MATERI KULIAH IPA-3
JURUSAN PENDIDIKAN IPA
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM

UNIT I:
PLANT AND ANIMAL REPRODUCTIVE SYSTEM

Introduction – 5’

Latar Belakang

- Pada K-13 terdapat KD sebagai berikut :

3.2 Memahami reproduksi pada tumbuhan dan hewan, sifat keturunan, serta kelangsungan makhluk hidup

4.2 Menyajikan karya hasil perkembangbiakan pada tumbuhan

- Kemampuan apa saja yang harus dilatihkan ke siswa?
- Materi apa saja yang harus dipelajari siswa?
- Bagaimana kegiatan belajar yang sesuai dengan kemampuan dan materi tersebut?

Tujuan

Setelah mengikuti sesi ini, mahasiswa mampu:

- Memahami maksud Kompetensi Dasar (KD) dan lingkup materi dalam KD 3.2 Kelas IX
- Memahami konsep reproduksi pada tumbuhan dan hewan, sifat keturunan dan kelangsungan makhluk hidup
- Mengembangkan ide pembelajaran di sekolah yang sesuai dengan "kemampuan" dan "Konten Materi" pada KD 3.2 Kelas IX

Garis Besar Kegiatan

Introduction - 5'

- Dosen menyampaikan latar belakang, tujuan, dan garis besar langkah kegiatan.

Connection – 10'

- Recall : Pemahaman tentang Organ reproduksi tumbuhan dan hewan.

Application – 80'

- Observasi gambar struktur organ reproduksi tumbuhan dan hewan

Reflection – 3'

- Mengingat kembali:
  - Komponen "Kemampuan" dan "Konten Materi" apa saja yang terdapat pada KD 3.2

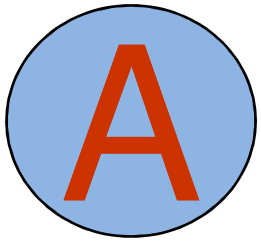
Extension/ Penguatan – 2'

- Baca buku Biologi Universitas mengenai reproduksi tumbuhan dan hewan
- penugasan

C Connection

Ungkap Pendapat (10')

- Apa saja penyusun putik dan benang sari??
- Bagaimana fungsi masing masing bagian tersebut?
- Apa saja jenis reproduksi pada hewan?
- Masih ingatkah jenis reproduksi aseksual pada hewan?



Application – 80'

Kemampuan apakah yang harus dikuasai siswa?
Materi apakah yang terkandung di dalamnya?

3.2 Memahami reproduksi pada tumbuhan dan hewan, sifat keturunan, serta kelangsungan makhluk hidup

4.2 Menyajikan karya hasil perkembangbiakan pada tumbuhan

Catatlah hasil amatan Saudara menggunakan kertas plano dengan format seperti berikut:

KD 3.3		KD 4.3	
Kemampuan	Materi	Kemampuan	Materi

Berbagi Gagasan

- Sajikanlah hasil diskusi kelompok Saudara kepada kelompok lain
- Kelompok lain: Berikan komentar, khususnya terkait KETEPATAN jawaban atas pertanyaan tadi.

SISTEM REPRODUKSI TUMBUHAN

- Vegetatif (asexual)

❖ Lebih sering terjadi pada Tumbuhan.

❖ Tidak melibatkan pertemuan gamet jantan dan gamet betina.

- Generatif (sexual)

❖ Terjadi baik pada Tumbuhan maupun Hewan

❖ Melibatkan pertemuan gamet jantan dan betina.

BEBERAPA CONTOH REPRODUKSI SECARA VEGETATIF ALAMI DAN BUATAN PADA TUMBUHAN

- Alami

1. **Tunas** (pisang, tebuh, pohon pinang dan bambu).
2. **Spora (**Lumut dan tumbuhan paku)
3. **Tunas adventif (**cocor bebek)
4. **Stolon / geragih** (pegagan, strawberry, semanggi)
5. **Rizoma / rimpang (**Kunyit, jahe, Bangle, lengkuas dan tebuh.
6. **Umbi batang** (kentang, ubi jalar)
7. **Umbi lapis** (bawang-bawangan dan bunga tulip).

- Buatan

Mencangkok

Menempel/Okulasi

Menyambung atau Enten

Merunduk

Stek

Kultur jaringan

Asexual Reproduction

- Asexual reproduction is natural “cloning.” Parts of the plant, such as leaves or stems, produce roots and become an independent plant.

Sexual Reproduction

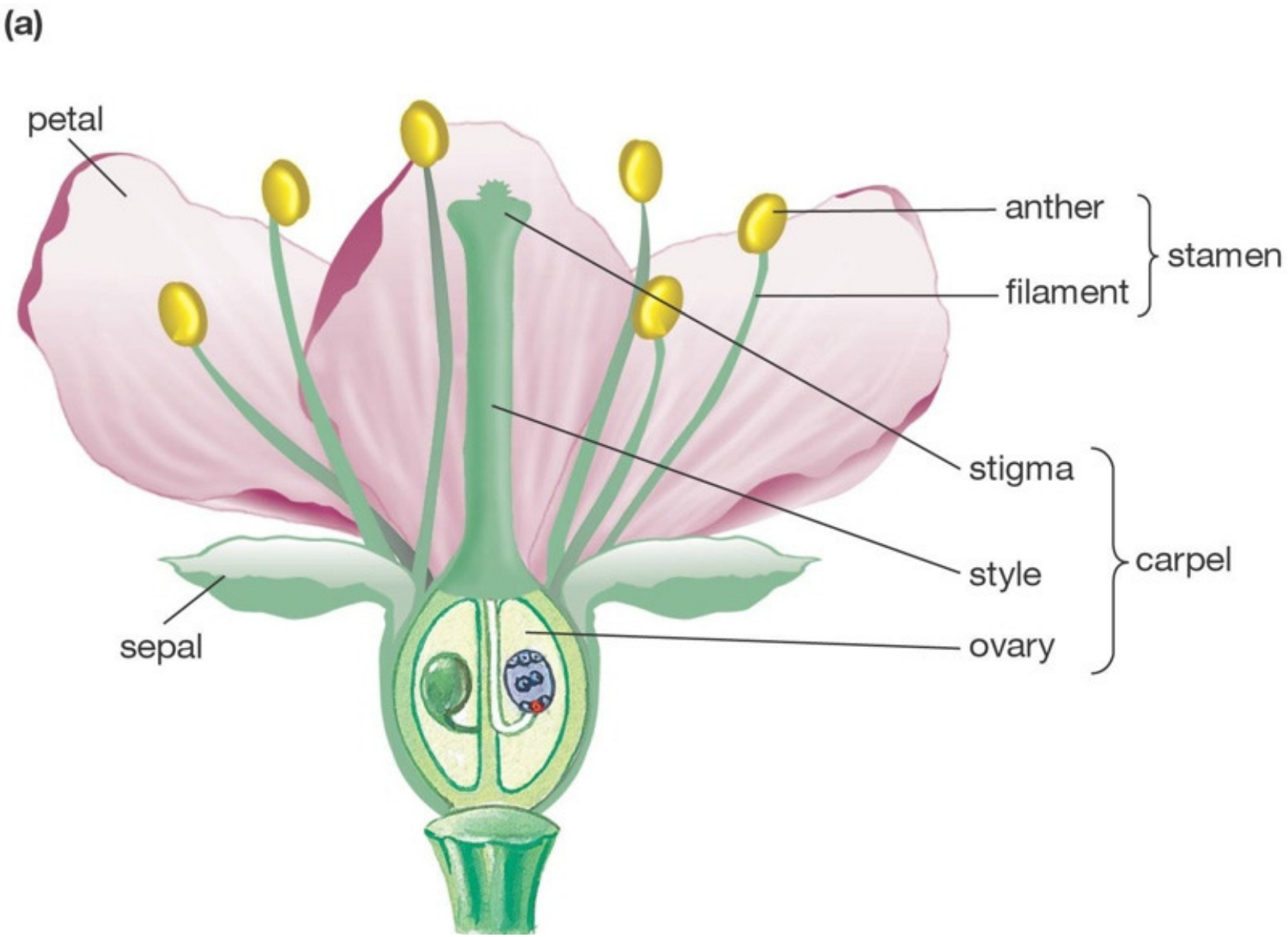
- Sexual reproduction requires fusion of male cells in the pollen grain with female cells in the ovule.

Pergiliran Keturunan

- Plants have a double life cycle with two distinct forms:
  - Sporophyte: produce diploid spores by mitosis.
  - Gametophyte: produce gametes by meiosis

Reproduksi Generatif pada Tumbuhan

Flower Parts

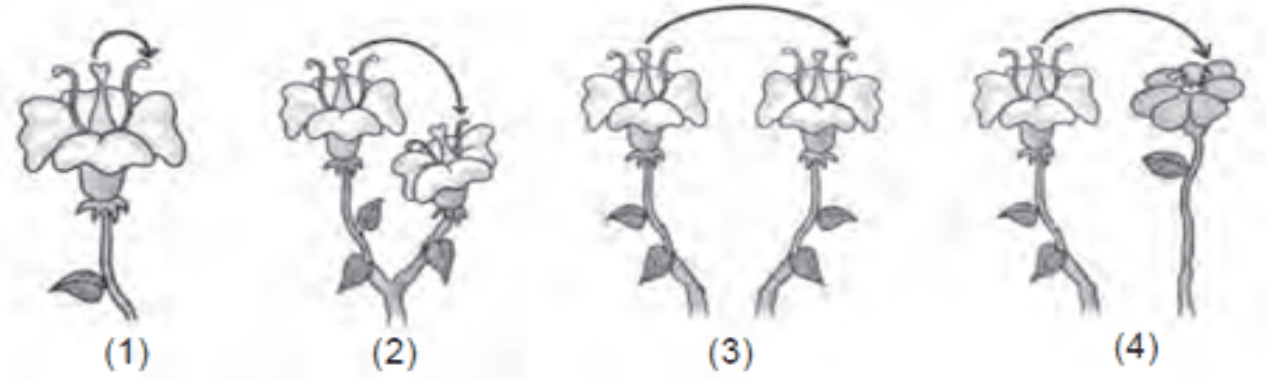


Klasifikasi Bunga

- Bunga lengkap dan bunga tak lengkap
- Bunga sempurna dan Bunga tidak sempurna

MACAM MACAM PENYERBUKAN BERDASARKAN ASAL SERBUK SARI

- Penyerbukan sendiri (autogami)
- Penyerbukan tetangga(geitonogami)
- Penyerbukan silang(allogami / xenogami)
- Penverbukan bastar (hvbridogami)



Penyerbukan pada tumbuhan meliputi penyerbukan (1) sendiri, (2) tetangga, (3) silang, dan (4) bastar.

