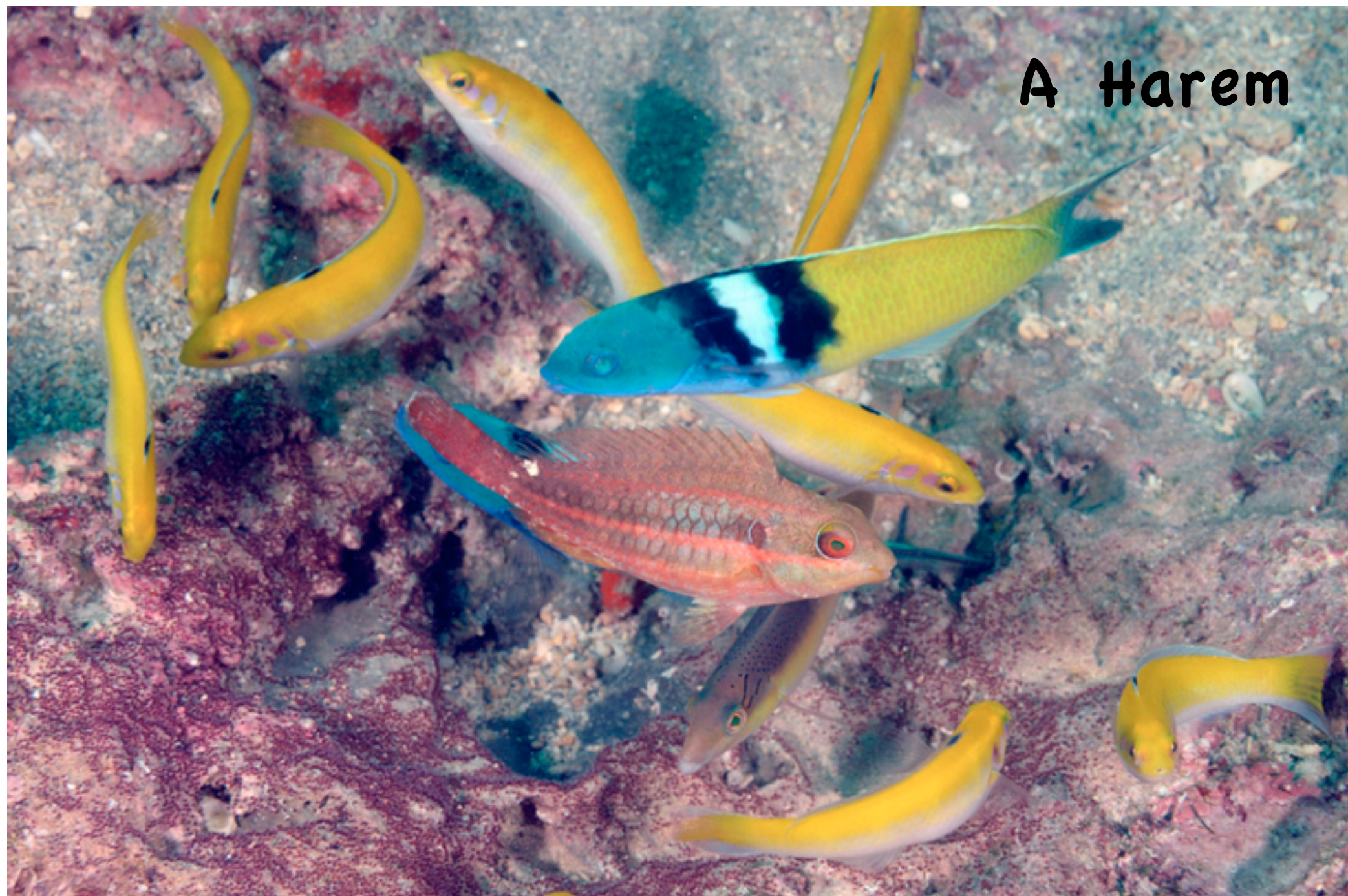
- Finding a partner for sexual reproduction can be challenging.
- Adaptations have arose to meet this challenge.
- Some species meet this challenge in a novel way- to blur the distinction between male and female
- *Hermaphroditism*- individuals are born with male and female reproductive systems.
 - finding a mate is now easier because any two individuals can mate
 - each animal donates and receives sperm
- Some hermaphrodites are capable of self-fertilization, which does not require any partners!

- *Hermaphroditism*- arose in sessile organisms, whose lack of locomotion challenged their ability to reproduce
- ex. barnacles, clams, sea slugs



Another Novel Adaptation of Sexual Reproduction

- Sex Reversal; organisms can transform into the opposite sex.
- Bluehead Wrasse, Oysters



A single,
Large
Male

Numerous,
Small
Females

Females → Males

- Bluehead Wrasse live in harems, a single male and numerous females
- When male dies, the largest female turns into a male
- In one the new male is producing sperm
- Large males are needed to defend the harem



Males → Females

- Oysters are born male and grow
- When male grows large enough it becomes female
- The larger the female the more eggs it produces
 - males' sperm production is similar in all sizes
- The increased number of gametes increases the odds of fertilization in the open ocean



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.
 - moist external environments are not required
 - parents do make contact with each other
 - it requires cooperative behavior on each behalf
 - it requires sophisticated and compatible reproductive systems
 - males require copulatory organ to deliver sperm and females require receptacle organ to receive and store sperm

continued

- *External Fertilization*- females release eggs into the environment and males then fertilize them.
- moist environments are required so gametes do not dry out and it provides a medium for sperm to swim to the egg
- parents do not even make contact with each other
- timing of gamete release by both sexes is critical (spawning)
- location is important the closer males and females, the better
- Gamete release is controlled by hormones, environmental cues or if it is not synchronized it requires courtship behaviors (ex. frog).
 - Courtship behaviors have additional advantages: 1. it allows mate choice and 2. it triggers gamete release at the same time

Pheromones

- 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
 - they are small volatile or water soluble
 - they require only tiny amounts exert their effects
 - many act as male attractants

External
Fertilization
in Frogs



- T-shirt pheromone video clip...

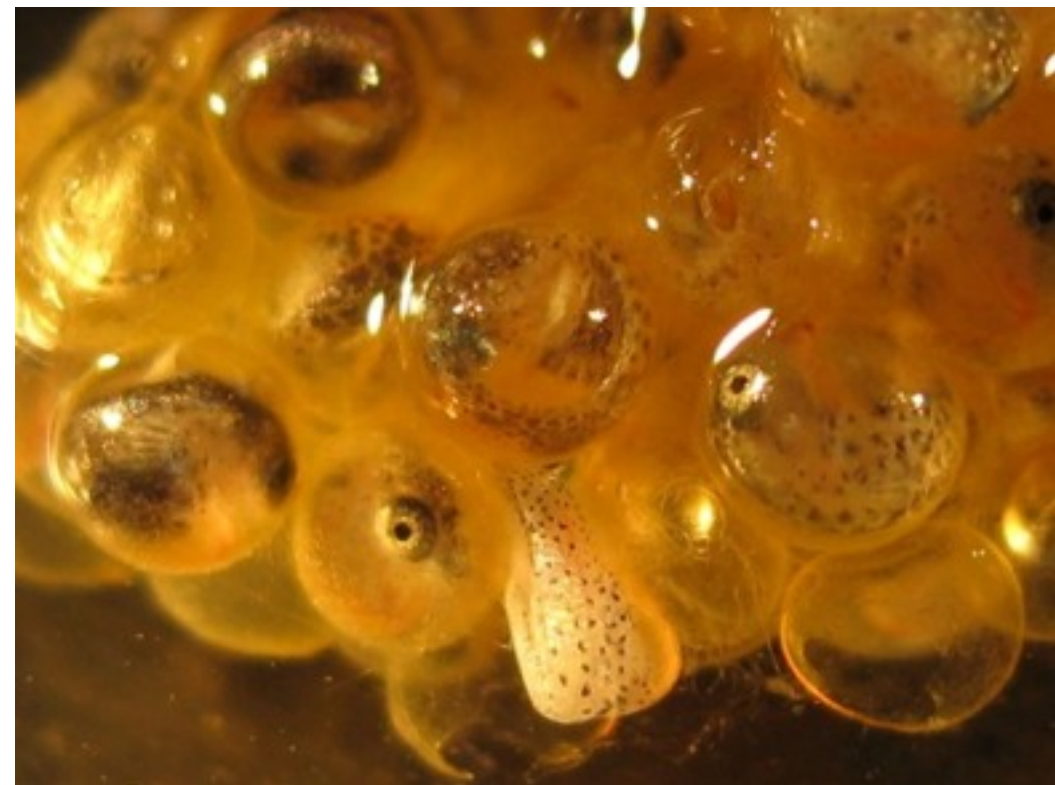
Ensuring the Survival of Offspring

- 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
- embryos are better protected and furthermore organisms with internal fertilization most often provide greater parental care of young



Internally Fertilized Bird Eggs

Which egg
type provides
greater
protection?



Externally Fertilized Fish Eggs

Ensuring the Survival of Offspring

- Rather than protecting embryos in eggs some animals retain the embryo for part or all of its development inside the female reproductive tract
 - Marsupials mammals (kangaroos and opossums) spend a only a short period of development in mother's *uterus*, crawl out and complete development in a pouch receive nourishment from a mammary gland
 - Eutherian (placental) mammals (humans) complete their development in the mother's *uterus*, they receive nourishment from mother's blood supplied through a temporary organ called the *placenta*.

What do you call a baby kangaroo?

...a **JOEY**

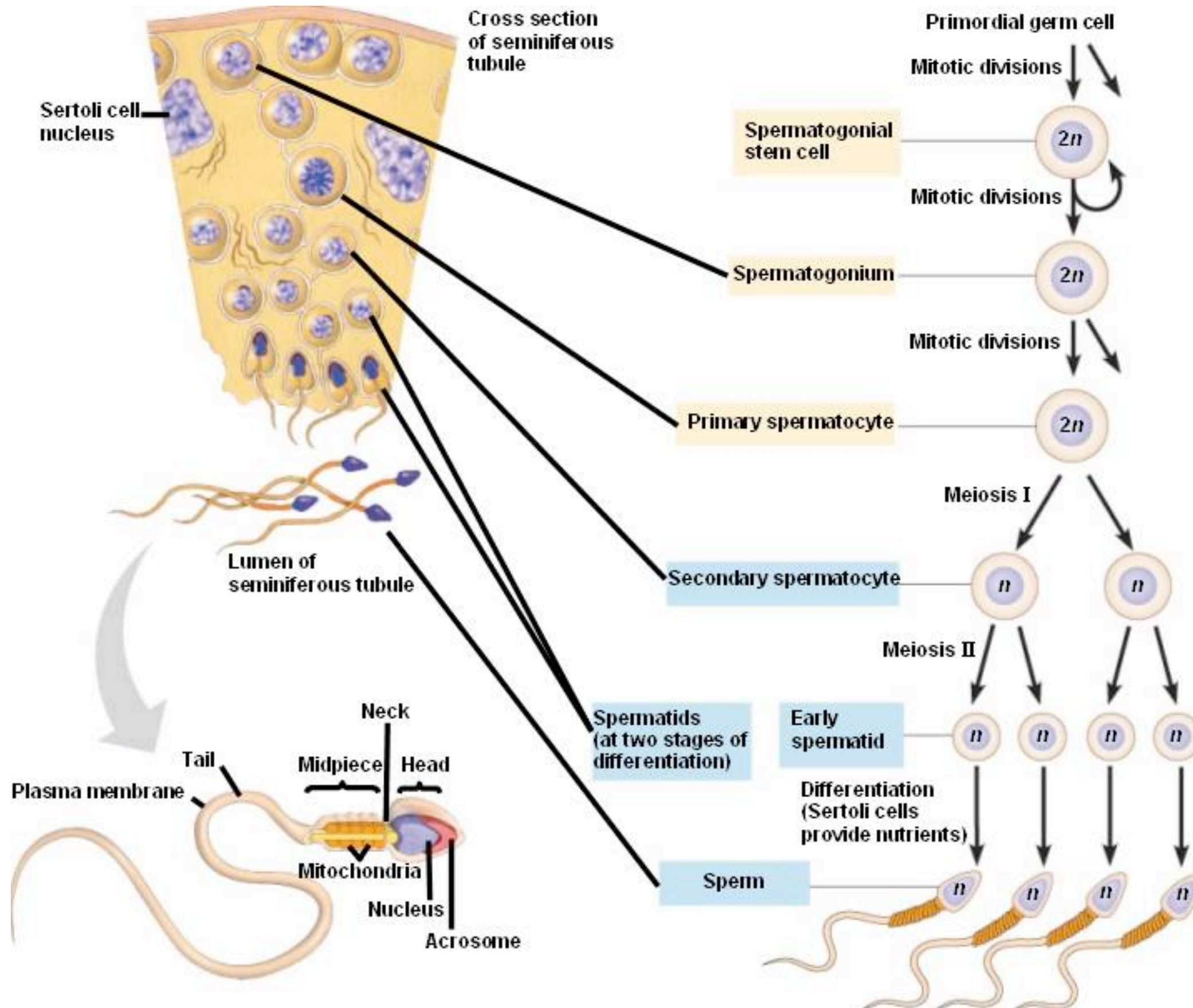
BBC



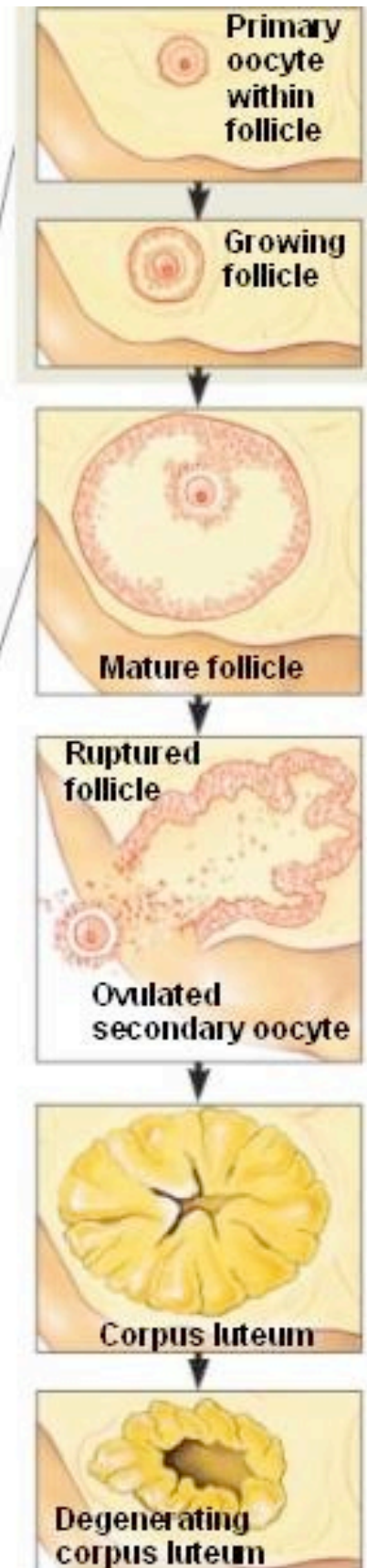
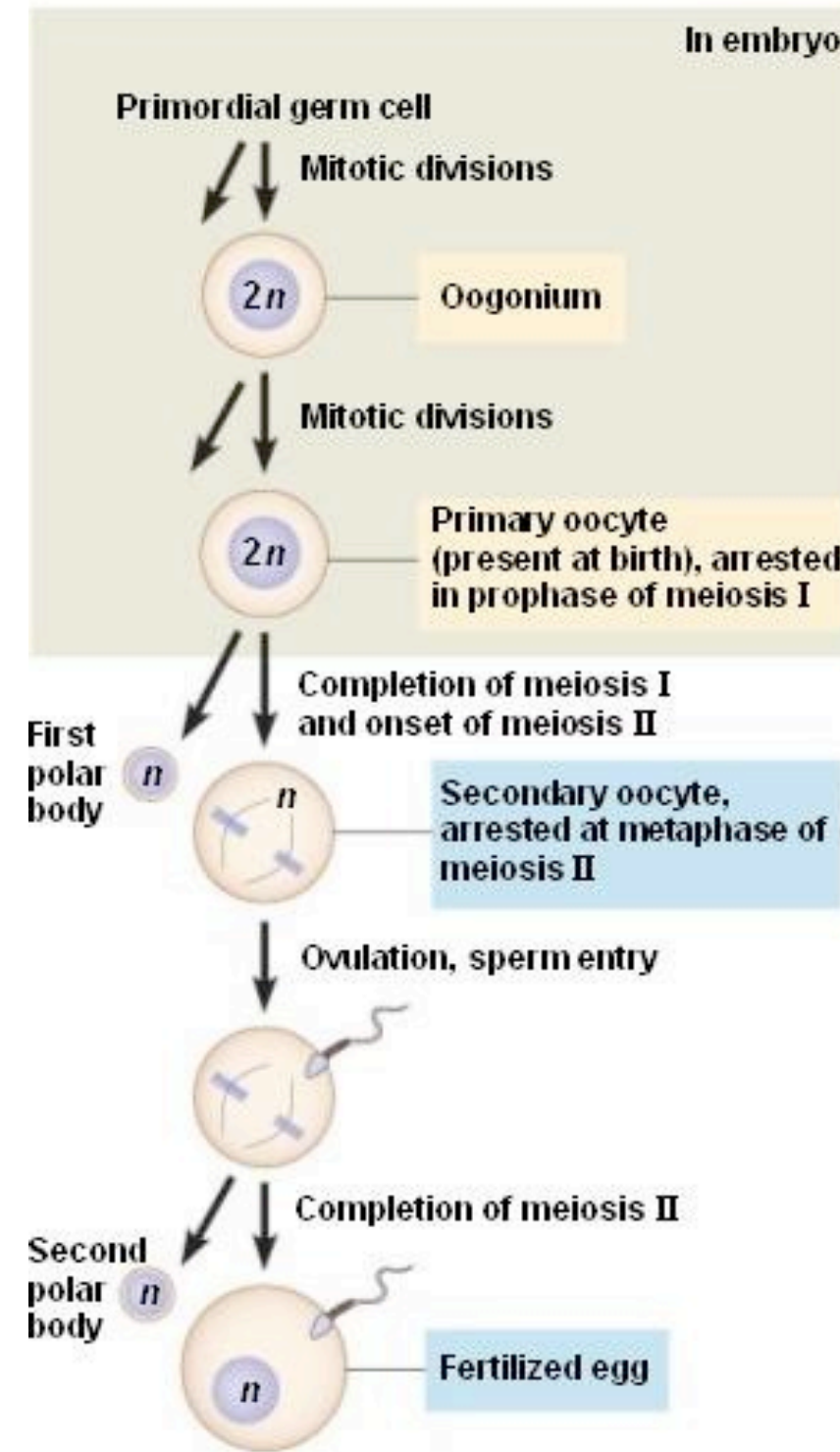
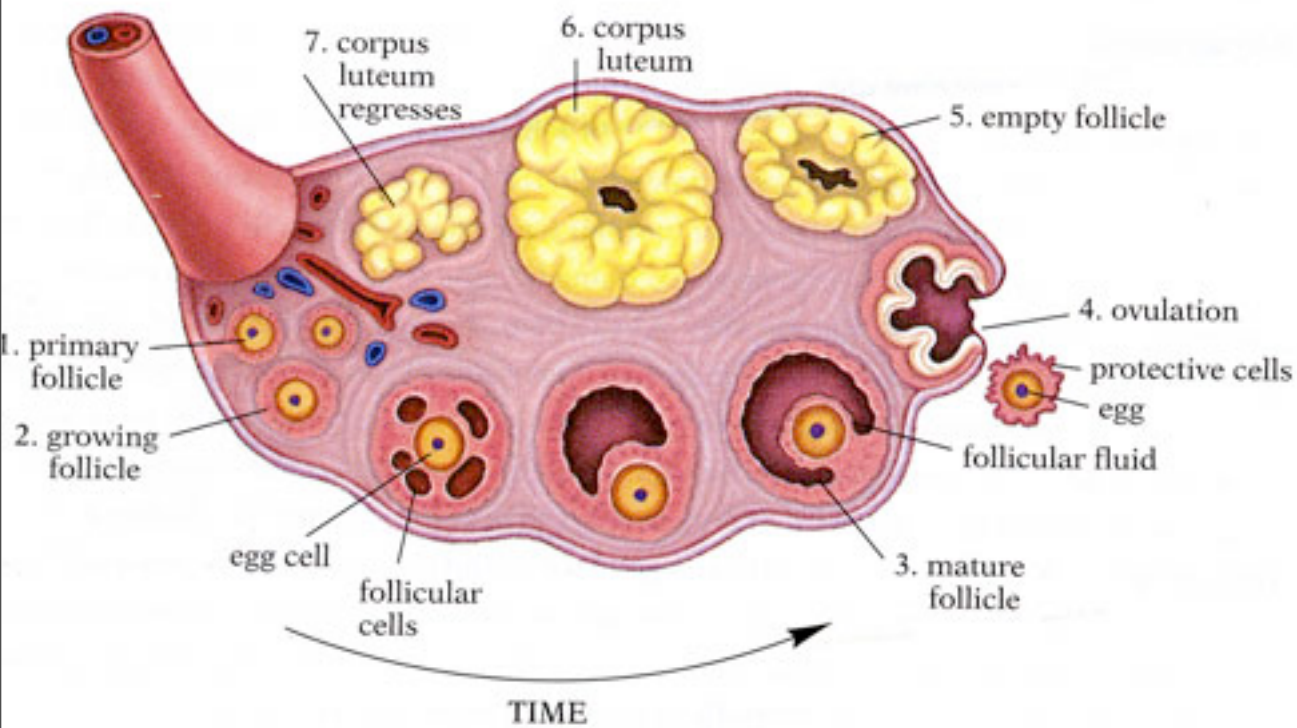
Gamete Production

- Sexual reproduction in animals relies on special cells..... (germ cells) that give rise to sperm and eggs
- In some simple reproductive systems special cells in animal's body cavity (coelom) 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



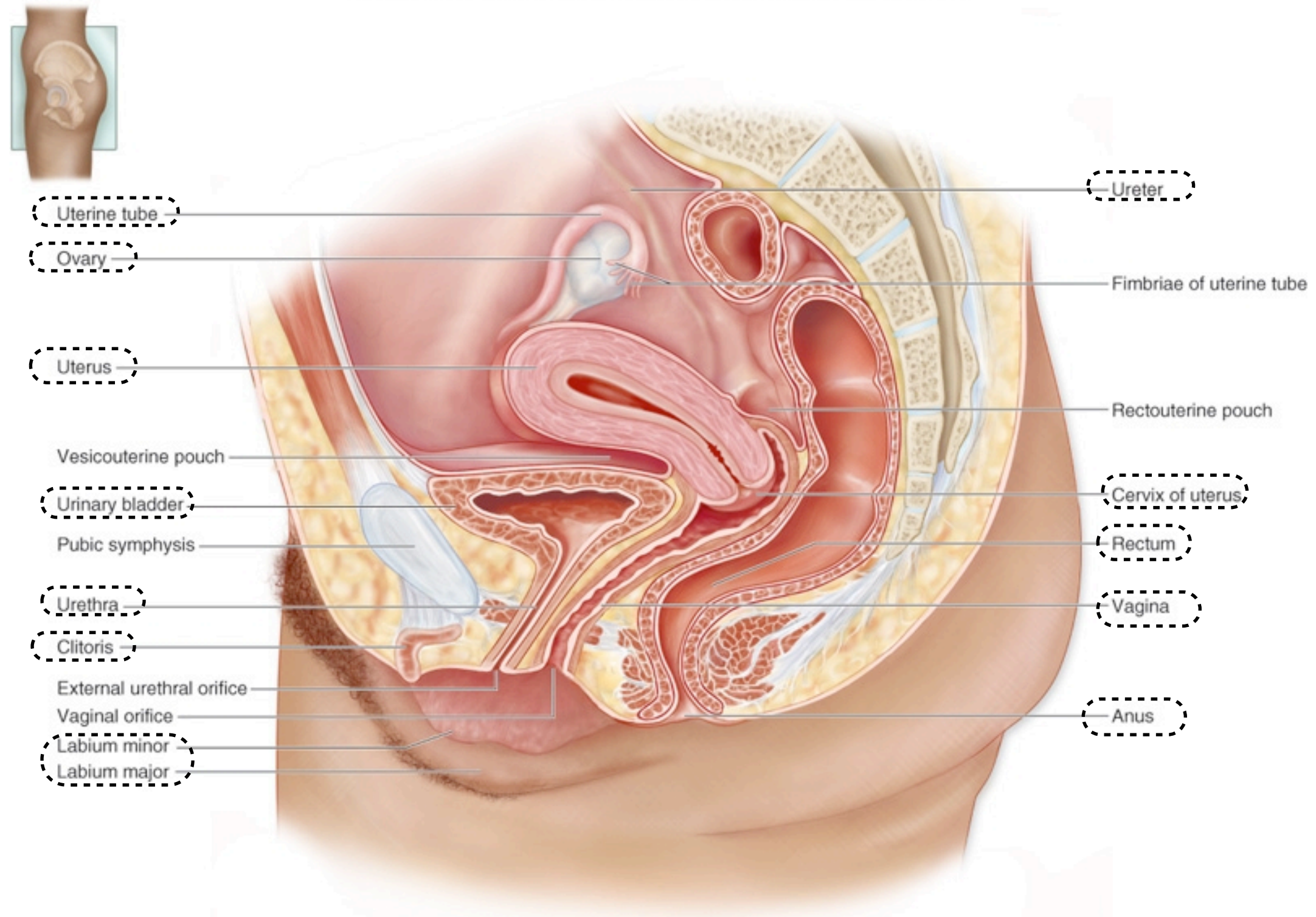
Comparison of Gamete Production

3 Significant Differences

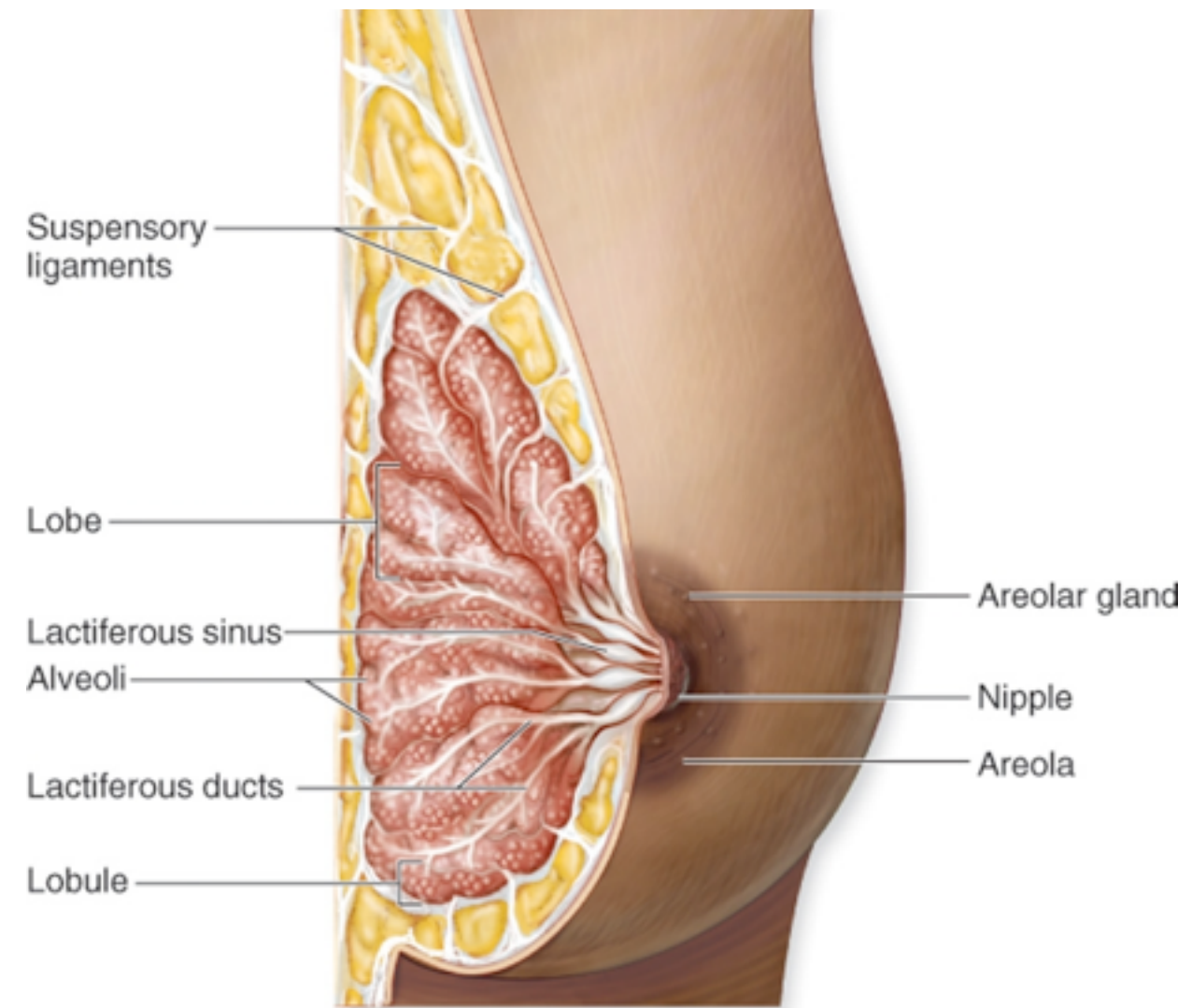
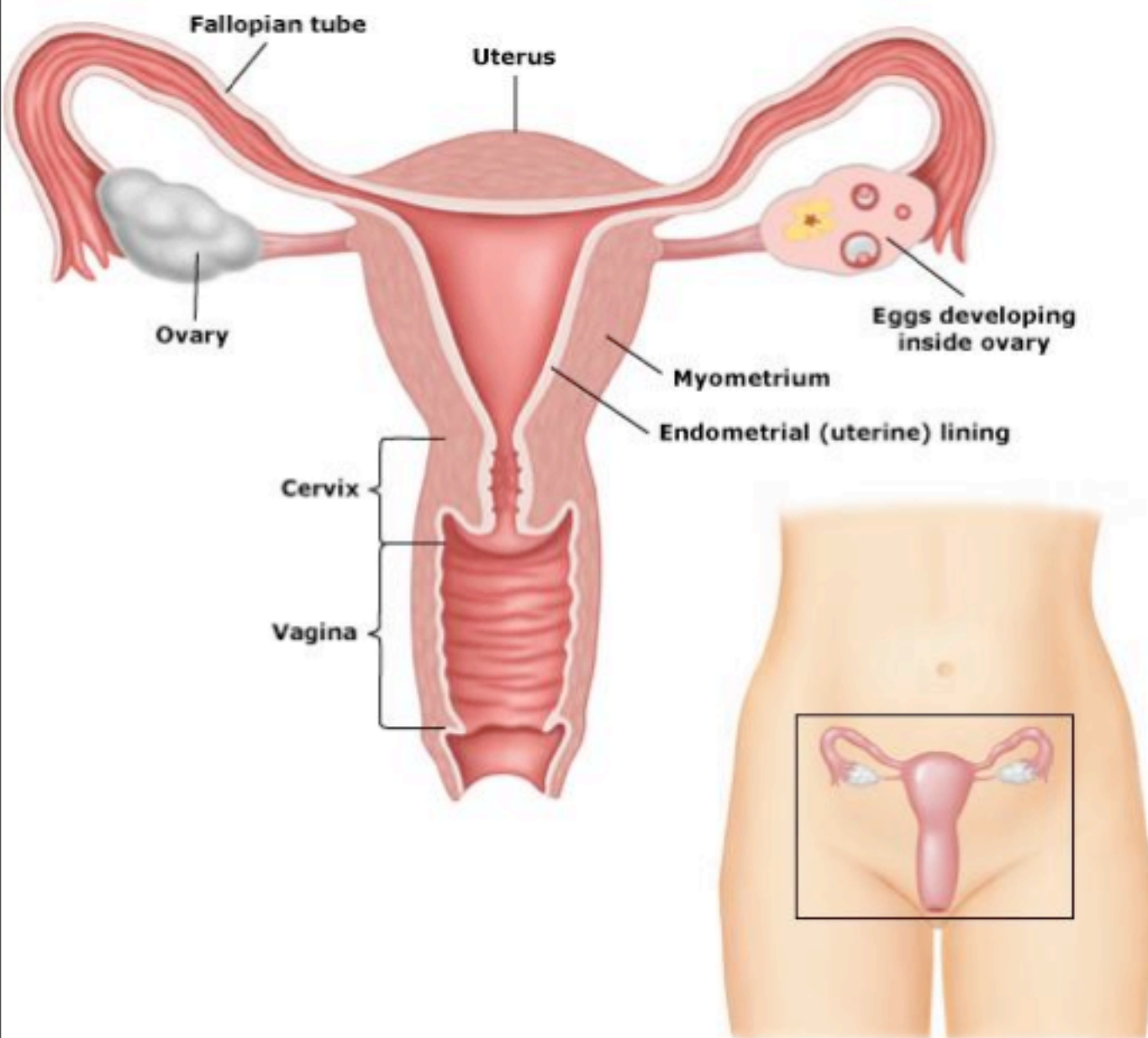
- First; Spermatogenesis produces 4 functioning gametes, oogenesis only produces 1
- Second; Spermatogenesis occurs throughout adolescence and adult, oogenesis begins before birth and stops completely at menopause (~50 years of age)
- Third; Spermatogenesis produces gametes in a continuous sequence, oogenesis produces gametes with long interruptions

Human Reproductive System

Female Anatomy



Female Anatomy



Not apart of the reproductive system BUT important in reproduction.