MACAM MACAM PENYERBUKAN BERDASARKAN VEKTOR/PERANTARA.

- Anemogami (perantaraan angin).
- Hidrogami (perantaraan air).
- Antropogami (perantaraan manusia).
- Zoidiogami (perantaraan hewan).

siput : malakogami
serangga : entomogami
kelelawar : kiropterogami
burung : ornitogami

Perkembangan Generatif pada Tumbuhan

- **Konjugasi**, yaitu reproduksi generatif pada tumbuhan yang belum jelas alat kelaminnya. Contoh: *Spyrogyra* (ganggang hijau) yang koloninya berbentuk benang.
- **Isogami**, yaitu peleburan 2 sel gamet atau kelamin yang sama besar. Contoh:*Clamydomonas* (ganggang biru)
- **Anisogami**, yaitu peleburan 2 sel gamet yang besarnya tidak sama. Gamet 1 lebih kecil (mikrogamet) dan gamet 2 lebih besar (makrogamet). Contoh: *Ulva* (ganggang yang berbentuk lembaran).
- **Penyerbukan yang diikuti dengan pembuahan**. Terjadi pada tumbuhan berbunga (Antophyta) atau tumbuhan berbiji (Spermatophyta). Alat kelamin jantan berupa benang sari dan alat kelamin betinanya berupa putik.

MACAM – MACAM PEMBUAHAN

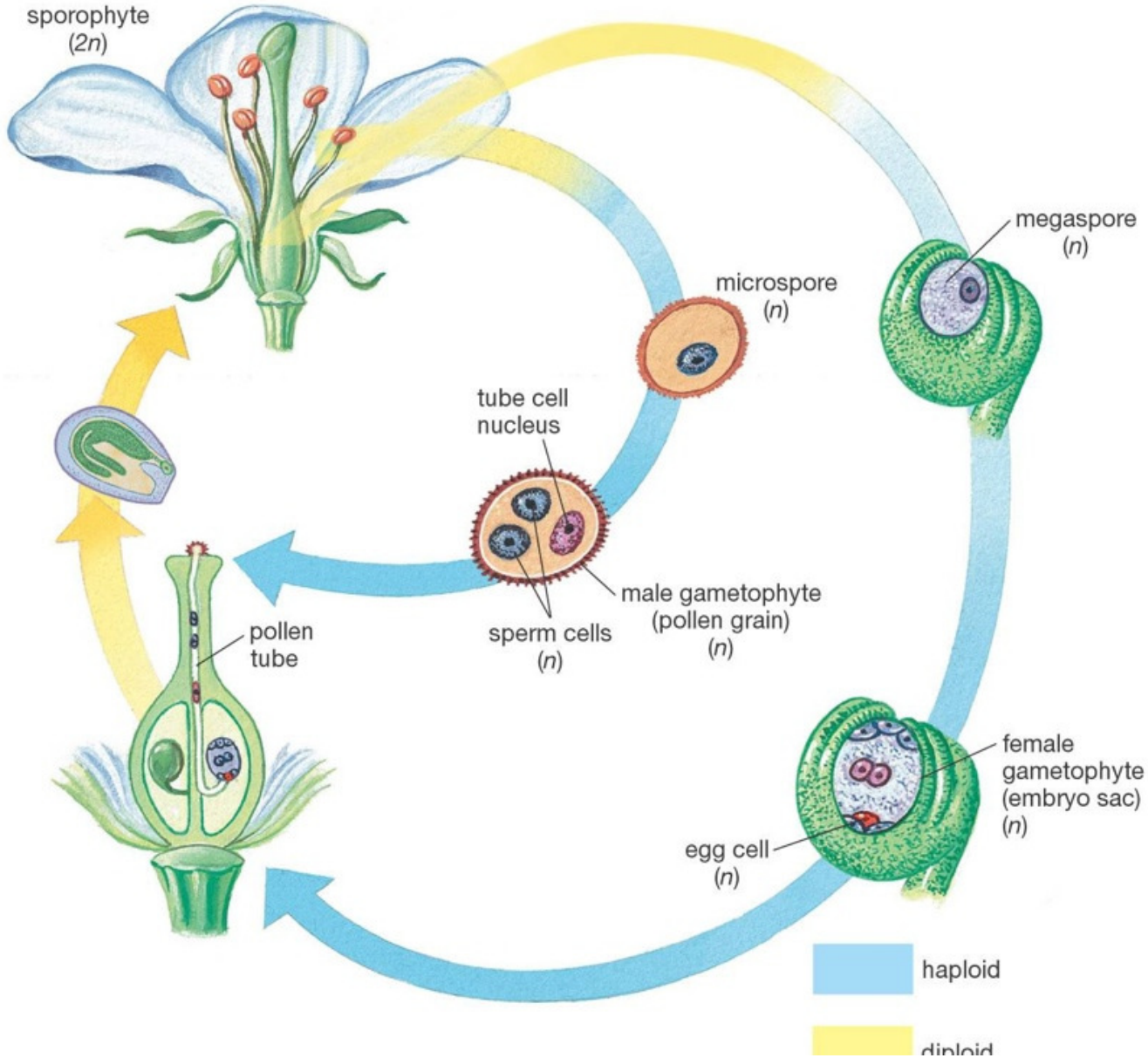
- GYMNOSPERMAE

  terjadi pembuahan tunggal (hanya terbentuk biji)

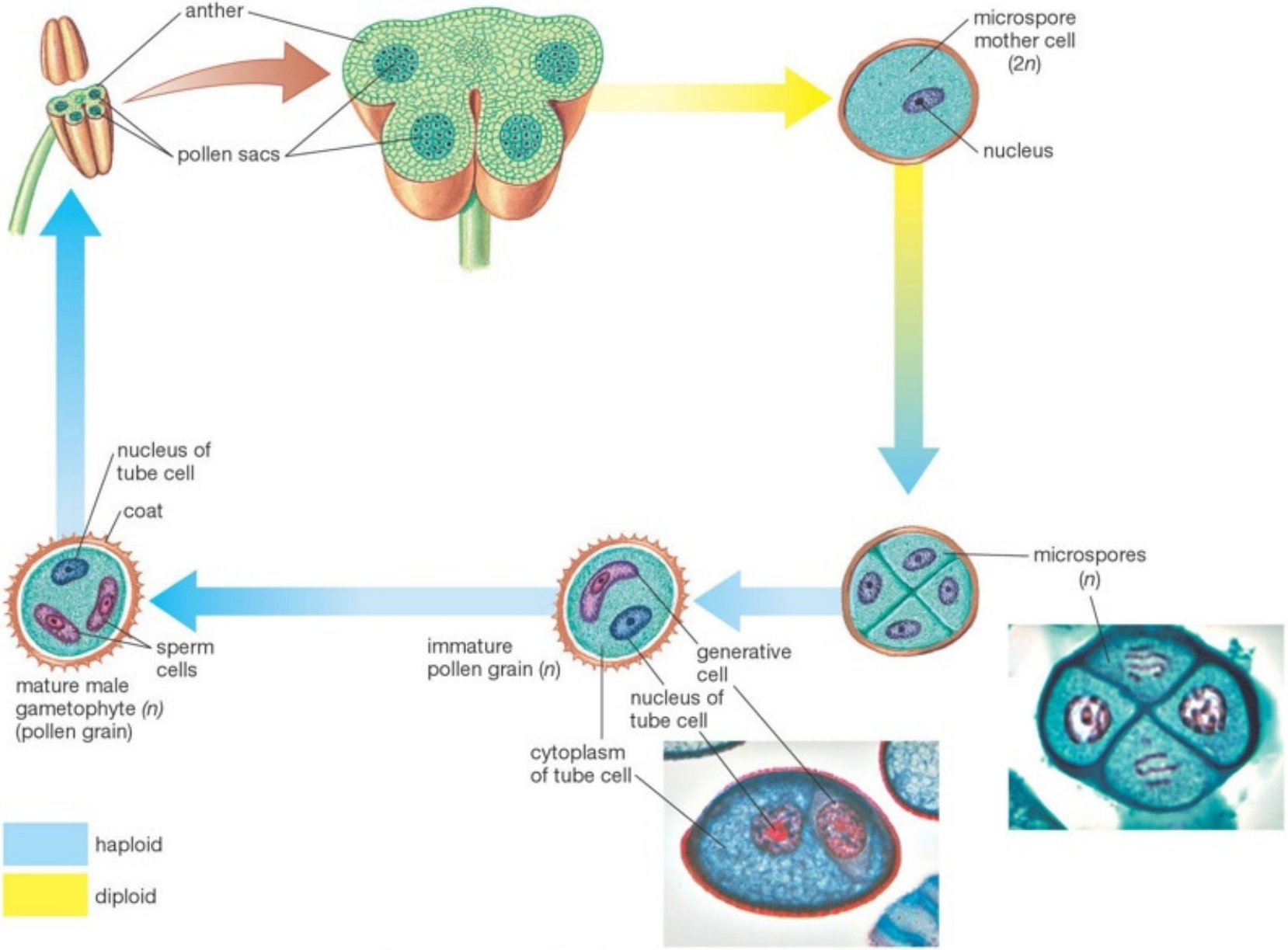
- ANGIOSPERMAE

  terjadi pembuahan ganda (terbentuk biji dan buah)