Both males and females have breasts but generally only females excrete milk

Ovaries

- The female gonads, the ovaries
 - Lie in the abdominal cavity
- Each ovary is enclosed in a tough protective capsule and contains many follicles
- A follicle consists of one egg cell surrounded by one or more layers of follicle cells
 - Cells of the follicle produce estrogen
 - Most of the 400,000 + 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

Recall Estrous Cycles

- Season /climate has strong effect on these cycles
- Only time when vaginal changes permit mating
- Rat cycle is 5 days, some like bears and dogs have only one cycle per year (others a few)



Menstrual Cycles

- Two organs are most directly involved: ovaries & uterus
- consequently the menstrual cycle is divided into two cycles: the ovarian cycle and the uterine cycle
- each cycle is furthered divided into phases

I. Menstrual Cycle

A.Ovarian Cycle

1.Luteal Phase

2.Follicular Phase

B. Uterine Cycle

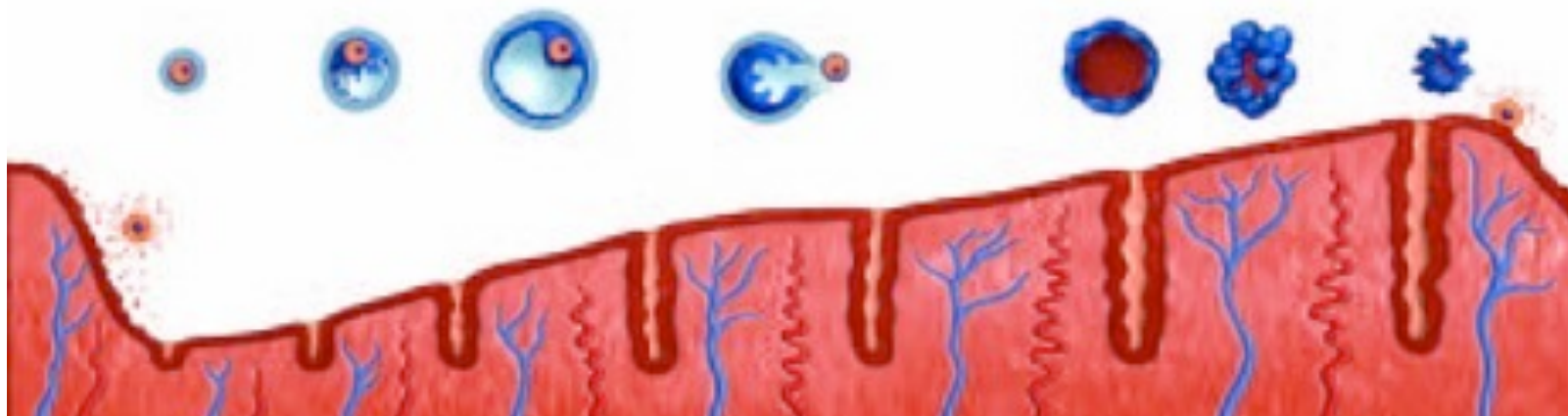
1.Menstrual Phase

2.Proliferation Phase

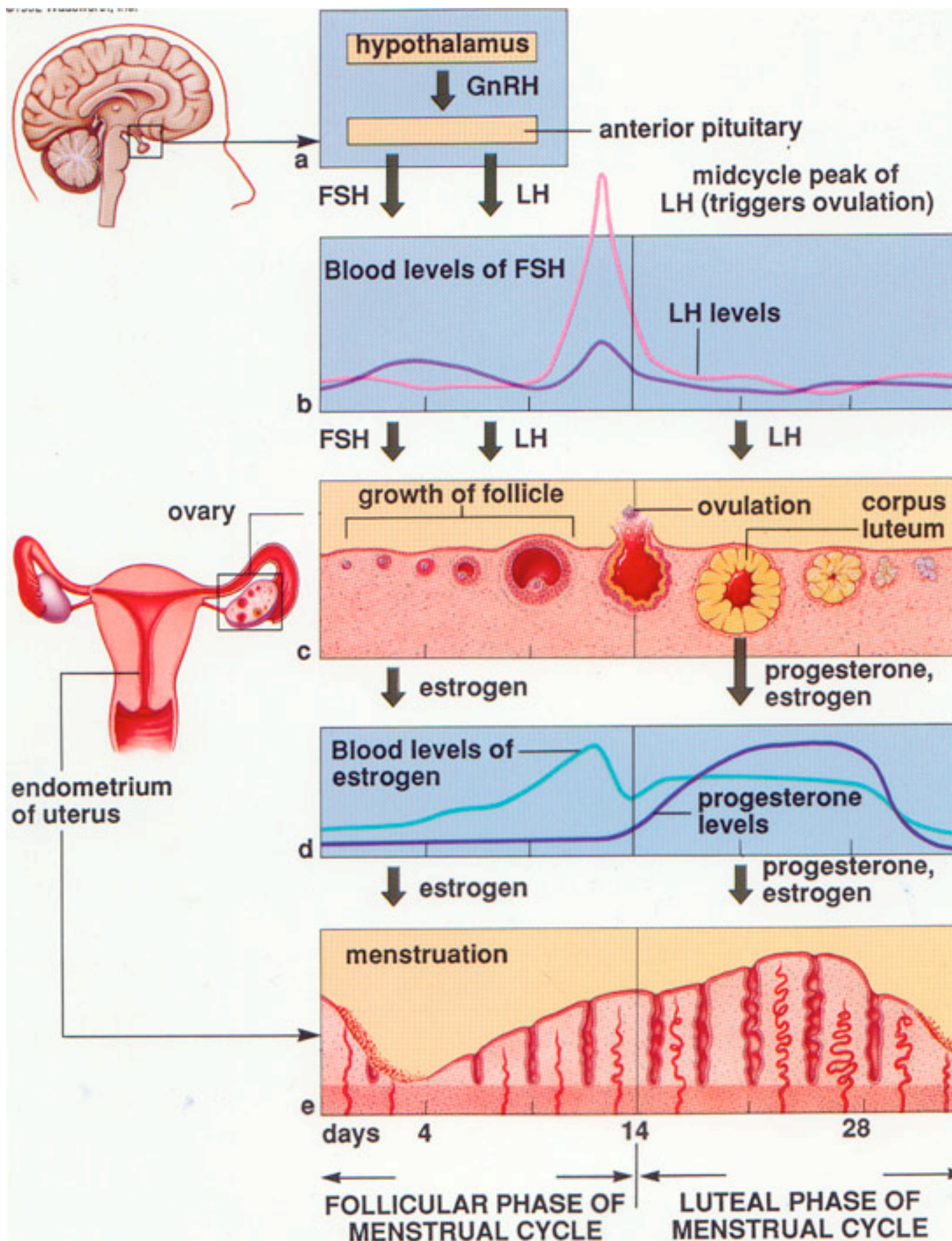
3.Secretory Phase

Menstrual Cycles

- Range from 20-40 days (28 on average)
 - cycles can be regular or irregular
- 5 different hormones are involved
- It includes 3 phases: menstrual, proliferation, secretory
- It employs both negative and positive feedback loops
- Two organs are most directly involved: ovaries & uterus

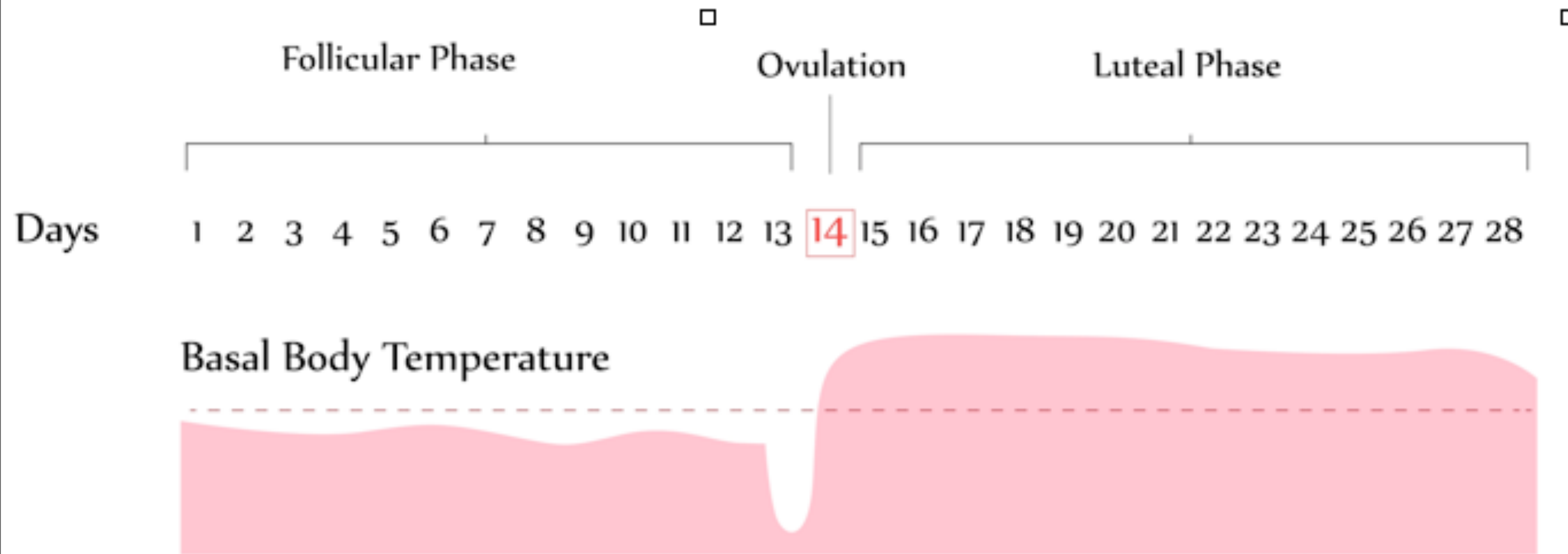


Overview of Menstrual Cycle

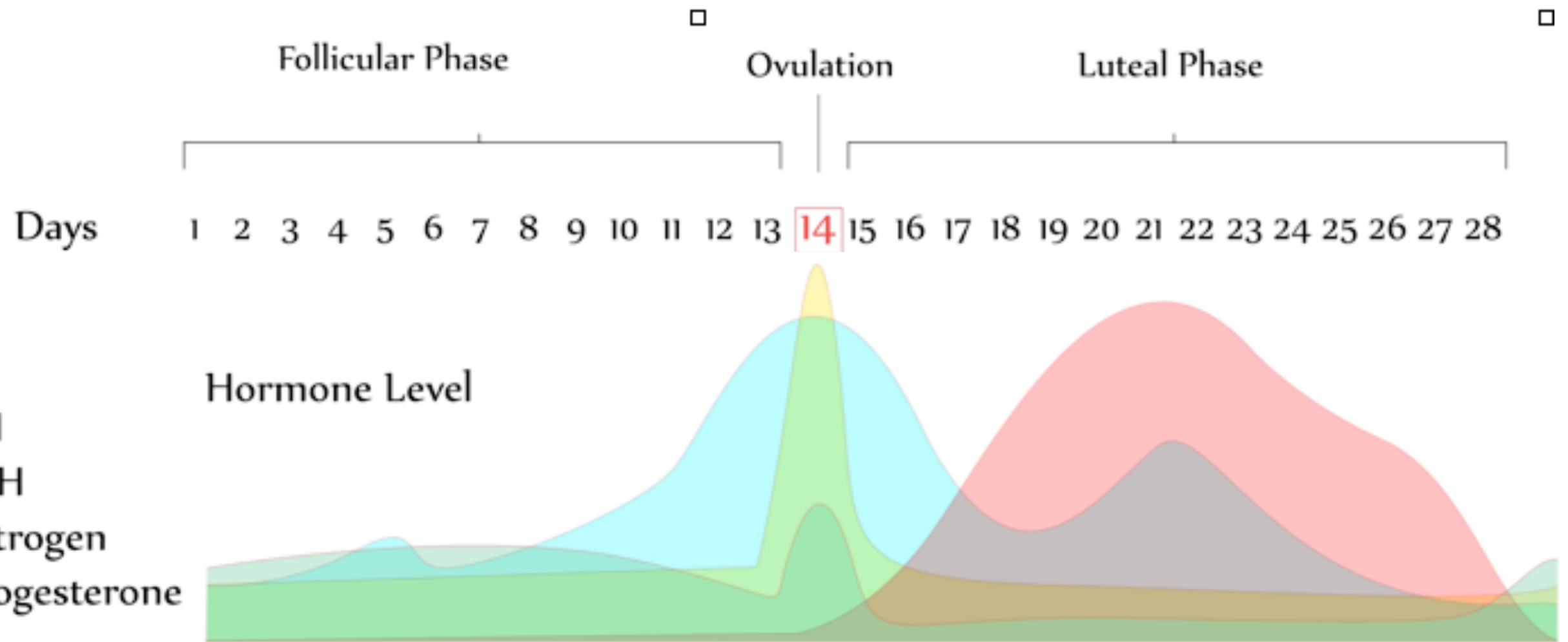


Changing hormone levels during the menstrual cycle.