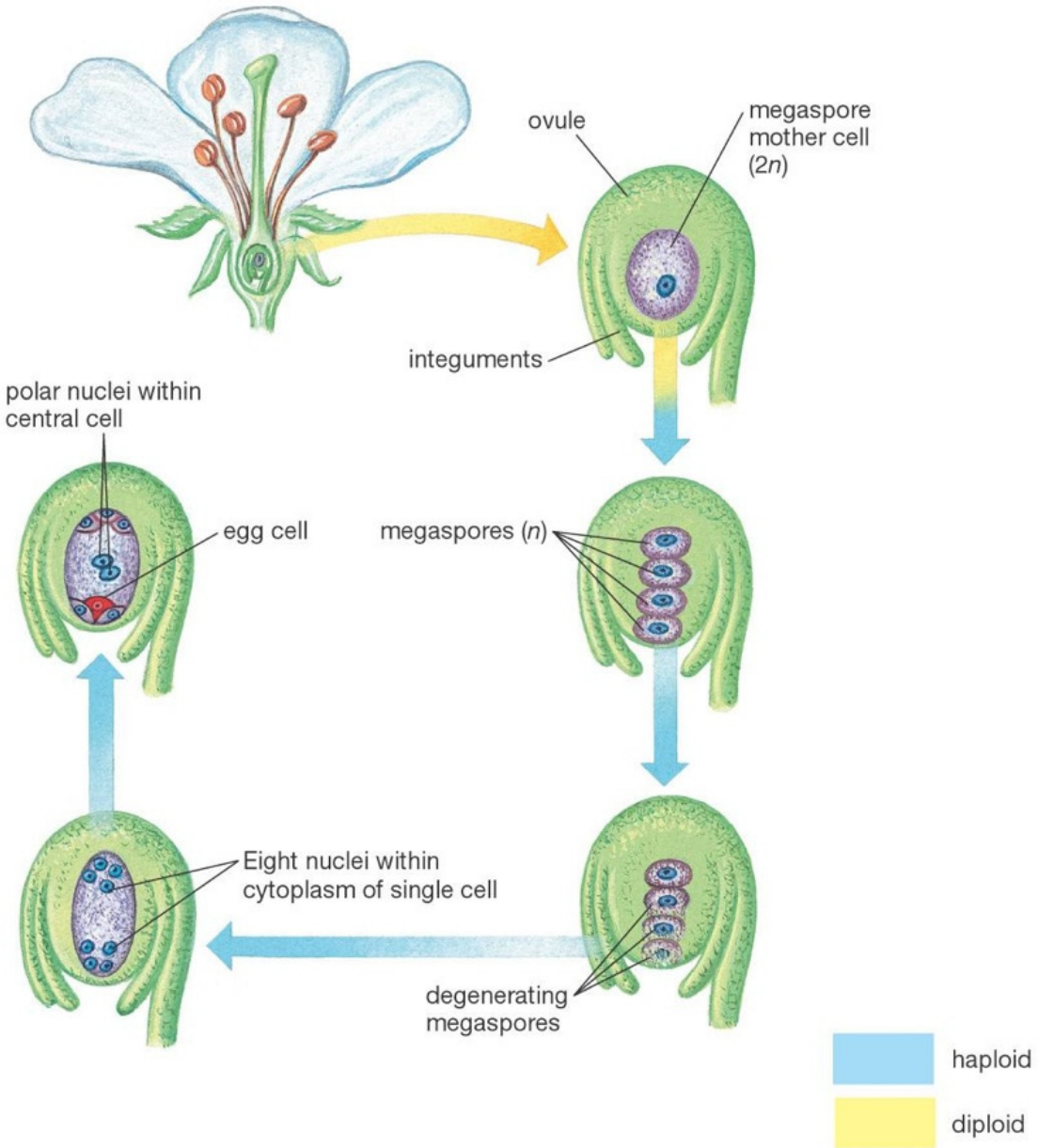
Angiosperm Life Cycle



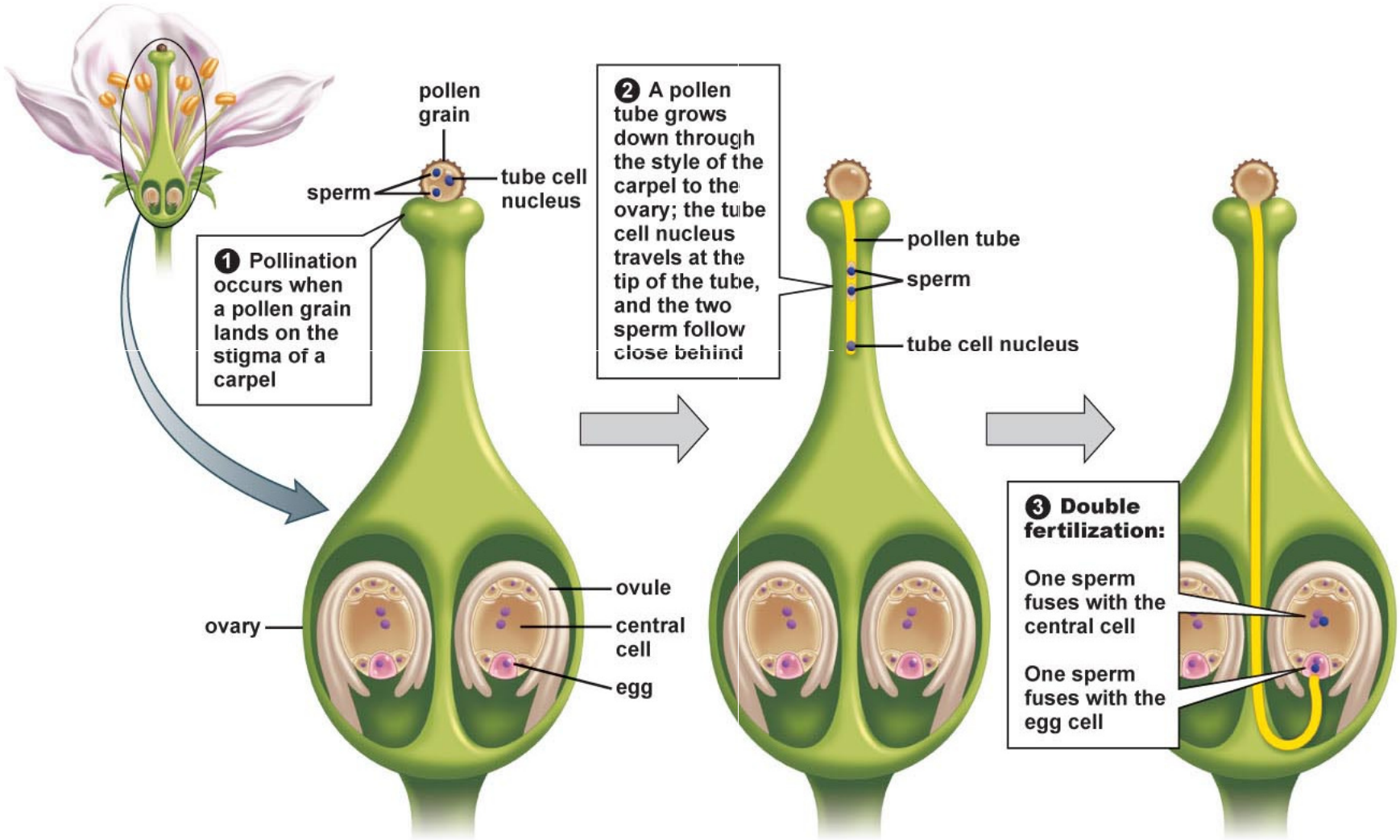
Gametogenesis: Male



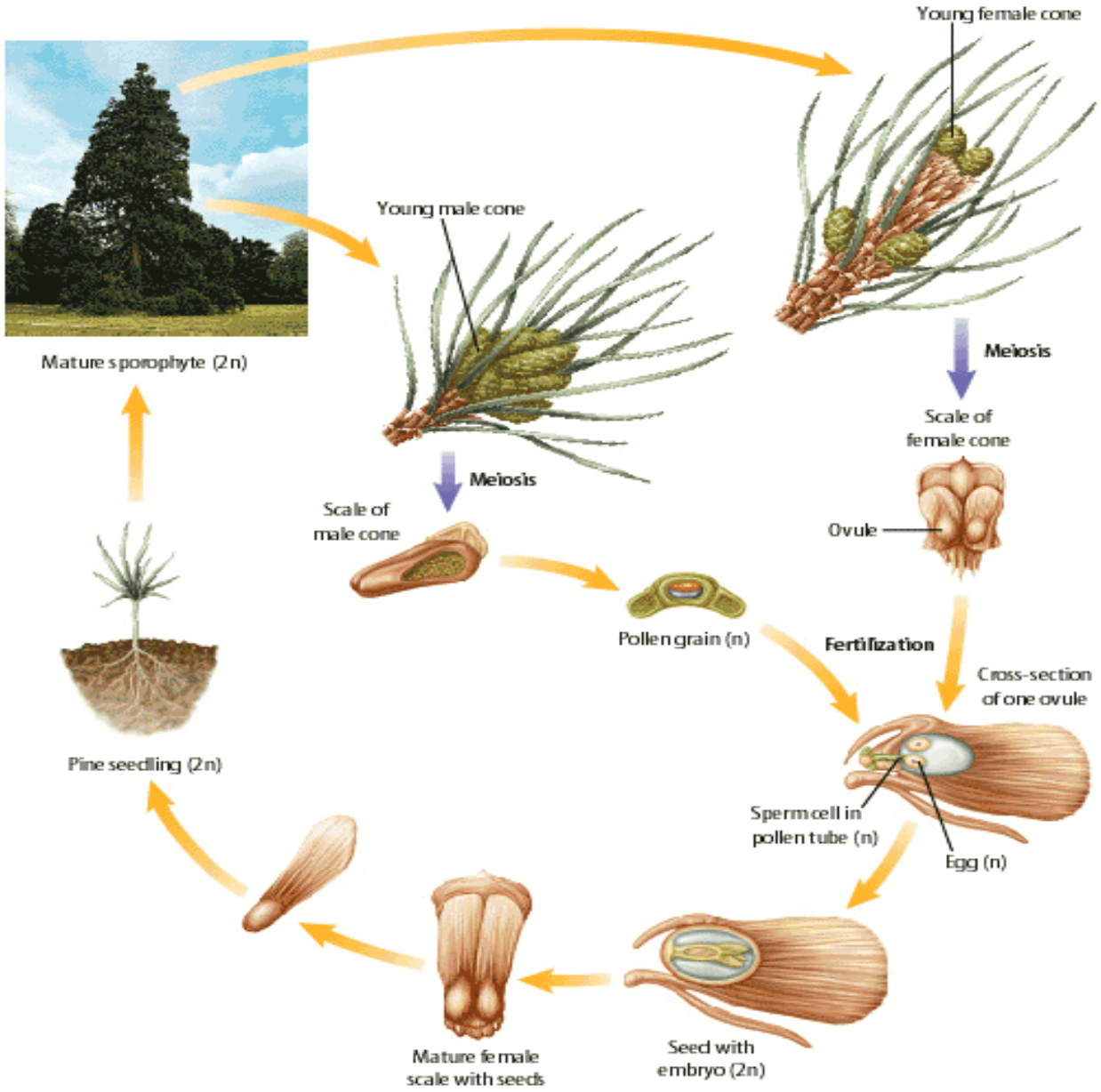
Gametogenesis: Female



Double Fertilization



LIFE CYCLE OF PINUS



STROBILUS

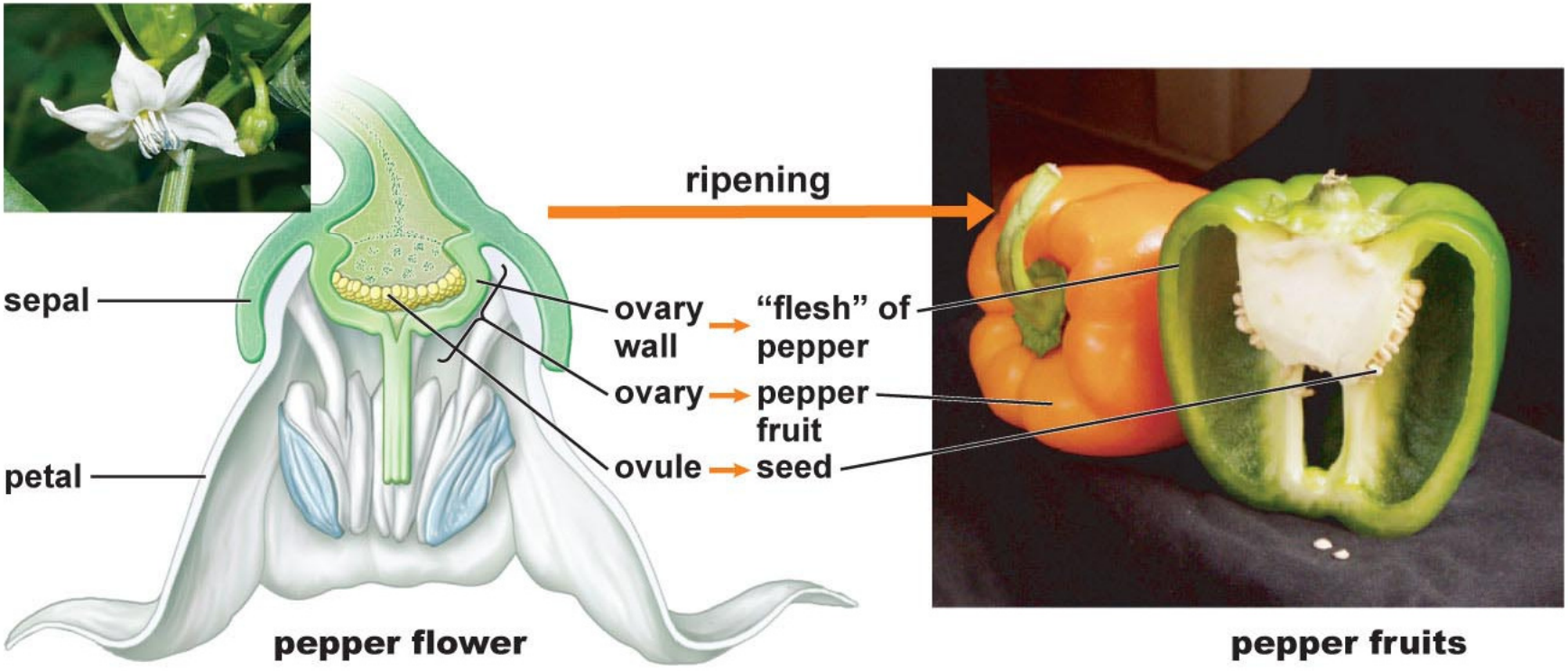
- Strobilus yang telah pecah.