Menstrual Cycle-Body Temperature



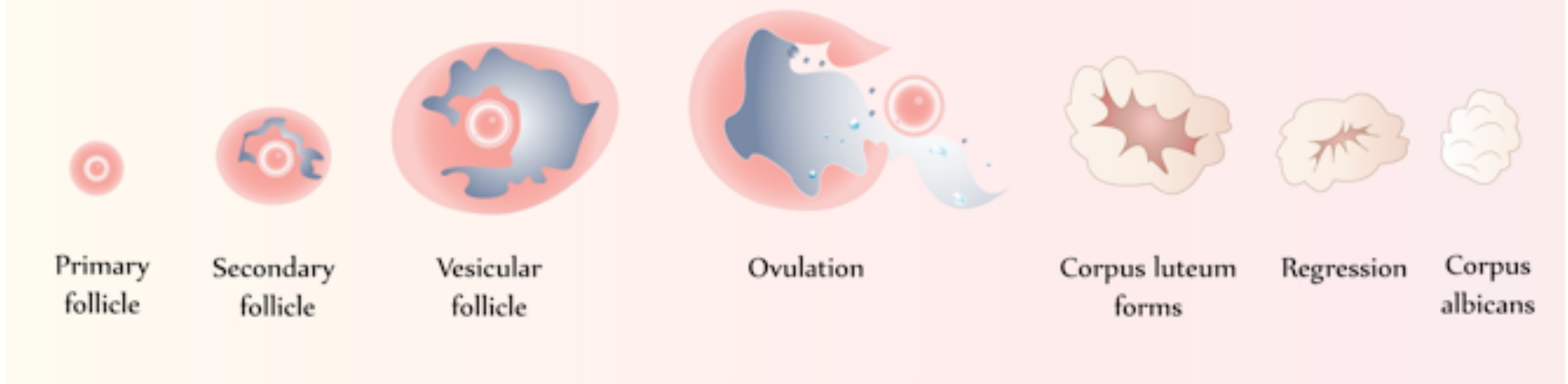
Menstrual Cycle-Hormones



Menstrual Cycle-Ovarian Cycle

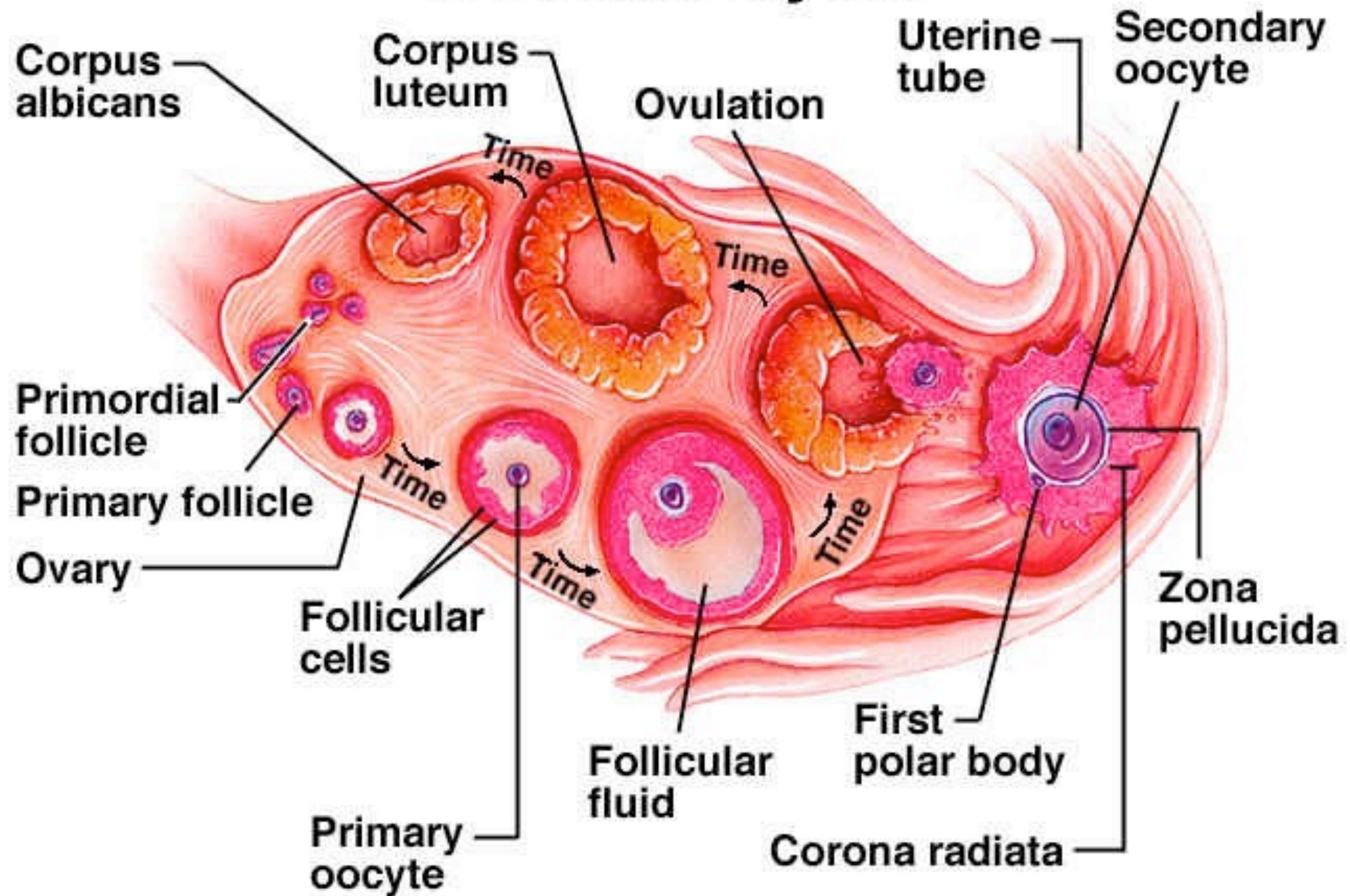


Ovarian Cycle

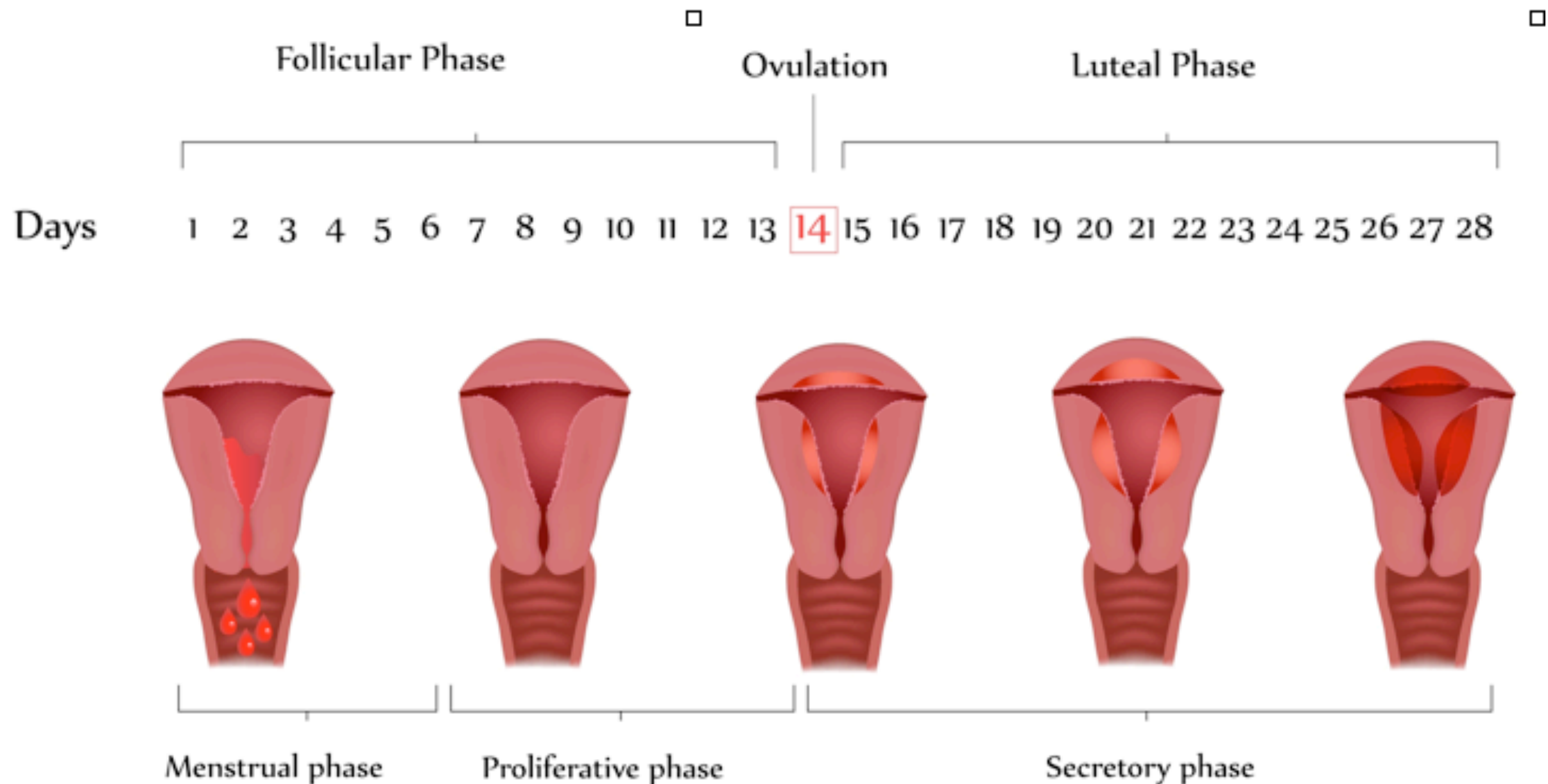


Another Perspective-

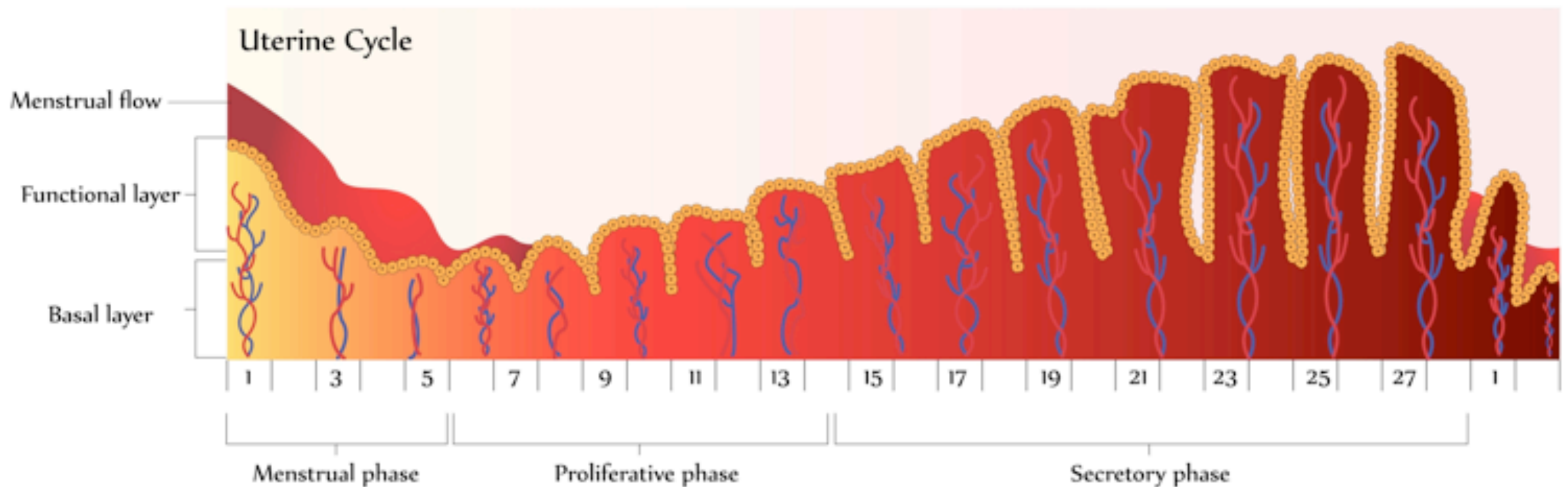
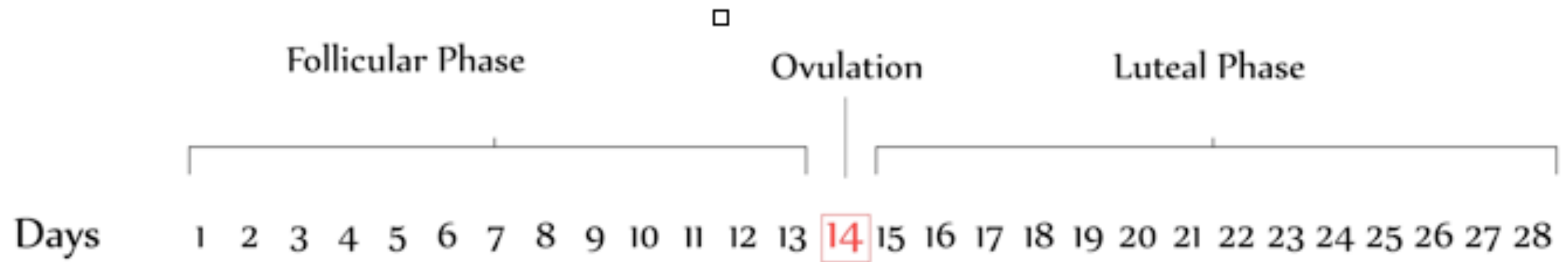
Ovarian Cycle



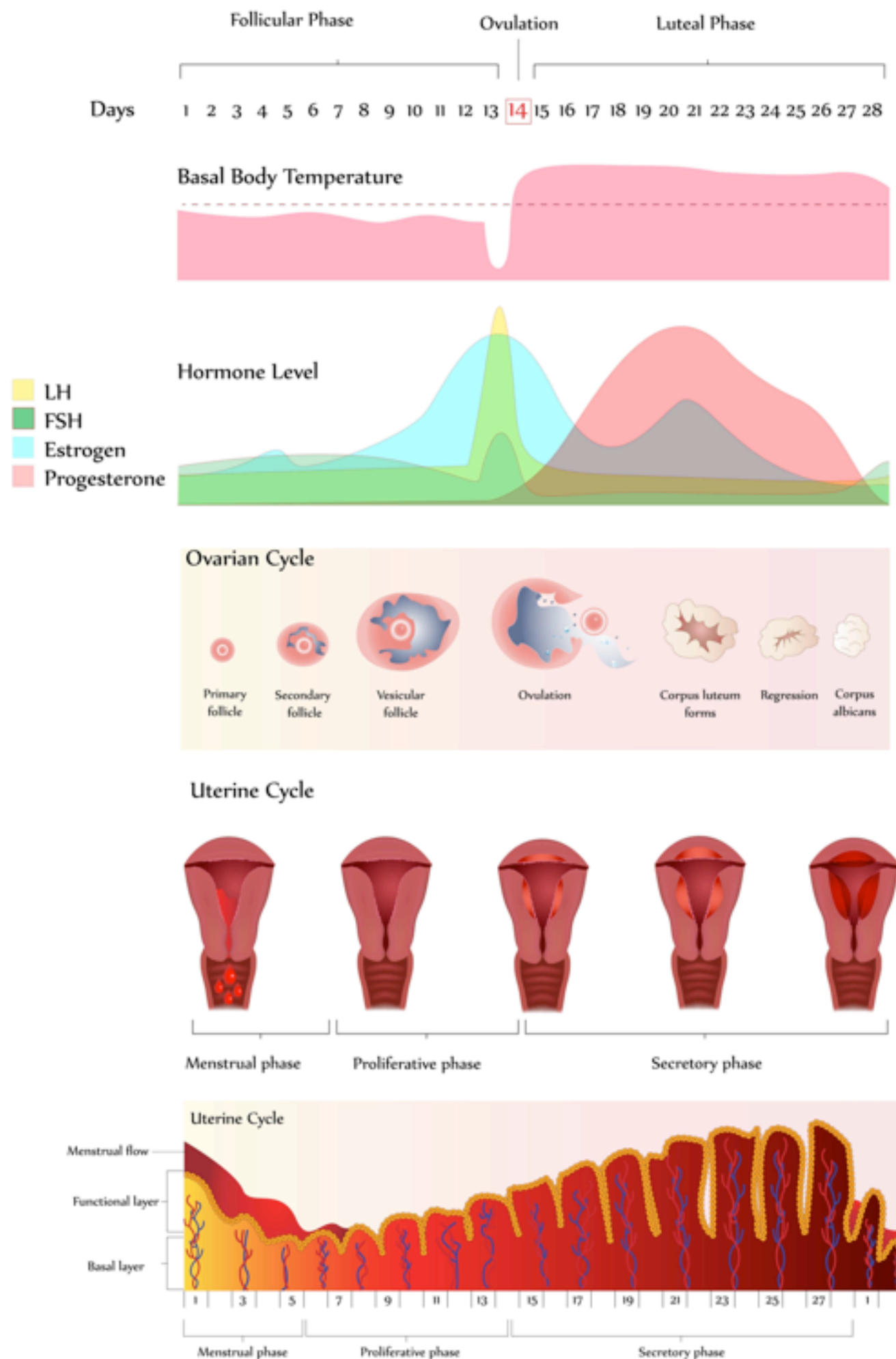
Menstrual Cycle-Uterine Cycle



Menstrual Cycle-Uterine Cycle



Review of Menstrual Cycle



I. Menstrual Cycle

A. Ovarian Cycle

1. Luteal Phase

2. Follicular Phase

B. Uterine Cycle

1. Menstrual Phase

2. Proliferation Phase

3. Secretory Phase

Oviducts & Uterus

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



Vagina & Vulva (external genitalia)

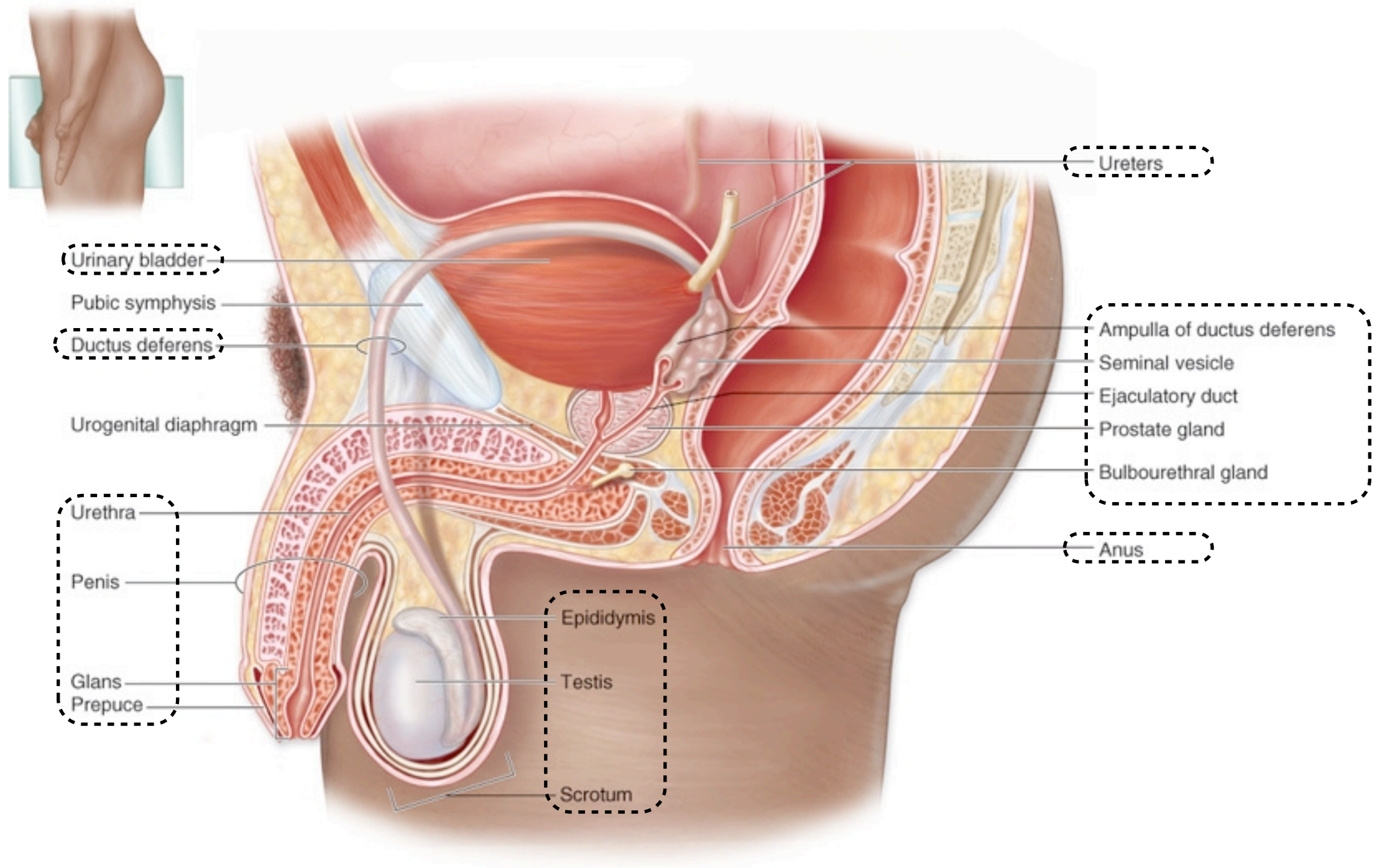
- The vagina is a thin-walled chamber
 - That is the repository for sperm during copulation
 - That serves as the birth canal through which a baby is born
- The vagina opens to the outside at the vulva
 - Which includes the hymen, vestibule, labia minora, labia majora, and clitoris

Mammary Glands

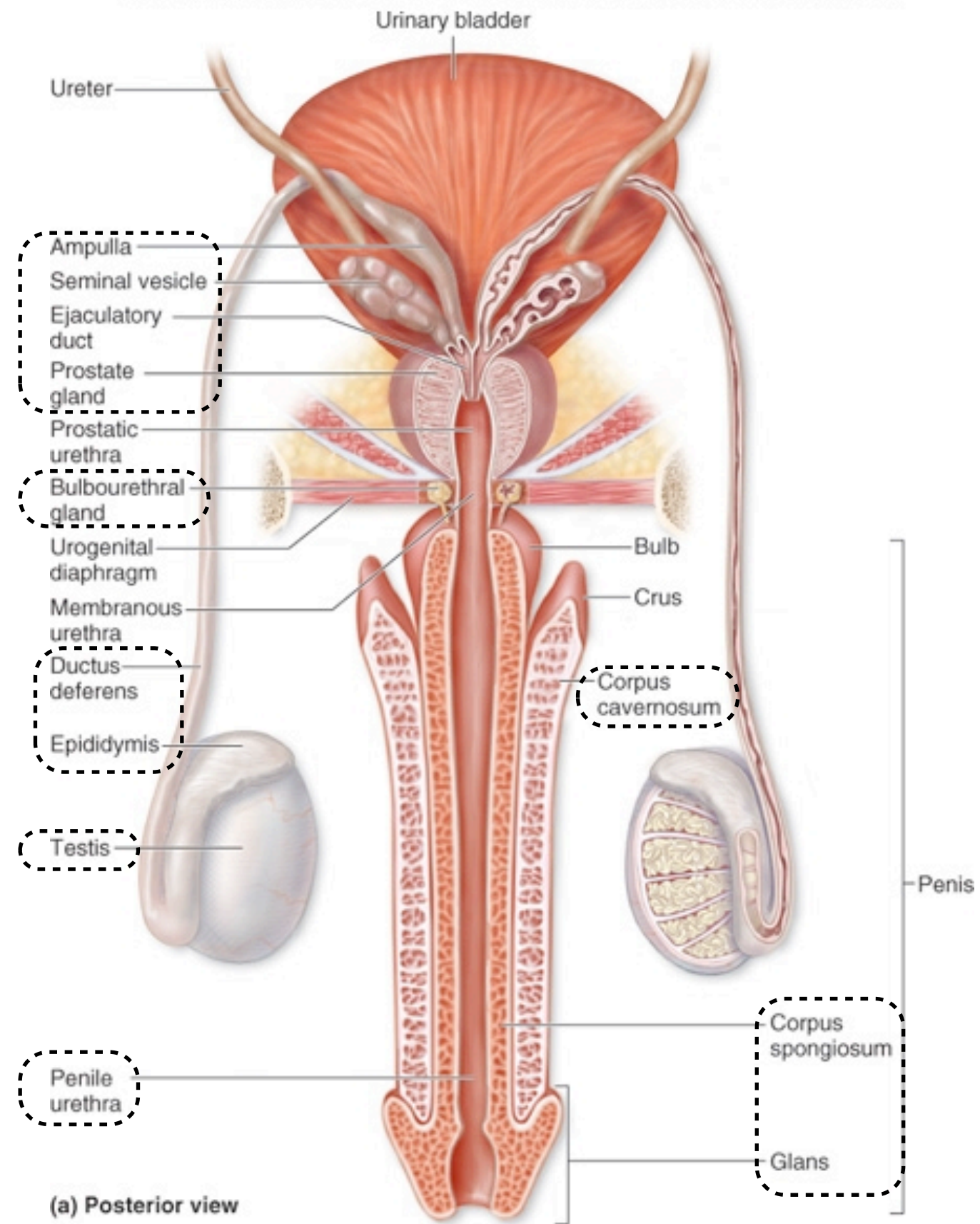
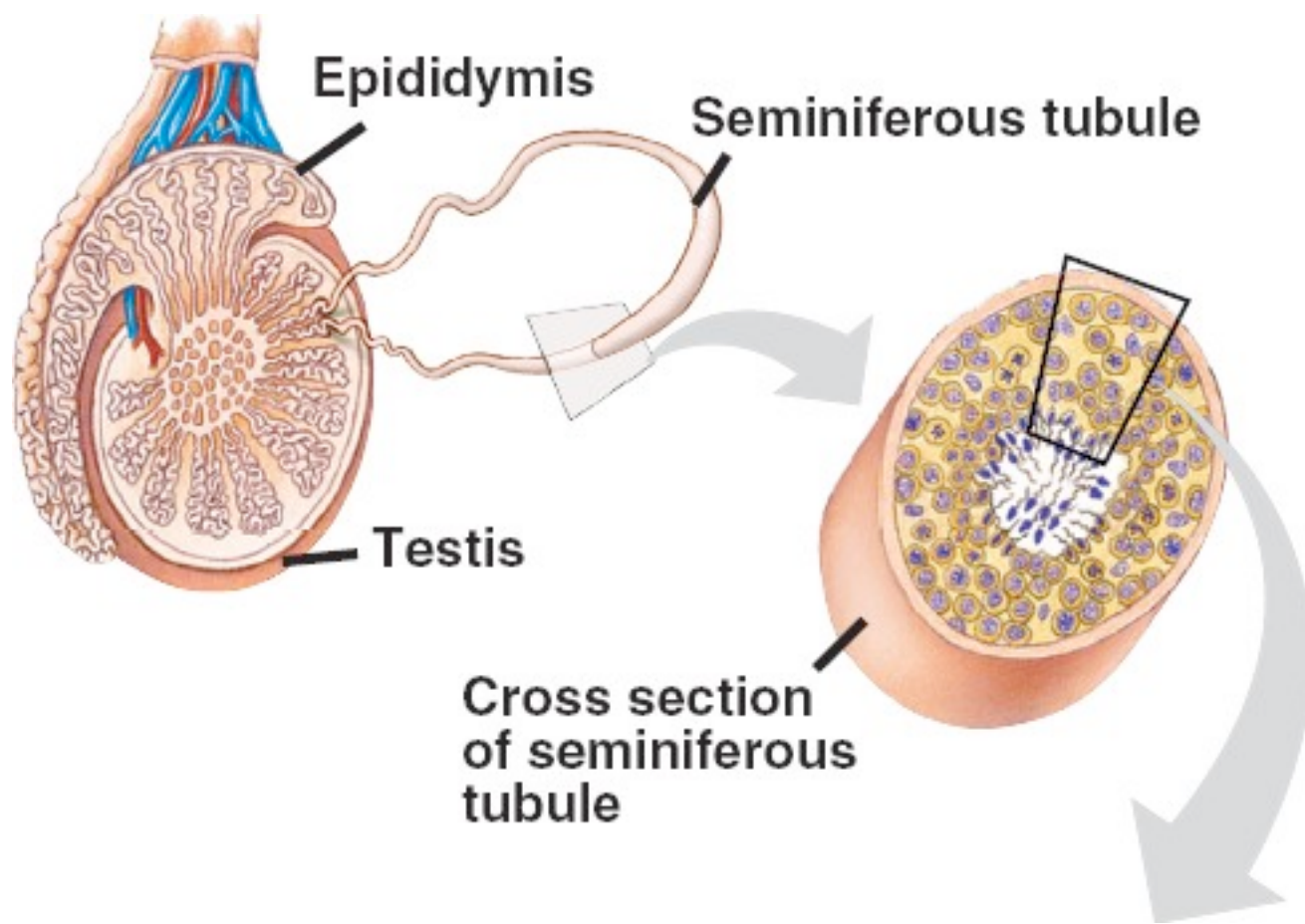
- The mammary glands are not part of the reproductive system
 - But are important to mammalian reproduction
- Within the glands
 - Small sacs of epithelial tissue secrete milk
 - Low estrogen keeps male breasts small and keeps the nipples from connecting to the ducts

Human Reproductive System

Male Anatomy



Male Anatomy



Testes

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

Testes/Sperm Production

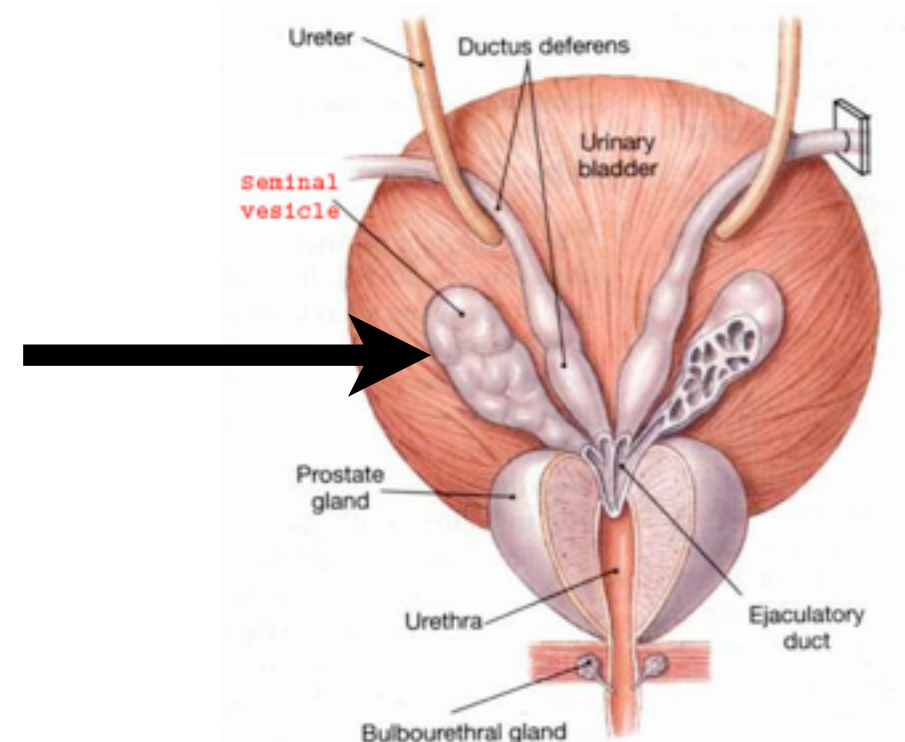
- Production of normal sperm
 - Cannot occur at the body temperatures of most mammals
- The lifespan of human sperm
 - Outside the body on the order of minutes to hours and inside female reproductive tract 5 days or more
- The testes of humans and many mammals
 - Are held outside the abdominal cavity 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)
- During ejaculation
 - Sperm are propelled through the muscular vas deferens, the ejaculatory duct, and exit the penis through the urethra
 - 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

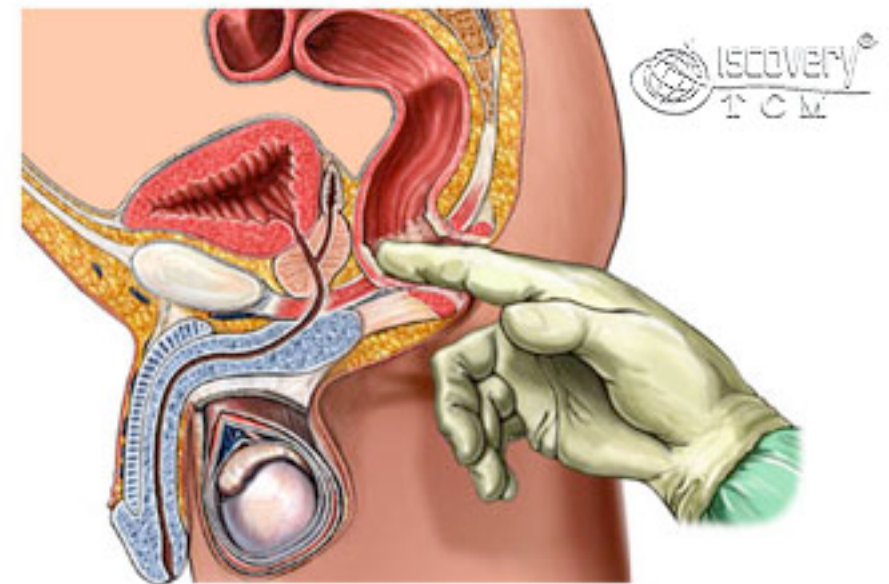
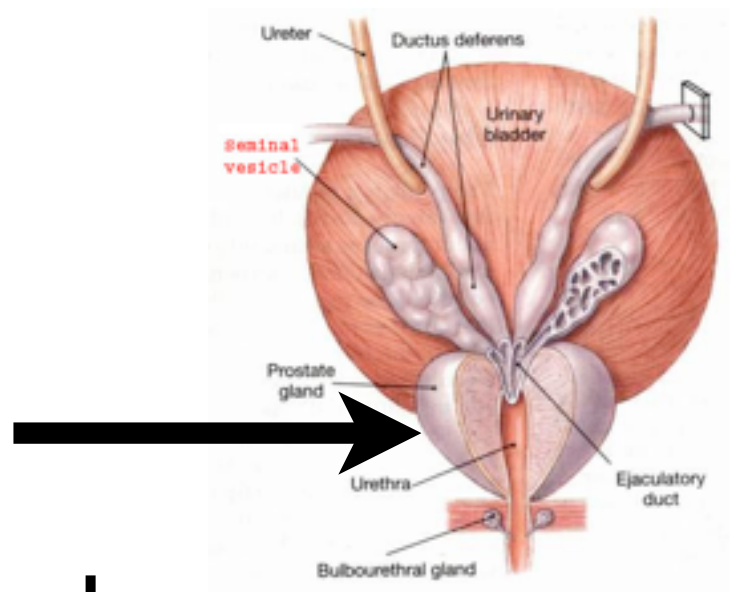
Glands

- 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

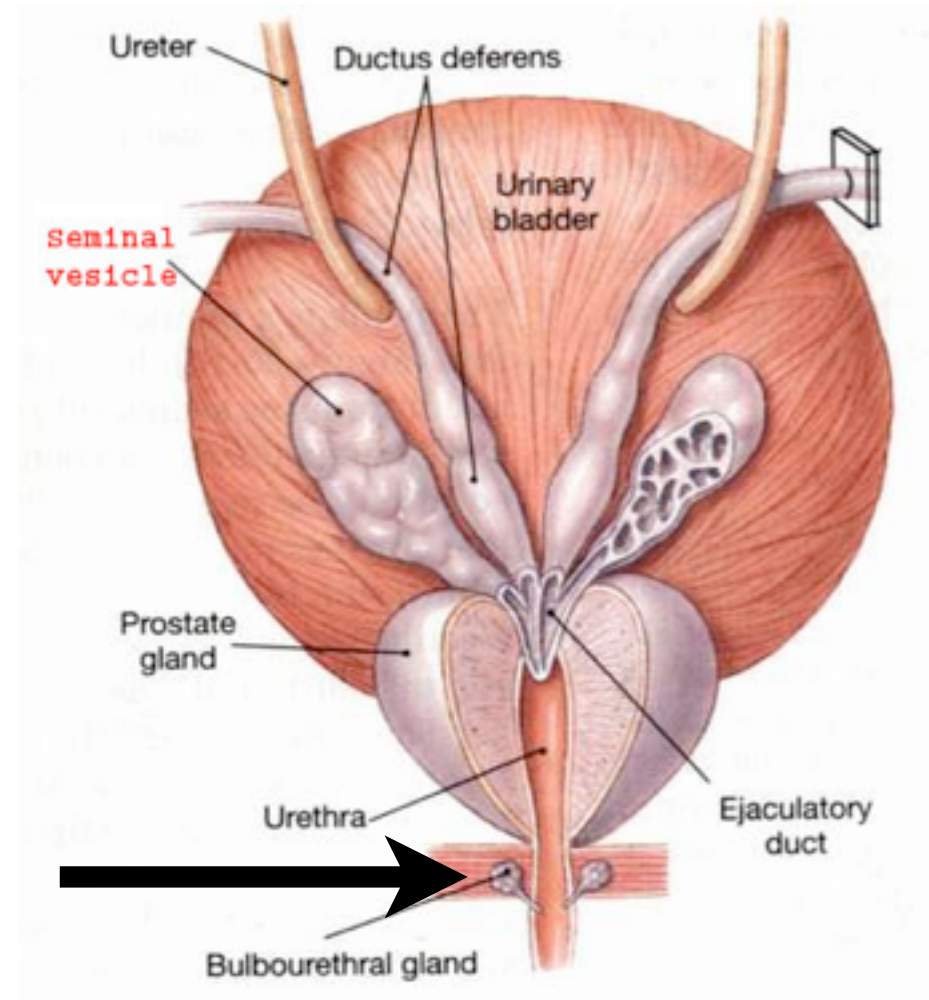
- The prostate gland
 - Largest of three, it secretes its products directly into the urethra through several small ducts
 - Thin and milky fluid
 - Contains: anticoagulant enzymes and citrate