- Strobilus yang belum pecah

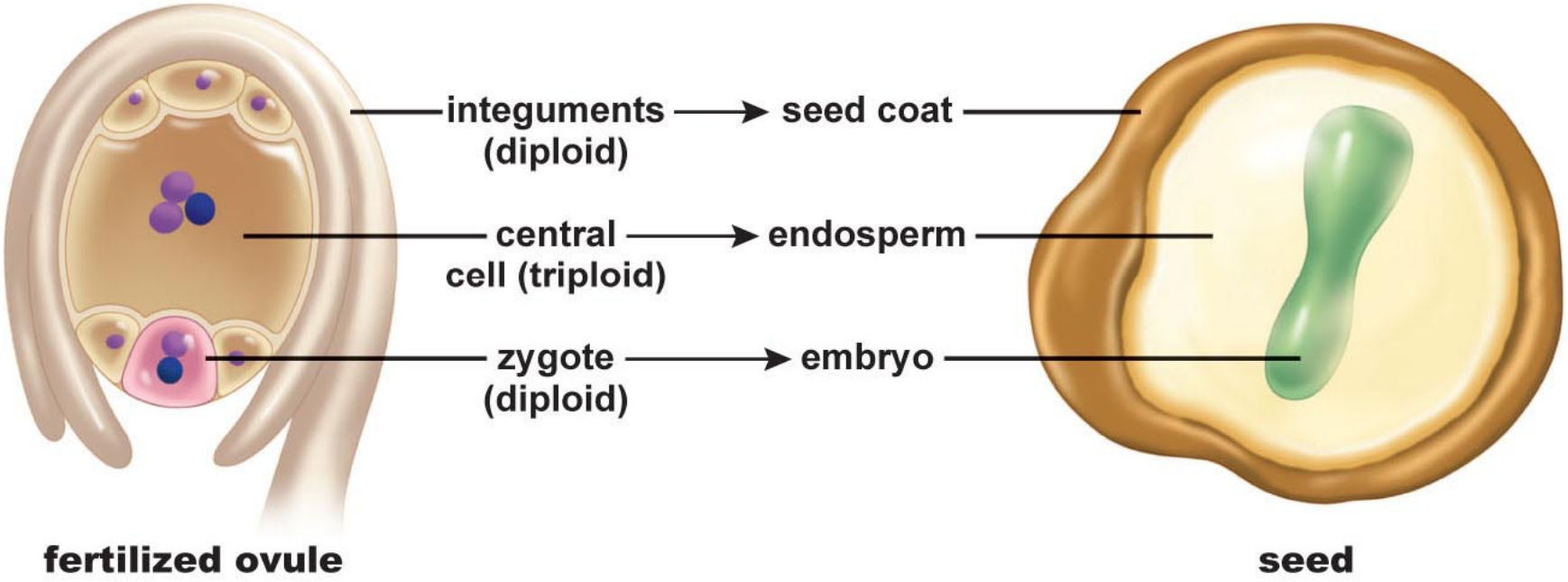
TUGAS KELOMPOK

- Tiap kelompok

Flower to Fruit

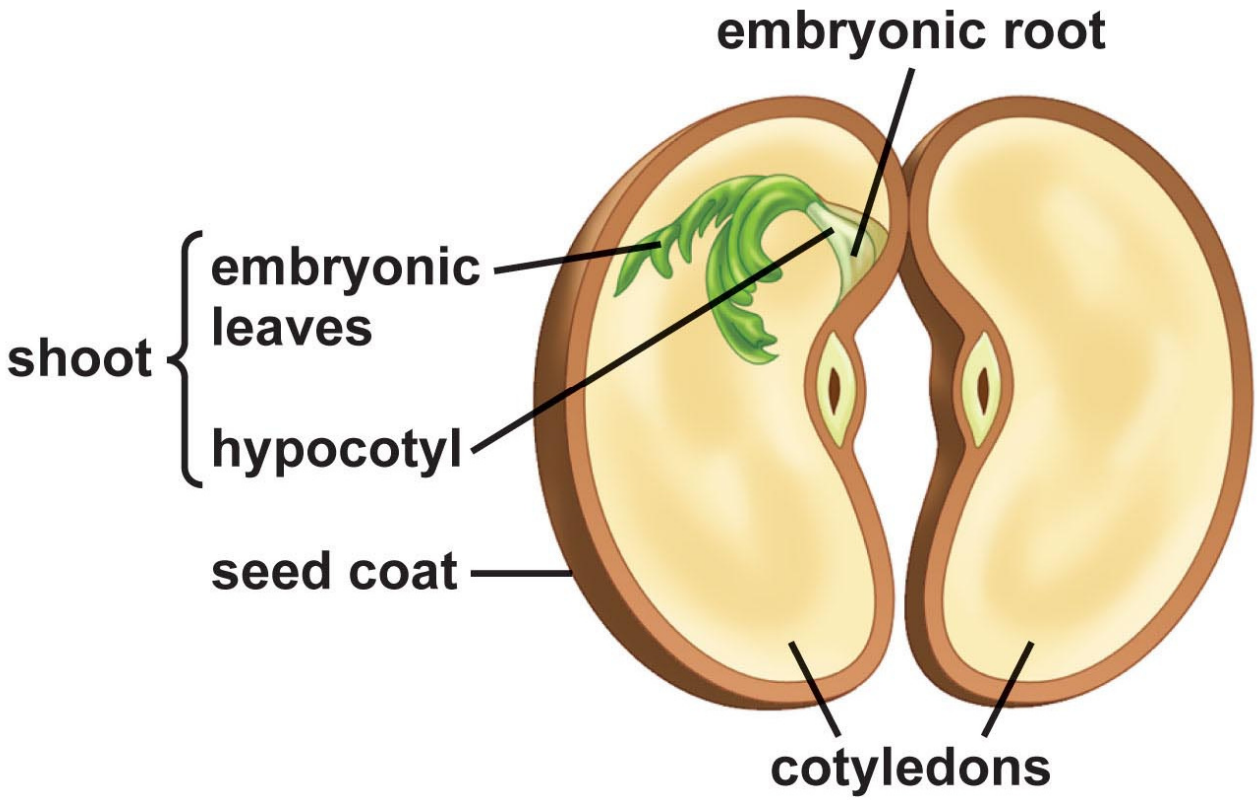


Ovule to Seed



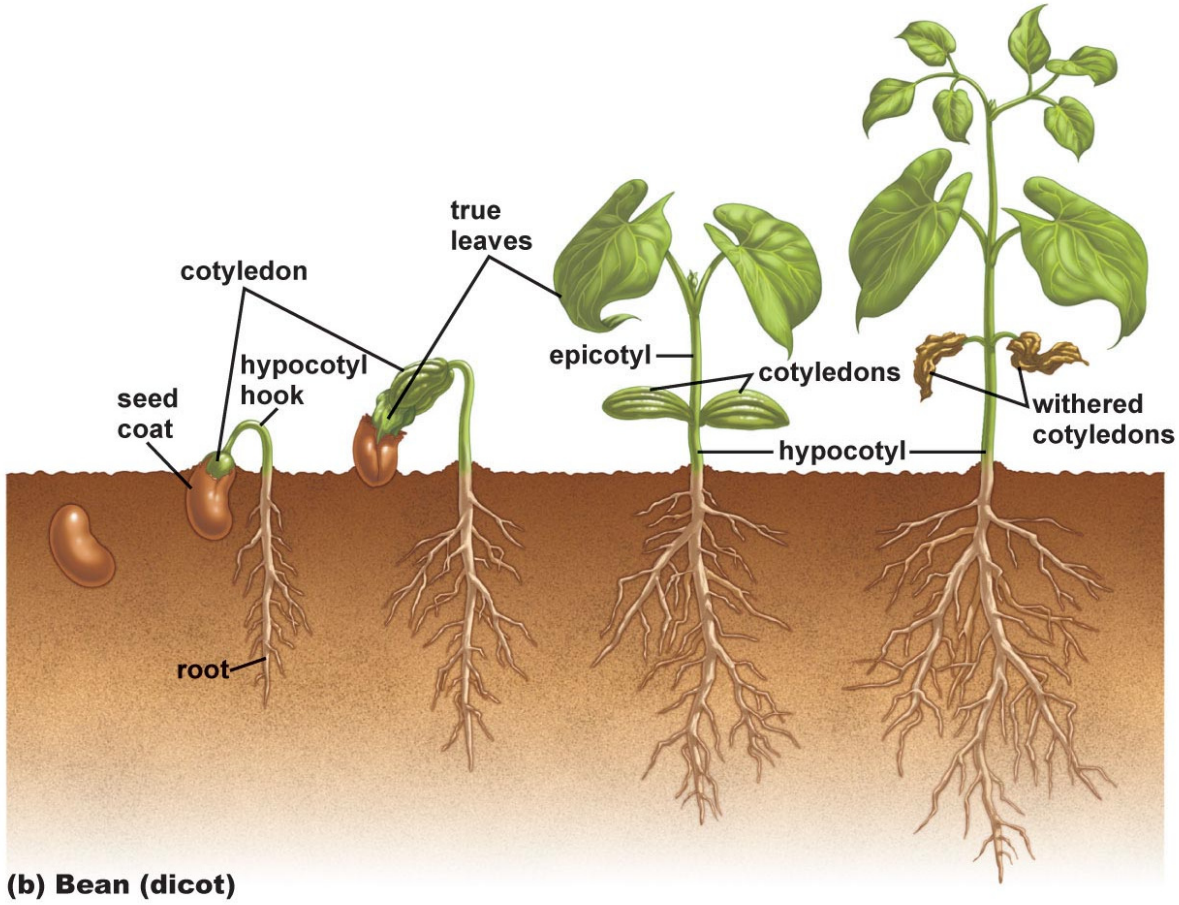
(a) Early development of the seed

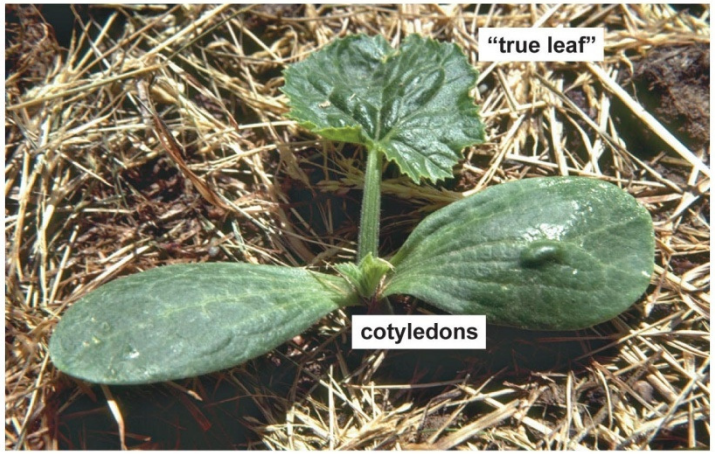
Seed Anatomy



(c) Bean seed (dicot)

Seed Germination





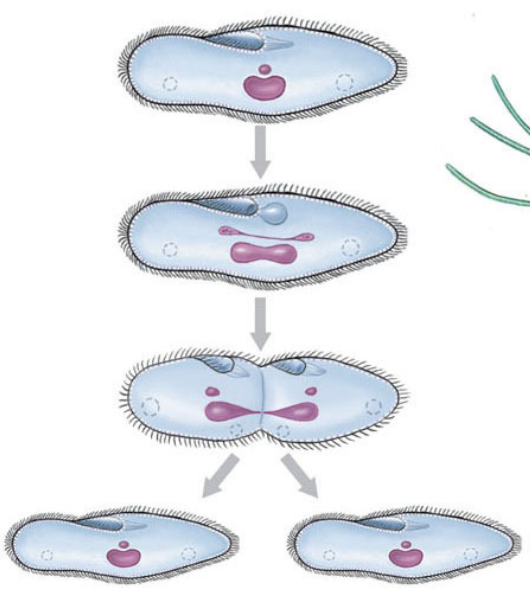
- Umbi bawang merah mengandung senyawa turunan asam amino yang mengandung sulfur yaitu Sikloalliin 2%, propilalliin dan propenilalliin. Bila sel-sel umbi pecah senyawa tersebut akan berubah menjadi bentuk ester (ester asam tiosulfinat), sulfinil disulfida (Kepaen), disulfida dan polisulfida, begitu juga tiofen. Di samping itu terbentuk pula propantial-S-oksida (suatu senyawa yang dapat menyebabkan keluarnya air mata).
  Disamping turunan asam amino, ditemukan pula adenosine dan prostaglandin.8,11)

- *www.wou.edu*
- *Buku solomon*

Animal Reproductive Process

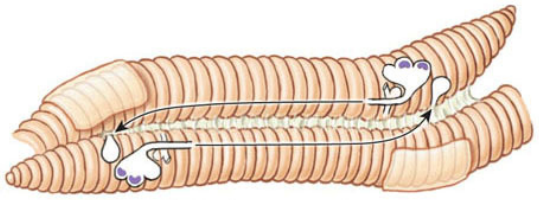
Reproduction

- **Reproduction** is one of the ubiquitous properties of life.
- **Evolution** is inextricably linked to reproduction.
- Two modes of reproduction are recognized:
  - **Asexual**
  - **Sexual**