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

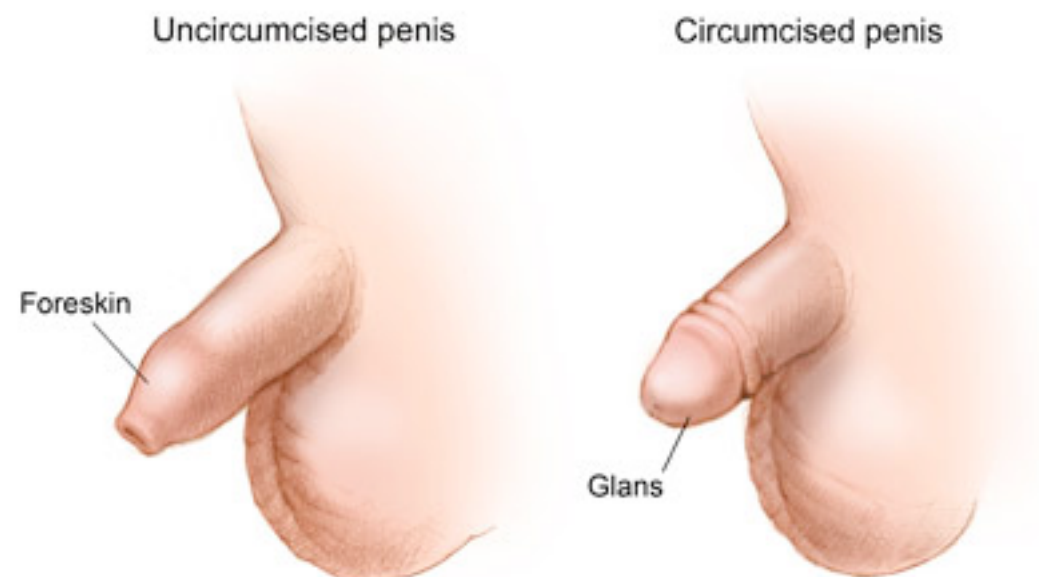
Glands

- The bulbourethral gland
 - secretes a clear mucus before ejaculation that neutralizes acidic urine remaining in the urethra
 - carries some sperm prior to ejaculation, one reason for low success rate of withdrawal method of birth control



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
 - Circumcision removes this foreskin; the act arose from religious traditions and has no basis in health or hygiene



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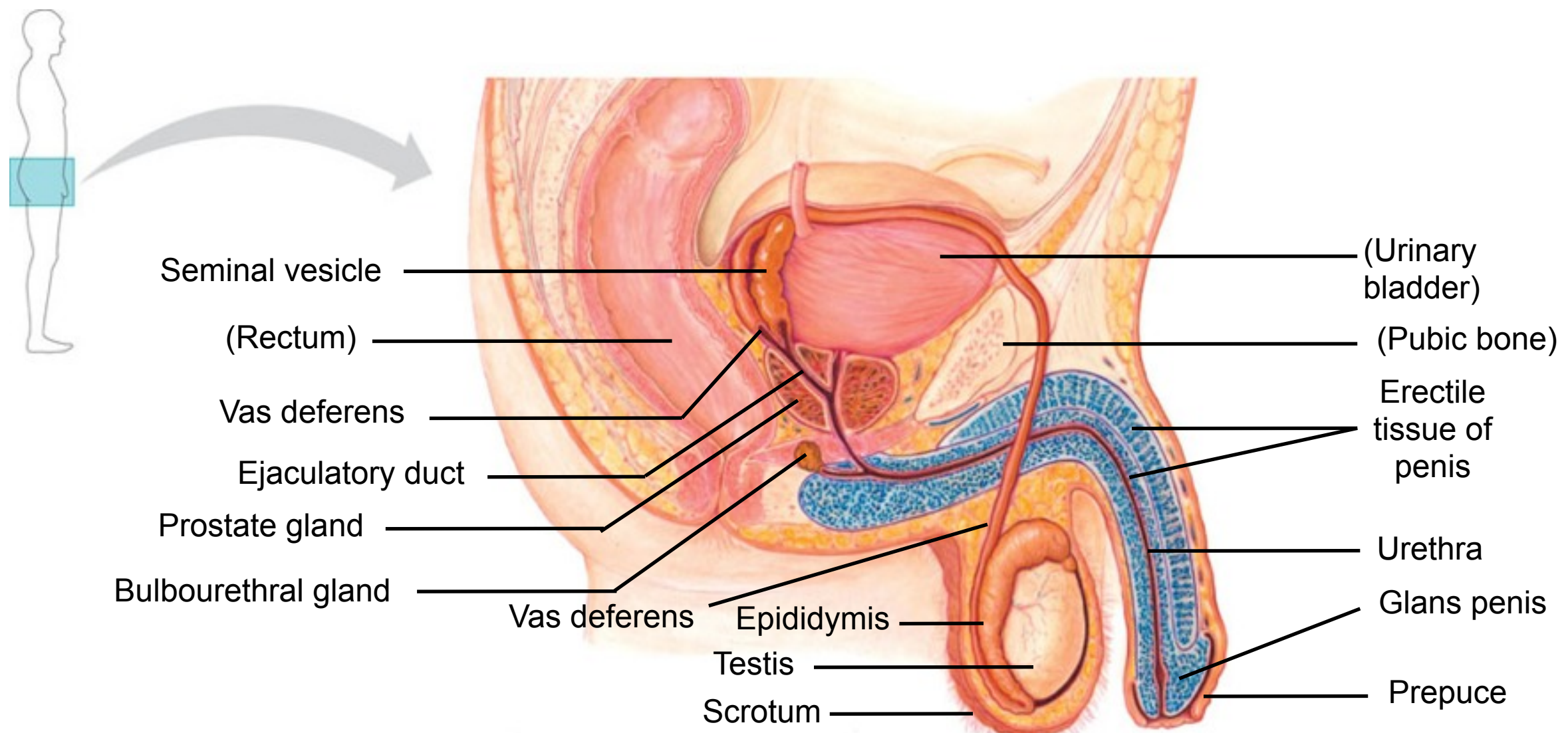
Erection

- During sexual arousal
 - The erectile tissue fills with blood from the arteries, causing an erection
 - Increase pressure in arteries seals the veins that drain the penis
 - Some animals (rodents, raccoons, walruses, whales) have *baculum*, a bone that helps stiffen the penis



Pathway of Sperm in Ejaculation

- Seminiferous tubules → Epididymus → Vas Deferens → Ejaculatory Duct → Urethra
- As sperm travels through the tract 3 glands (seminal vesicle, prostate and bulbourethral) secrete fluid that along with sperm produce what we call semen



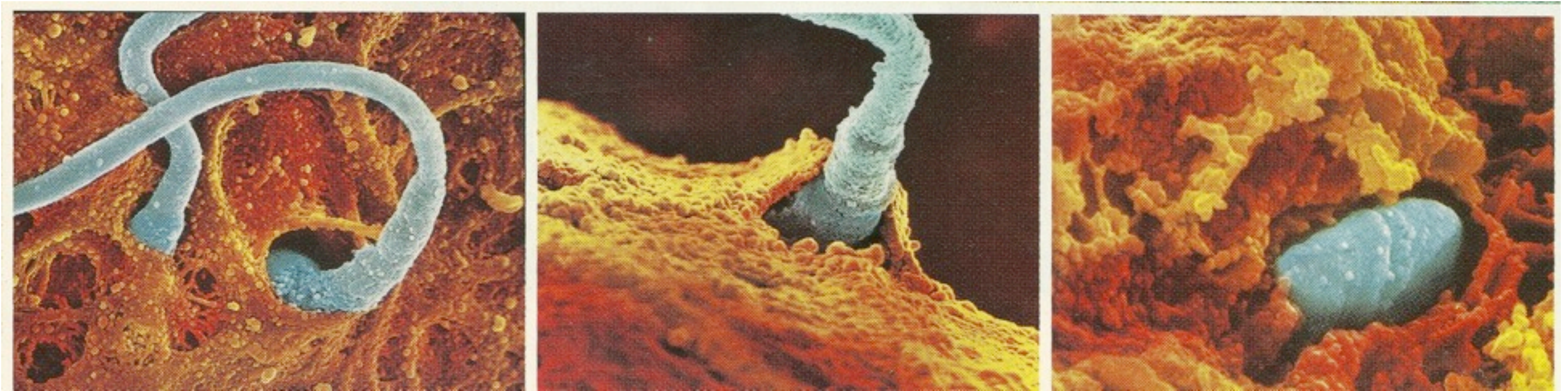
Semen in the Female Reproductive Tract

- Once in the female reproductive tract
 - A number of processes, including contractions of the uterus, help move the sperm up the uterus
 - Males ejaculate 50 -650 million sperm each time
- 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

- In humans and other placental mammals, an embryo grows into a newborn in the mother's uterus
- 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)

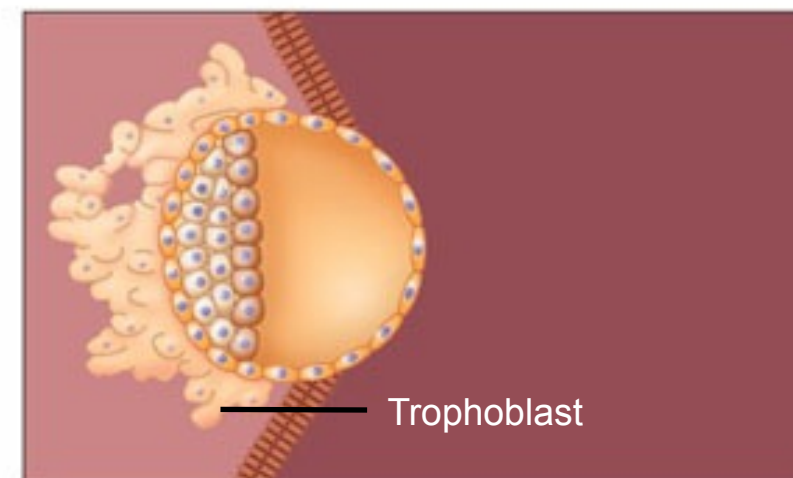
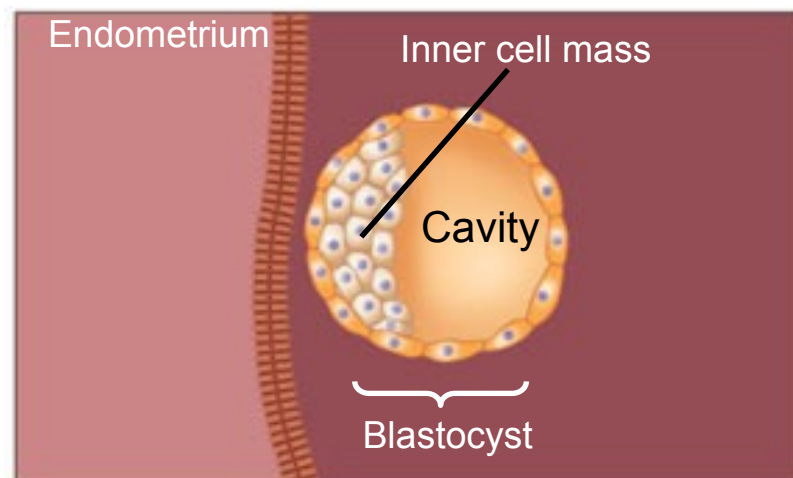
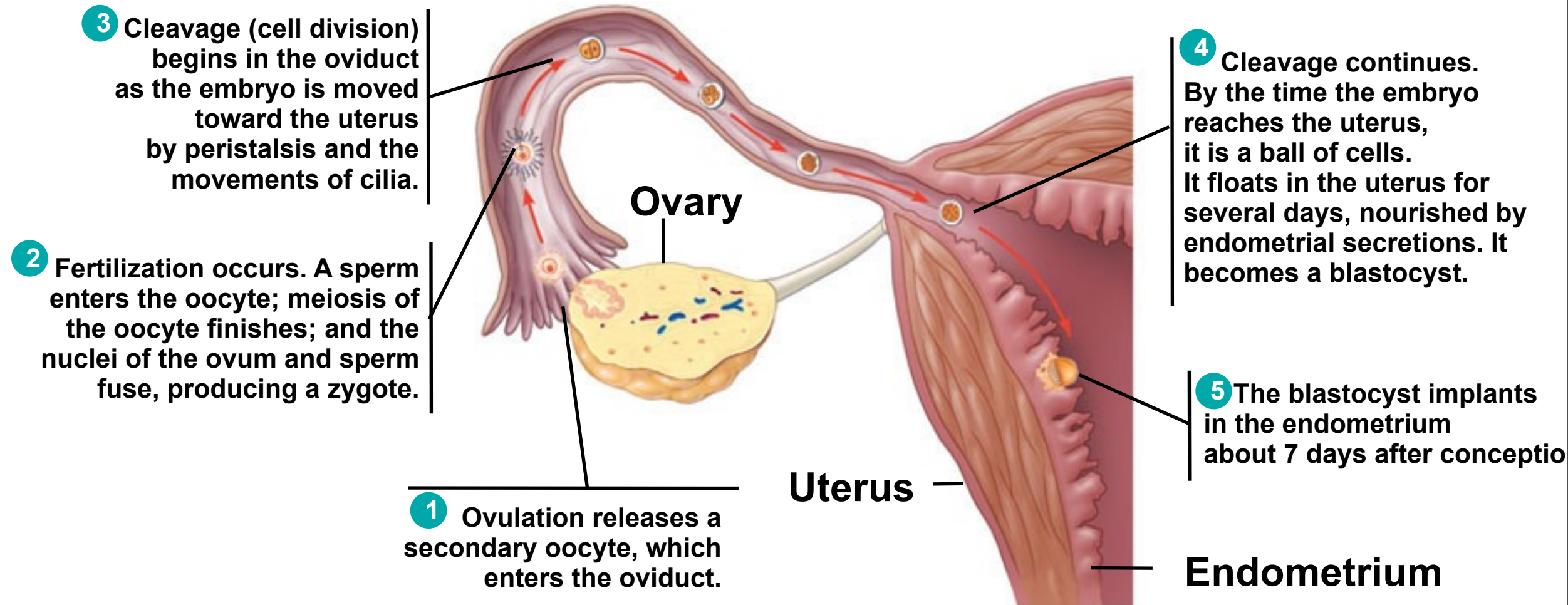
Fertilization/Conception



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

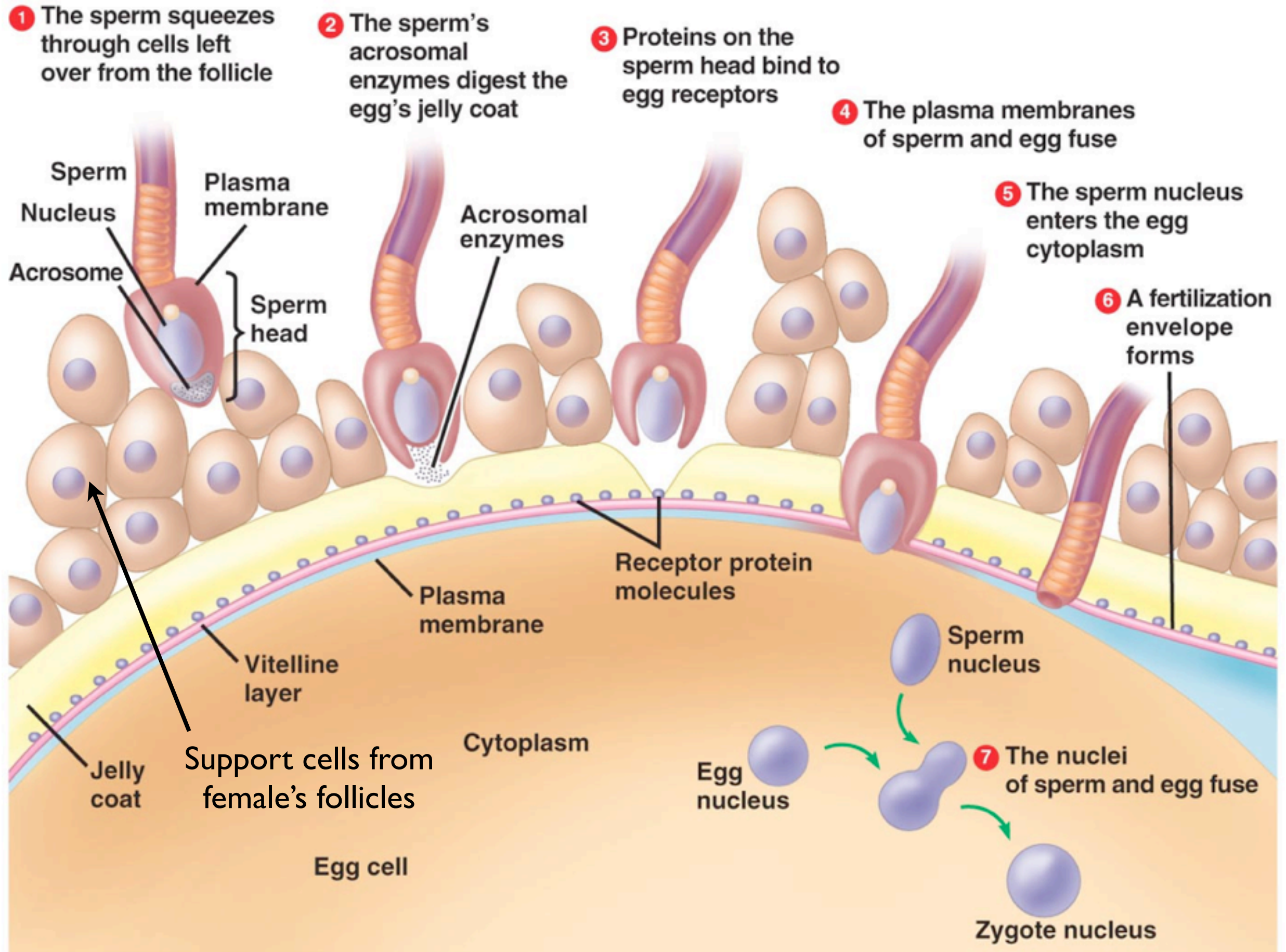
A Closer Look-Fertilization

From ovulation to implantation



Implantation of blastocyst

Fertilization/Conception



Plants

Reproduction

Plant Reproduction Intro

- *ALL Plants can be placed into one of four main groups.*
 - 1. Bryophytes: moss and other nonvascular plants
 - 2. Pterophytes & Lycophytes: ferns and other seedless vascular plants
 - 3. Gymnosperms (Conifers; seeds but no fruit)
 - 4. Angiosperms (90% of all plants; seeds and fruit)

As MYP students will focus only
on angiosperm reproduction

BRYOPHYTES

Liverworts



Hornworts



Moss



PTEROPHYTES & LYCOPHYTES

Horsetails



Ferns



Whisk Ferns

GYMNOSPERMS



Douglas Fir



Juniper



Bristlecone Pine



Cycads

Sequoia



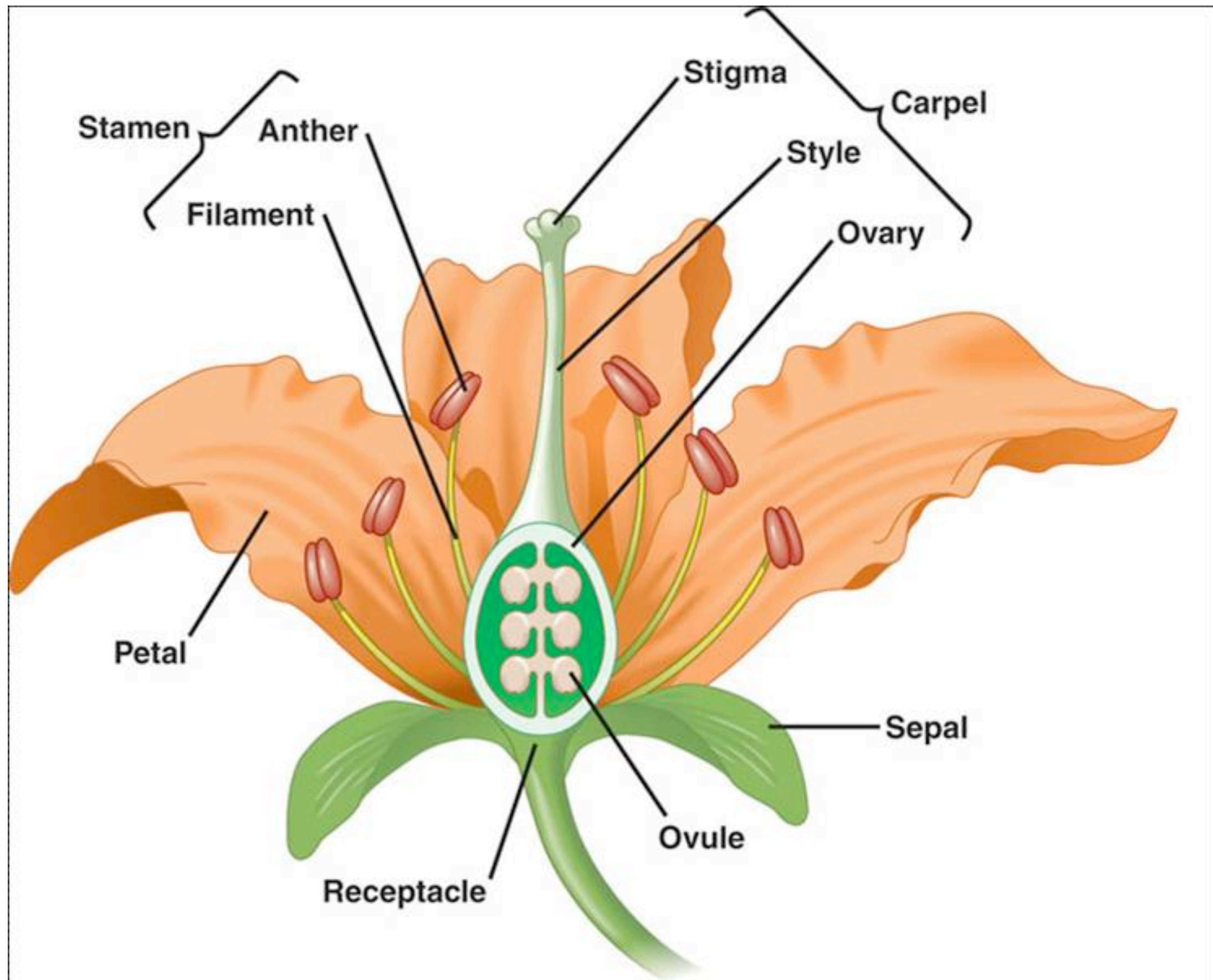
Plant Reproduction Intro

- *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

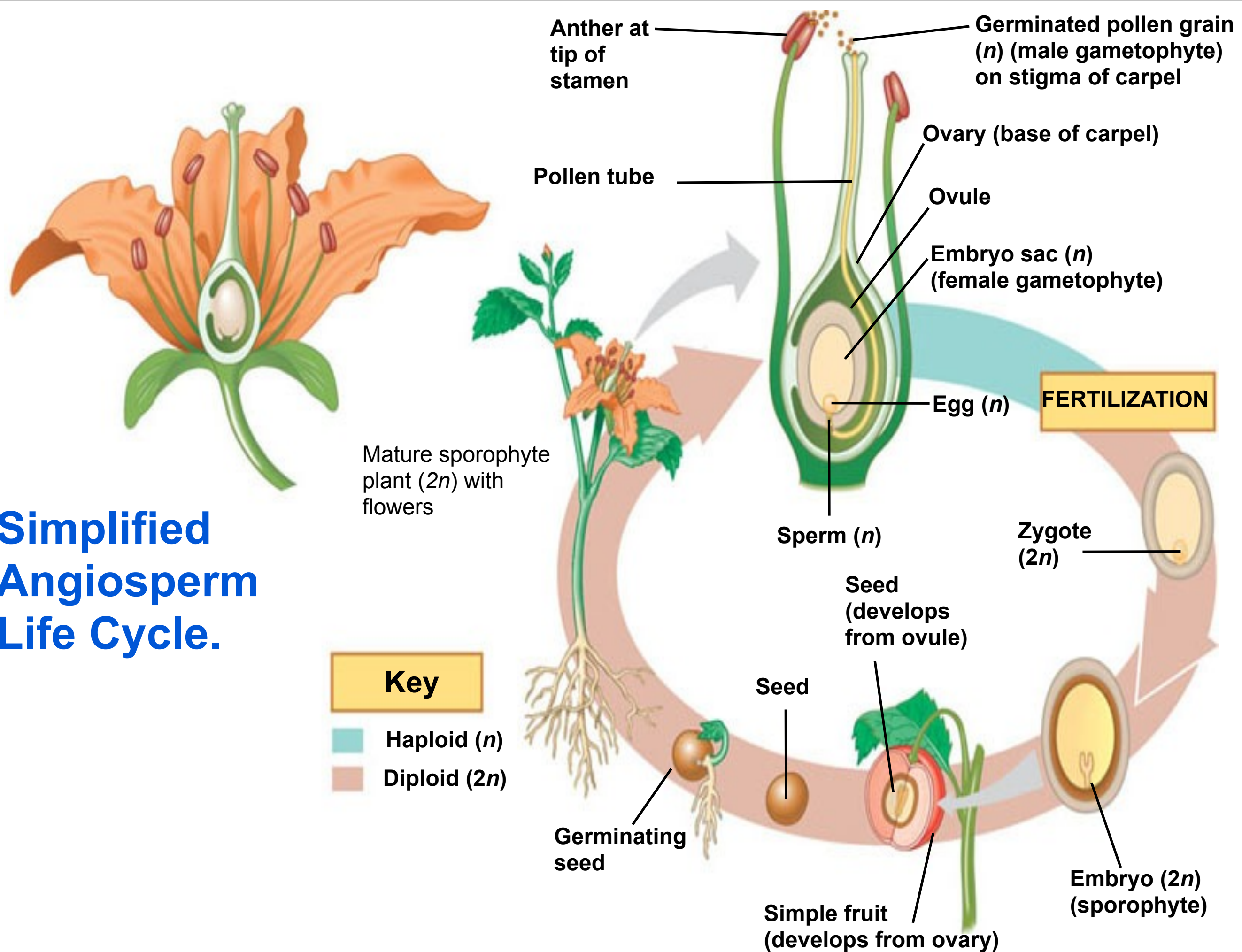
Plant Reproduction Intro

- The 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.



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

nearly 20 % of
all angiosperms

most temperate
trees and
grasses

inefficient so
lots of pollen
is produced



does not have
to attract
pollinators so
usually small,
lack color and
scent

appear early in
spring before
leaves get in
the way

Bee Pollination



flowers attract bees
bright yellows and
blues along with
sweet scents

bees use flower
nectar for food

flowers have
UV markings
called "nectar
guides"

bees are the
most important
pollinators

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



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

usually red
fleshy flowers

these flowers
smell like
dead, rotting
corpses

Moth & Bat Pollination



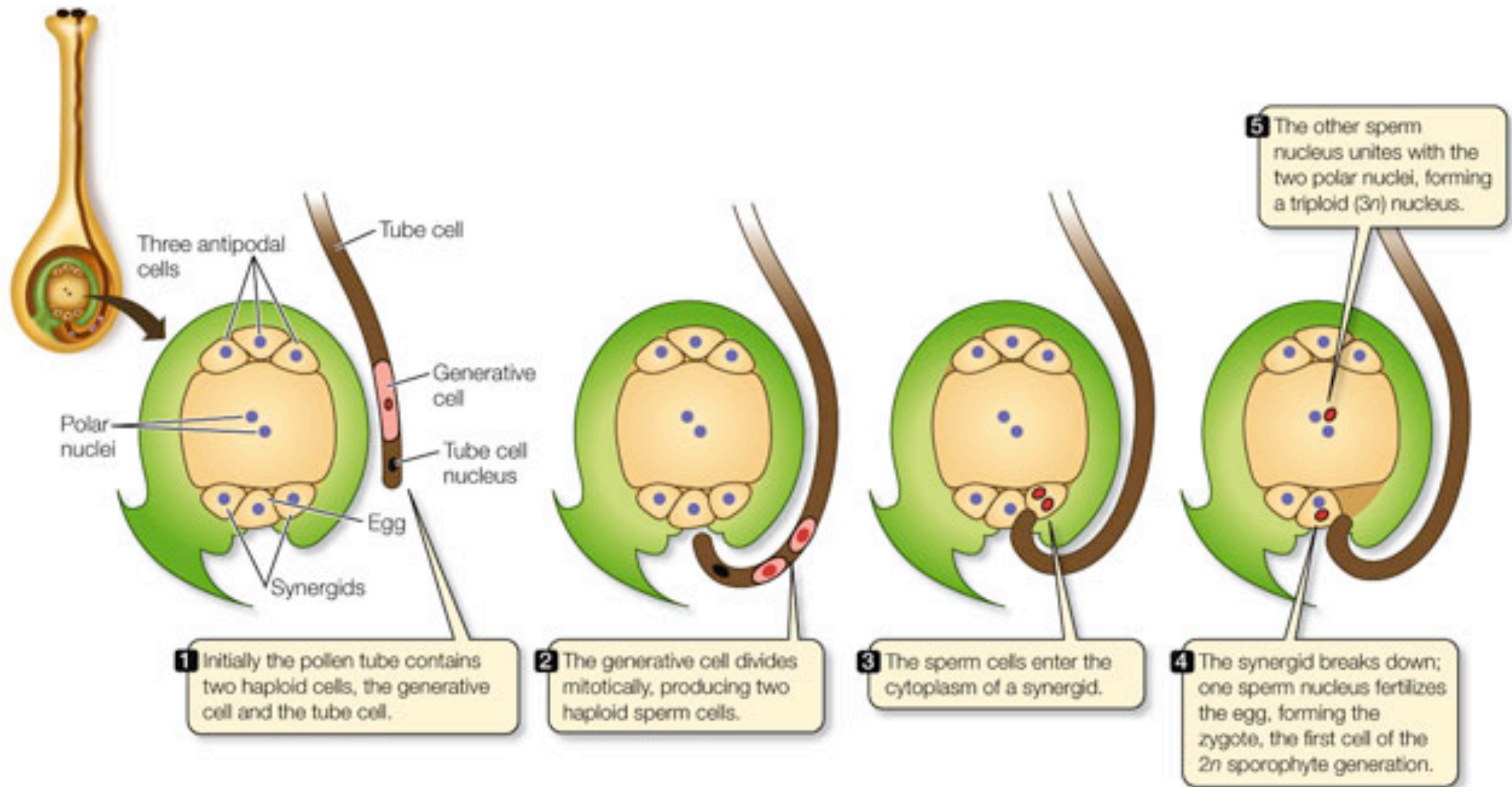
these flowers
smell sweet



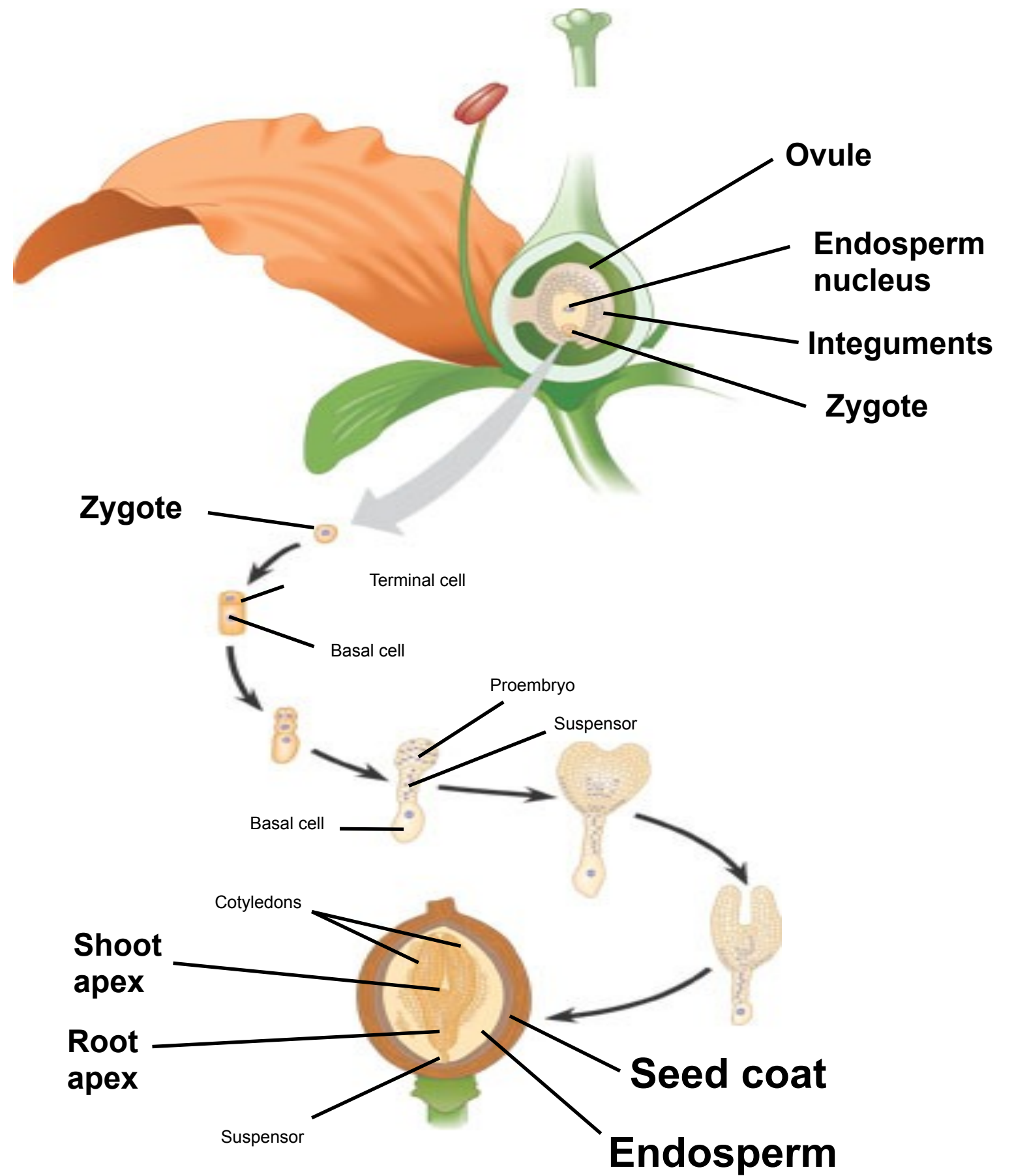
usually white or
light colored flowers
because pollinators
are often nocturnal