A Binary fission in *Paramecium*

B Hydra budding



C Earthworms mating

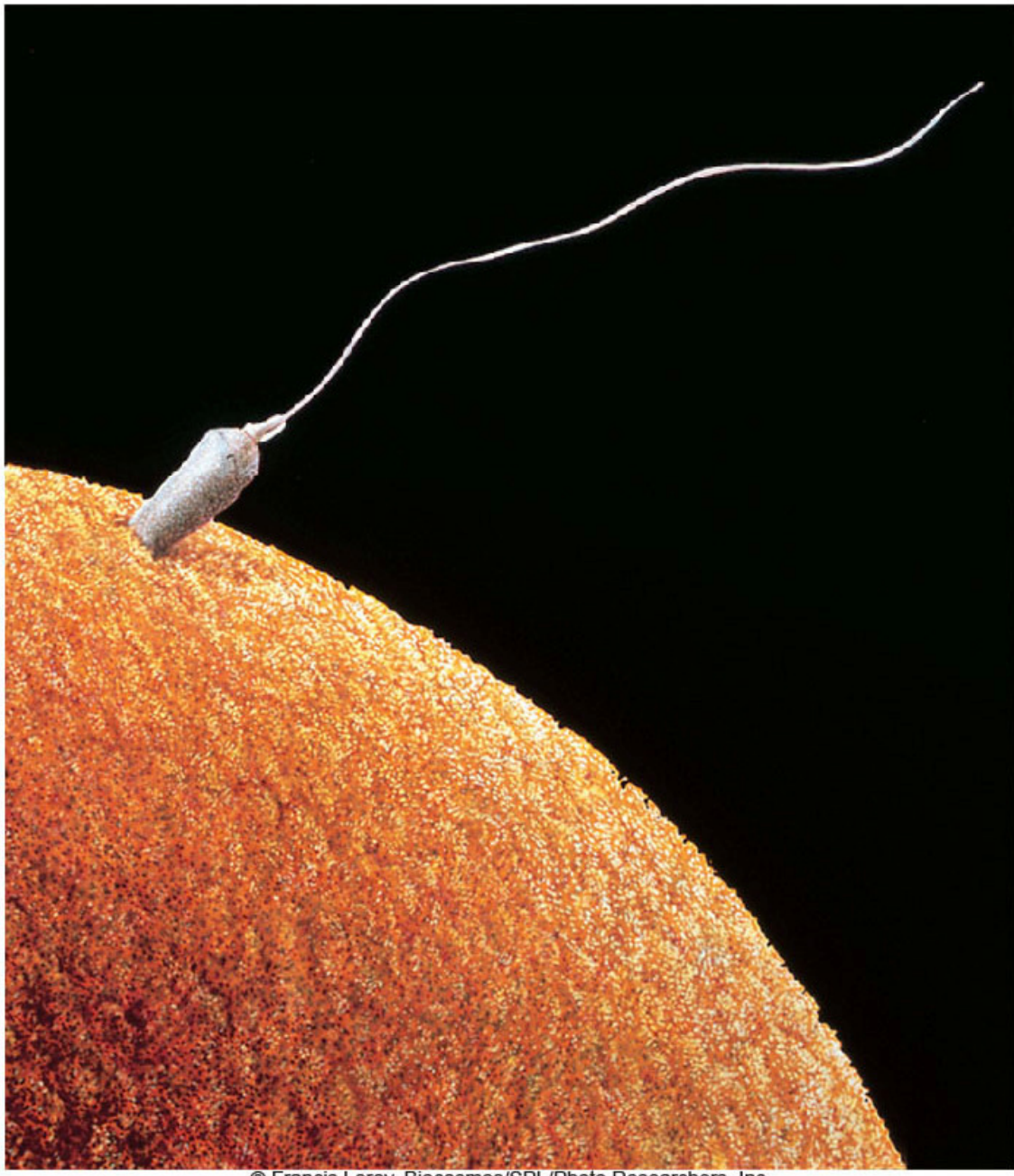
D Frogs in amplexus

Asexual vs. Sexual Reproduction

- **Asexual reproduction** – the production of offspring whose genes all come from one parent without the fusion of egg and sperm.
  - Usually diploid eggs are produced by mitosis which then develop directly.

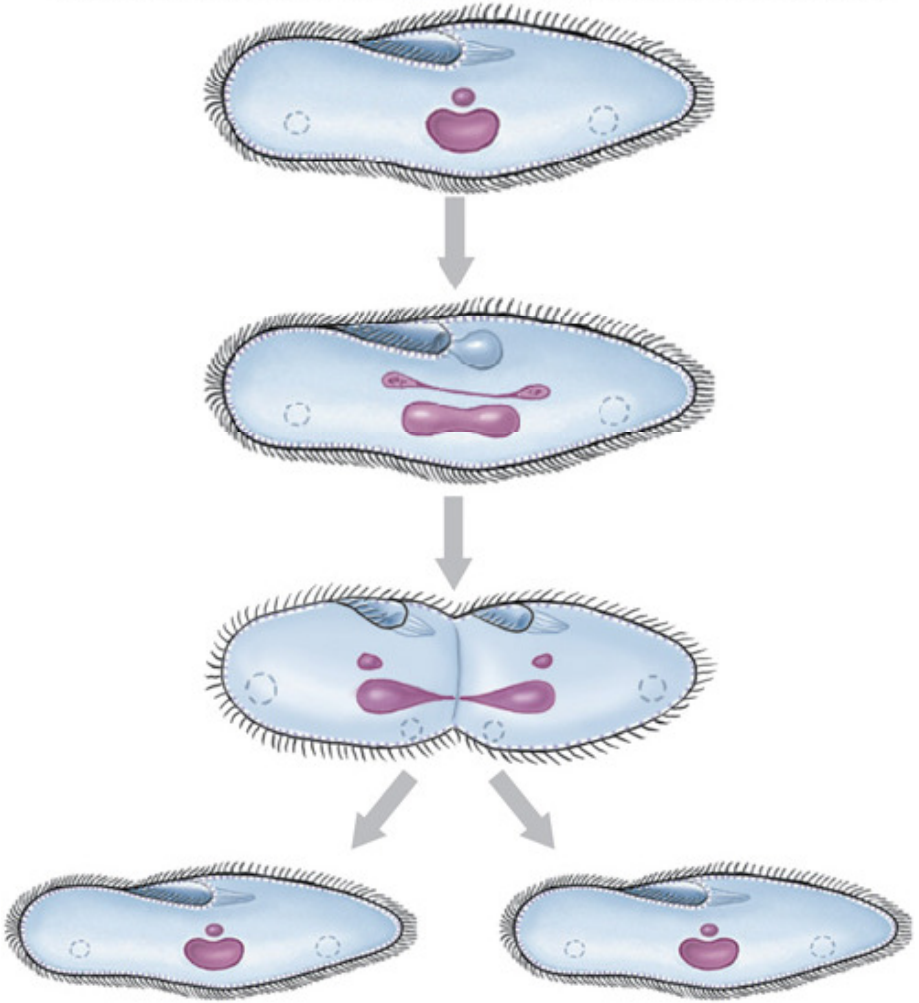
Asexual vs. Sexual Reproduction

- **Sexual reproduction** – the production of offspring by the fusion of haploid **gametes** (eggs & sperm) from two parents to form a diploid **zygote** (fertilized egg).
  - Gametes arise by meiosis.
  - Genetic variability is increased by the random combinations of genes from the parents.



Asexual Reproduction

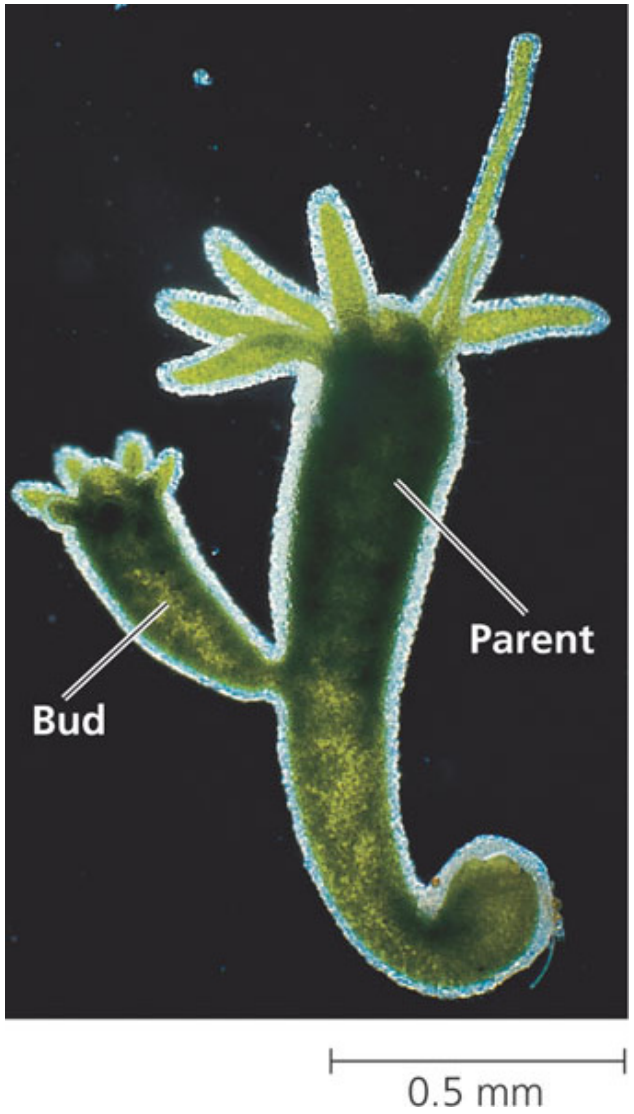
- Bacteria and many protozoa can reproduce by **binary fission** – separating into two or more individuals approximately the same size.