bats feed on nectar, moths lay
eggs on the flower's ovaries

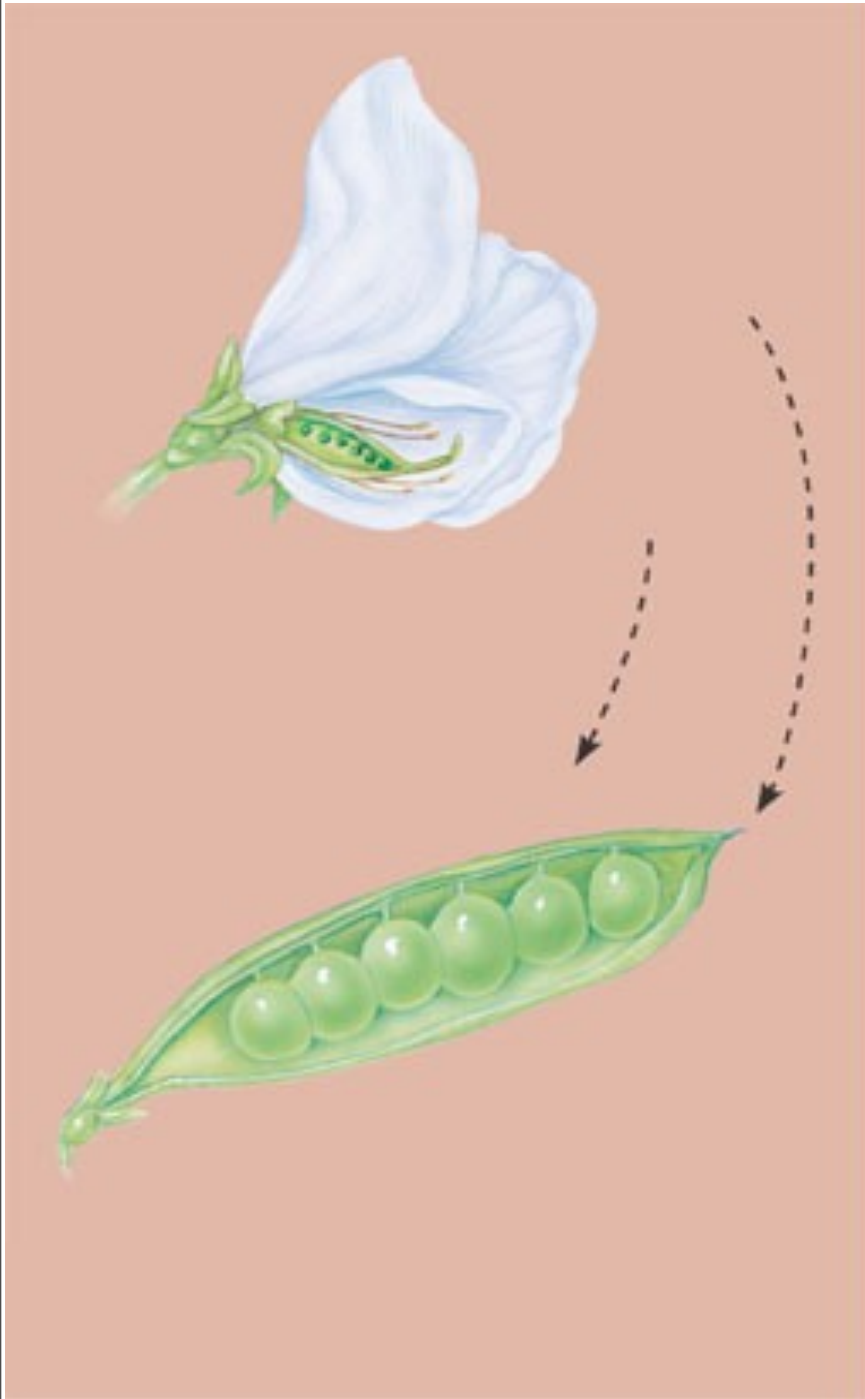
Double Fertilization



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

How Seeds Travel

by the wind



milkweed

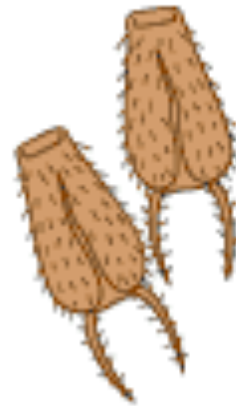


dandelion



maple

by animals



beggar-ticks



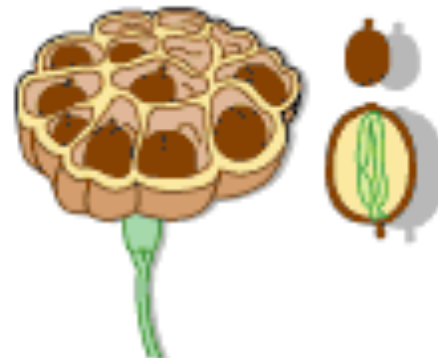
sandbur



blackberry

by water

lotus



cattail



coconut

by bursting

violet



jewelweed



witch hazel

by humans



bean



wheat



cherry

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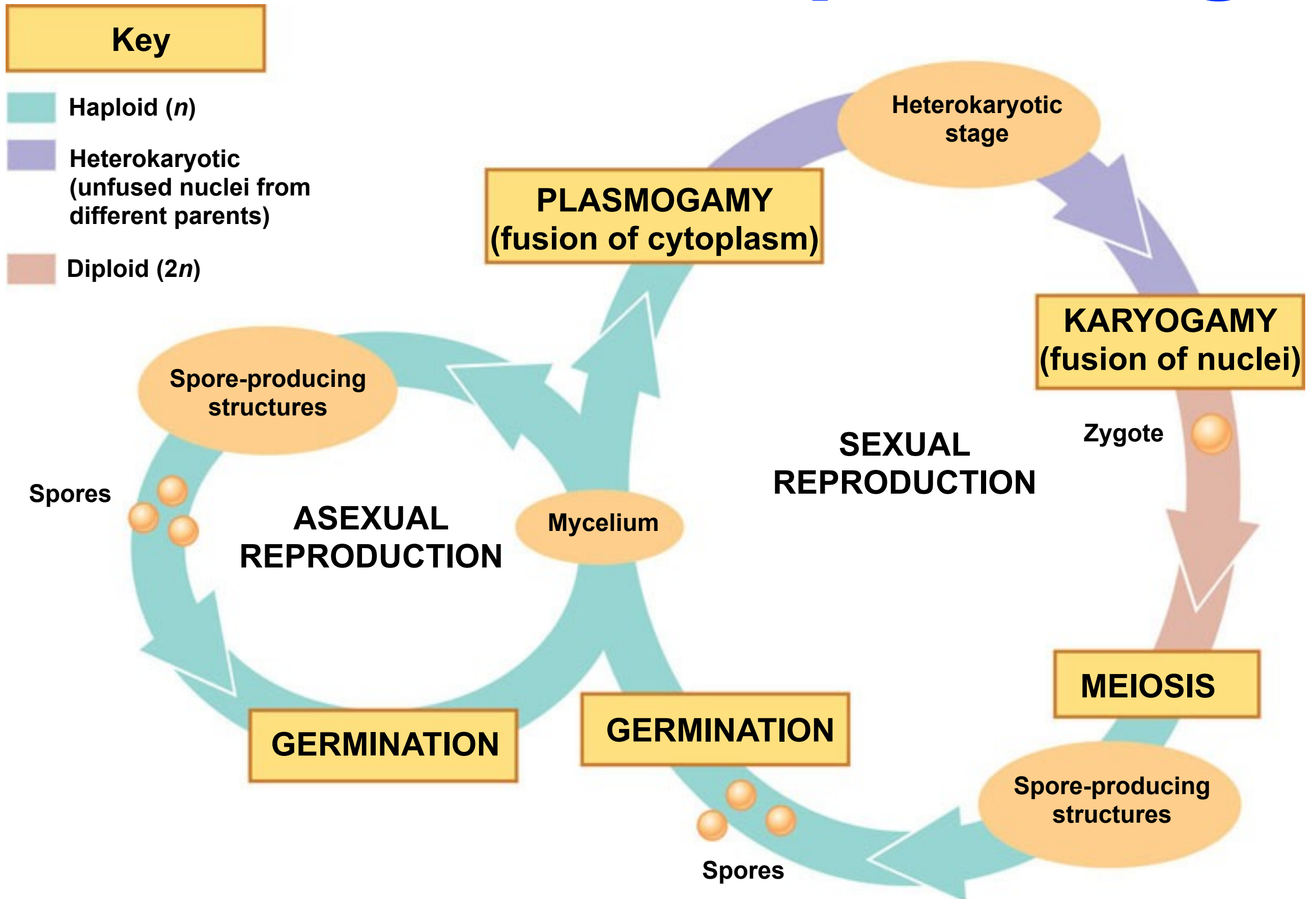
Fungi

Reproduction

Reproduction in Fungi

- Fungi produce spores through sexual or asexual life cycles.
 - Fungi can produce a vast number of spores
 - Spores are carried by wind or water and can travel long distances
 - Spores can germinate when they find a suitable environment, usually a moist one
 - Spores are everywhere...just leave some bread on the counter and return days later to find black bread mold consuming the bread

Generalized Life Cycle: Fungi



Sexual Reproduction

- Most fungal spores are haploid.
- Fungal hyphae of different “mating types” (instead of male or female) seek each other using pheromones.
- The two cytoplasms of hyphae/mycelia will fuse (plasmogamy) but the nuclei do not initially fuse
 - The hyphae/mycelia remain dikaryotic anywhere from a few days to a couple centuries
- When the two nuclei do fuse (karyogamy) the short lived diploid zygote undergoes meiosis to restore the haploid condition, followed by the release of more haploid spores

Basidiomycetes

- When most think of mushrooms, they likely visualize mushrooms on pizza, or on their salad, or perhaps mushroom caps that spring up from the ground.
- In any case basidiomycetes is a group of familiar mushrooms and by examining their life cycle we can see and review common principles of fungal reproduction

Basidiomycetes



(a) Fly agaric (*Amanita muscaria*), a common species in conifer forests in the northern hemisphere



(b) Maiden veil fungus (*Dictyophora*), a fungus with an odor like rotting



(d) Puffballs emitting spores



(c) Shelf fungi, important decomposers of wood



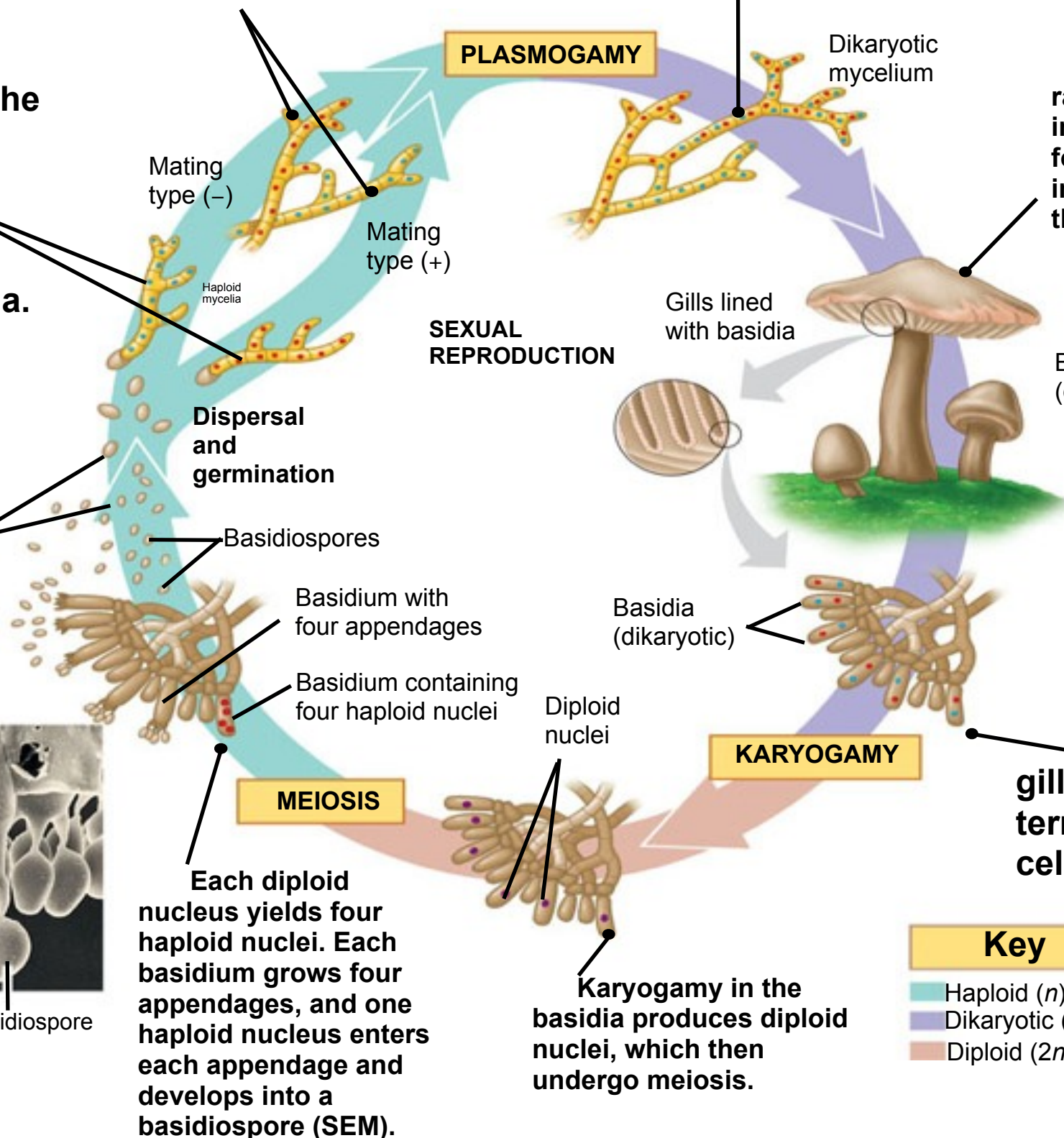
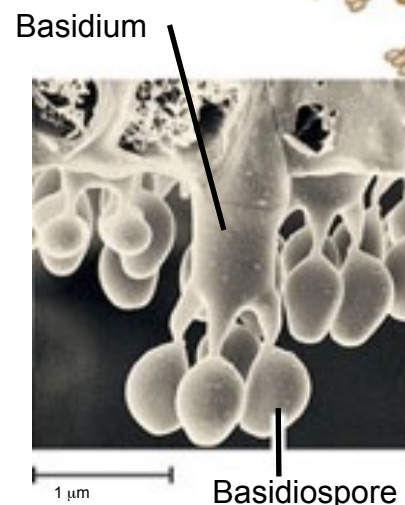
Basidiomycetes

A dikaryotic mycelium forms, growing faster than, and ultimately crowding out, the haploid parental mycelia.

Two haploid mycelia of different mating types undergo plasmogamy.

In a suitable environment, the basidiospores germinate and grow into short-lived haploid mycelia.

When mature, the basidiospores are ejected, fall from the cap, and are dispersed by the wind.



Environmental cues such as rain or temperature changes induce the dikaryotic mycelium to form compact masses that develop into basidiocarps (mushrooms, in this case).

Basidiocarp (dikaryotic)

Gills lined with basidia

Basidia (dikaryotic)

The basidiocarp gills are lined with terminal dikaryotic cells called basidia.

Key	
■	Haploid (n)
■	Dikaryotic ($n + n$)
■	Diploid ($2n$)

Karyogamy in the basidia produces diploid nuclei, which then undergo meiosis.

Each diploid nucleus yields four haploid nuclei. Each basidium grows four appendages, and one haploid nucleus enters each appendage and develops into a basidiospore (SEM).

Protists

Reproduction

Reproduction in Protists

- Reproduction in protists are highly varied.
- Some reproduce sexually, some asexually and yet others can reproduce either way.
- All 3 General life cycles are represented in protists, along with variations that do not quite fit any of the these three.

Bacteria

Reproduction

Reproduction in Bacteria

- Prokaryotes reproduce asexually and very quickly in favorable environments.
- Ideal conditions bacteria can reproduce every 1-3 hours.
 - some as fast as every 20 minutes and others slower every few days.
- If ideal conditions were unlimited, a single bacteria could produce a colony that outweighed the earth in two days.

In reality reproduction is limited...nutrients limited, waste becomes toxic, they are consumed, competition increases, etc

Reproduction in Bacteria

- Prokaryotes are small, they have short generations and reproduce by binary fission.
- As a result bacterial colonies can approach the trillions, they reproduce at incredible rates and adapt quickly to environmental challenges.



Binary Fission

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- ① A young cell at early phase of cycle
- ② A parent cell prepares for division by enlarging its cell wall, cell membrane, and overall volume. Midway in the cell, the wall develops notches that will eventually form the transverse septum, and the duplicated chromosome becomes affixed to a special membrane site.
- ③ The septum wall grows inward, and the chromosomes are pulled toward opposite cell ends as the membrane enlarges. Other cytoplasmic components are distributed (randomly) to the two developing cells.
- ④ The septum is synthesized completely through the cell center, and the cell membrane patches itself so that there are two separate cell chambers.
- ⑤ At this point, the daughter cells are divided. Some species will separate completely as shown here, while others will remain attached, forming chains or doublets, for example.