A Binary fission in *Paramecium*

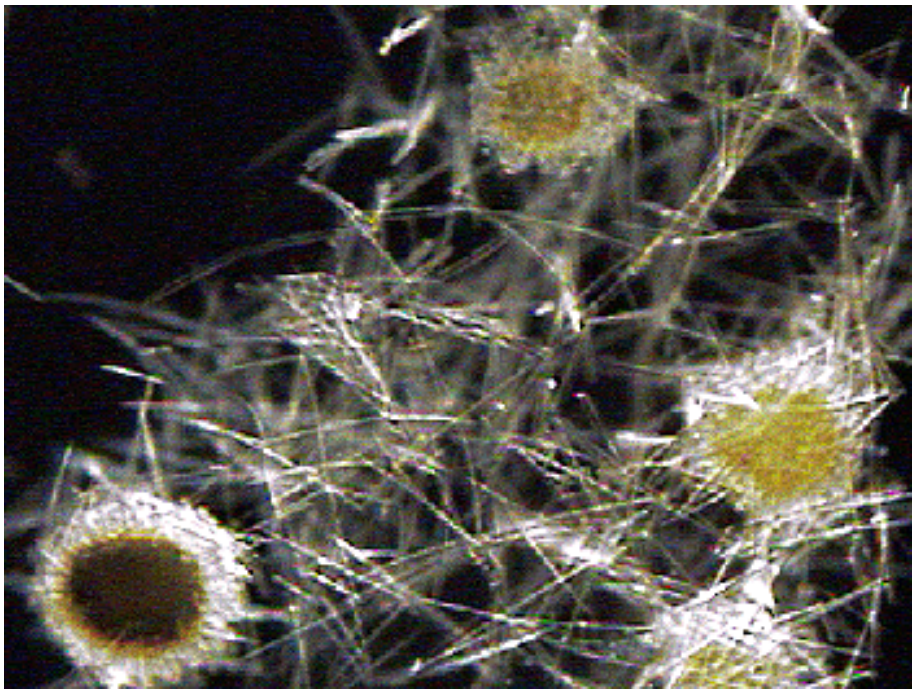
Asexual Reproduction

- **Budding** is a form of asexual reproduction where new individuals form as offshoots of a parent.
- The offspring may separate or remain attached to form colonies.



Asexual Reproduction

- Freshwater sponges release specialized groups of cells called **gemmules** that can grow into new individuals.



Asexual Reproduction

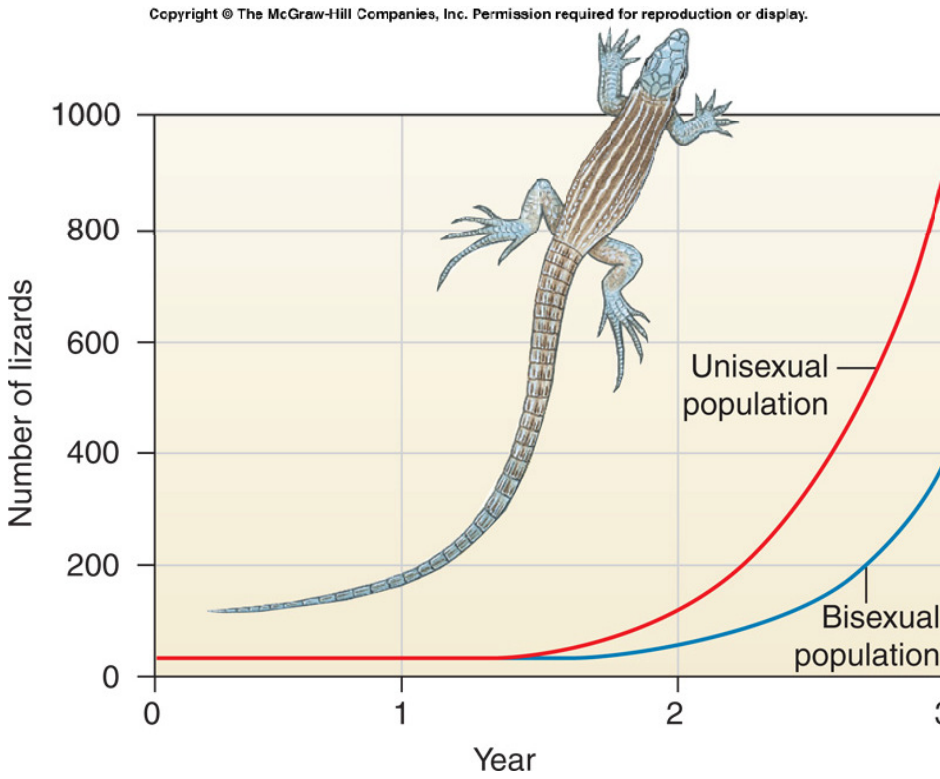
- **Fragmentation** results when an organism's body is broken into several pieces and each piece grows into a new organism.
  - **Regeneration** – the regrowth of lost body parts.

Asexual Reproduction

- Fragmentation occurs in some sponges, cnidarians, polychaete annelids, tunicates.
  - Sea stars can regenerate lost limbs, but only species in the genus *Linckia* can form new individuals from broken arms.

Asexual Reproduction - Advantages

- Animals living far from members of their own species can reproduce without having to search for a mate.
- Numerous offspring quickly – ideal for colonizing a new area.
- Advantageous in a stable, favorable environment because it reproduces a successful genotype precisely.



Sexual Reproduction

- Generally involves two parents.
- Special **germ cells** unite to form a **zygote.**
- Sexual reproduction recombines parental characters.
  - A richer, more diversified population results.
- In haploid asexual organisms mutations are expressed and selected quickly.
- In sexual reproduction a normal gene on the homologous chromosome may mask a gene mutation.

Sexual Reproduction

- Why do so many animals reproduce sexually rather than asexually?
- The costs of sexual reproduction are greater than asexual methods:
  - More complicated.
  - Requires more time.
  - Uses more energy.
  - The cost of meiosis to the female is passage of only half of her genes to offspring.
  - Production of males reduces resources for females that could produce eggs.

Sexual Reproduction

- However:
  - Sexual organisms produce more novel genotypes to survive in times of environmental change.
  - In crowded habitats, selection is intense and diversity prevents extinction.
  - On a geological time scale sexual lineages with less variation are prone to extinction.
  - Many invertebrates with both sexual and asexual modes enjoy the advantages of both.

Parthenogenesis

- **Parthenogenesis** involves the development of an embryo from an unfertilized egg or one where sperm & egg nuclei did not fuse.
  - **Ameiotic parthenogenesis** – no meiosis, egg is formed by mitosis (diploid)
  - **Meiotic parthenogenesis** – haploid ovum formed by meiosis, it may be activated by a male (or not).

Parthenogenesis

- In some animals (aphids (kutu daun), rotifers, *Daphnia (crustacea air tawar)*) the females can produce two types of eggs depends on environment condition.
  - One must be fertilized.
  - One type will develop directly into haploid adults – **parthenogenesis**.
    - Haploid females produce eggs by mitosis.(hewan dewasa yang dihasilkan bersifat haploid) dan sel-selnya tidak mengalami miosis dalam pembentukan telur baru.

Parthenogenesis

- *Daphnia* reproduce asexually (parthenogenesis) when conditions are favorable.
- pergantian reproduksi tergantung musim, reproduksi aseksual terjadi pada kondisi yang menguntungkan dan reproduksi seksual terjadi ketika adanya cekaman lingkungan.
- In times of environmental stress, they utilize sexual reproduction.
  - Increases variation!

Parthenogenesis

- In many social insects, like honeybees, males (drones) (lebah madu jantan) are haploid and are produced by **parthenogenesis** while females (workers & queens) develop from fertilized eggs.

Parthenogenesis

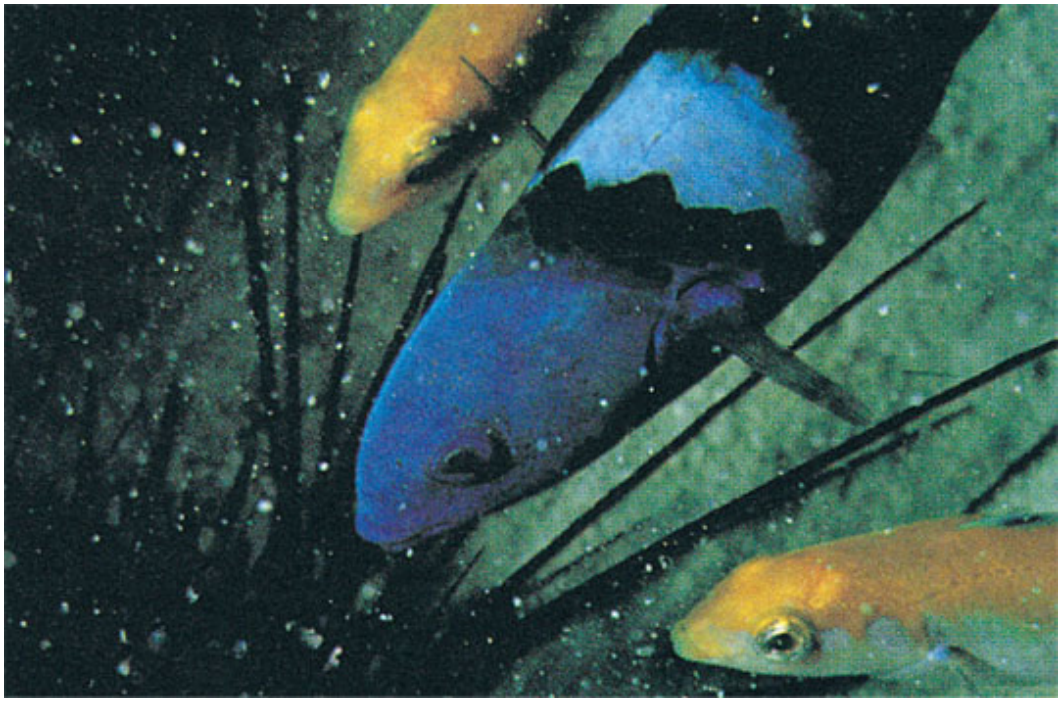
- Parthenogenesis occurs in vertebrates in some fishes, amphibians, lizards, and has recently been discovered in snakes.
  - After meiosis, the chromosomes are doubled, creating diploid “zygotes”.
  - Often mating behavior is required to stimulate development of offspring.
  - Bereproduksi melalui partenogenesis yang kompleks yang melibatkan penggandaan kromosom, contoh 15 spesies kadal.

Hermaphroditism

- **Hermaphroditism** occurs when an organism has both male and female reproductive systems.
  - **Monoecious**
  - Some can fertilize themselves.
  - Usually a mate is required – they can fertilize each other.

Sequential Hermaphroditism

- In **sequential hermaphroditism**, an individual reverses its sex during its lifetime.
  - In wrasses, sex reversal is associated with age, size and social conditions.
  - Fish are female first.
  - The largest female becomes male if the previous male dies.



Sequential Hermaphroditism

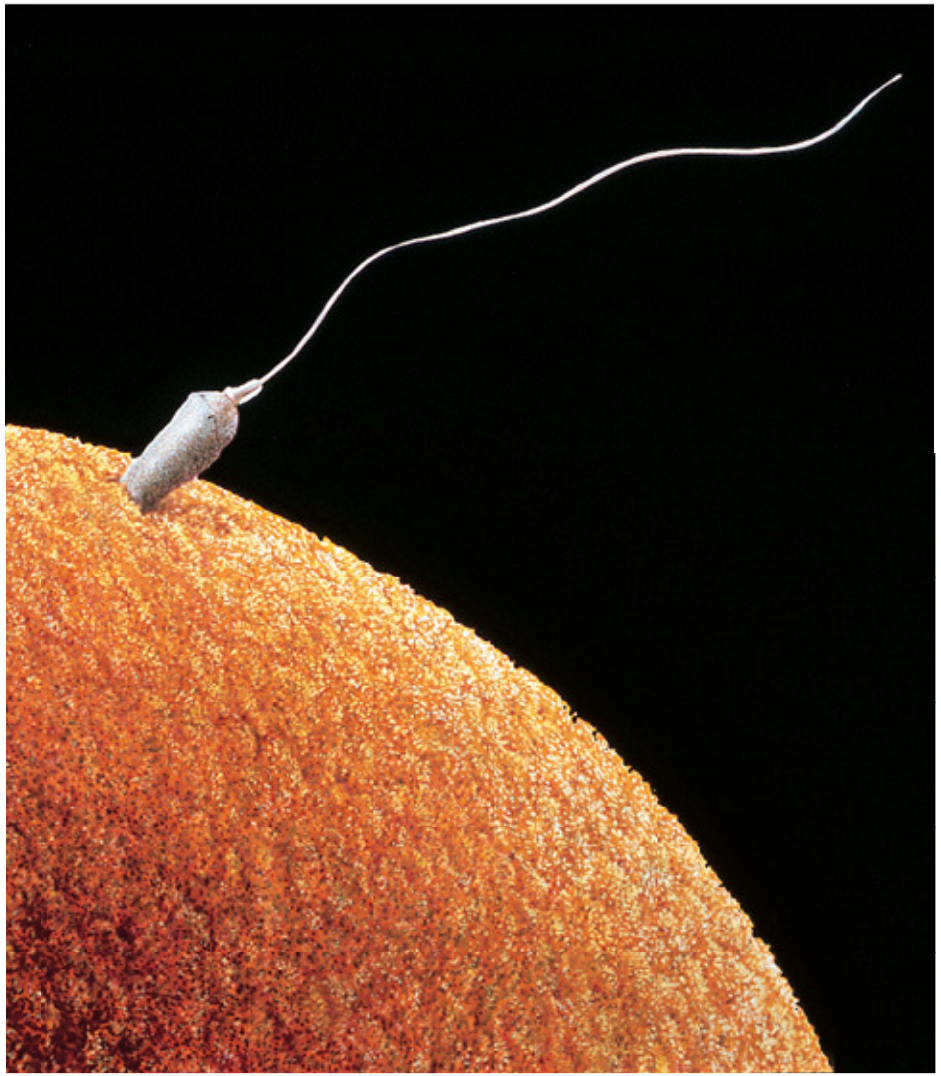
- There are also sequential hermaphrodites that are male first, later changing to female.
- This occurs in species that produce more eggs at a bigger size – so it is advantageous to have larger females.
  - Oysters

Perbalikan jenis kelamin pada ikan karang, wrasse

- Semua spesies pada ikan ini terlahir betina, tetapi indvidu yang tertua dan terbesar mengalami perubahan kelamin menjadi dan menyelesaikan kehidupannya sebagai jantan
- Perubahan jenis kelamin dikaitkan dengan ukuran tubuh

Fertilization

- **Fertilization** – fusion of egg and sperm into a single diploid cell, the **zygote**.
  - External
  - Internal



External Fertilization

- **External fertilization** – fertilization takes plac outside the female's body.
  - A wet environment i required so gametes don't dry out and so sperm may swim to the eggs.

Ensuring Survival of Offspring

- Species with external fertilization produce huge quantities of gametes that result in lots of zygotes.
  - Predation on young is high.
  - Few will survive to reproduce.

Ensuring Survival of Offspring

- Species with internal fertilization produce fewer zygotes, but protect them more from predation.
  - Tough eggshells
  - Embryo may develop in reproductive tract of female
  - Parental care of eggs & offspring

(Kutu air raksasa)

Perlindungan telur pada Kutu air raksasa

- Kutu air raksasa menghasilkan keturunan dalam jumlah relatif sedikit tetapi perlindungan dari induk meningkatkan kelangsungan hidup keturunan tersebut
- Fertilisasi internal dan betina menempelkan telur yang sudah dibuahi ke bagian belakang jantan
- Kutu air jantan membawa telurnya dan menjaganya supaya tetap lembab dan terhindar dari parasit.

Advantages of Sexual Reproduction

- Sexual reproduction has costs including finding mates, greater energy cost, reduced proportion of genes passed on to offspring, and slower population growth.
- However, sexual reproduction ***increases variability*** in the population – important during times of environmental change.

TUGAS kelompok

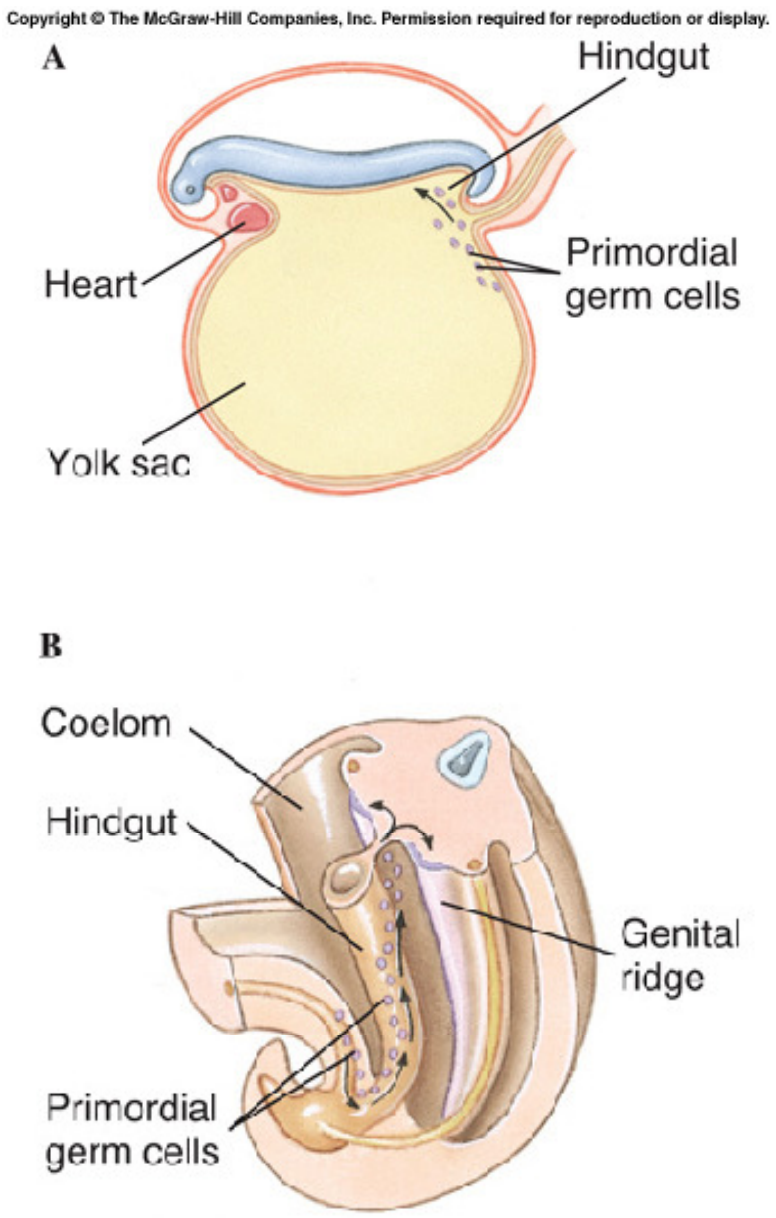
- TIAP KELOMPOK MEMBAHAS
- 1. PARTHENOGENESIS
- 2. BUDDING
- 3.FRAGMENTATION
- 4. BINER FUSION
- 5.EXTERNAL FERTILIZATION(ikan, katak)
- 6. Hermafrodit

Gamete Production & Delivery

- **Gametes** (eggs & sperm) are required for sexual reproduction.
- Usually, gametes are produced in **gonads** (ovaries & testes).
- **Germ cells** are set aside early in development. They will produce only gametes.

Migration of Germ Cells

- Germ cells arise in the yolk-sac endoderm of vertebrates – not in the gonads.
- They migrate to the gonads using amoeboid movement.



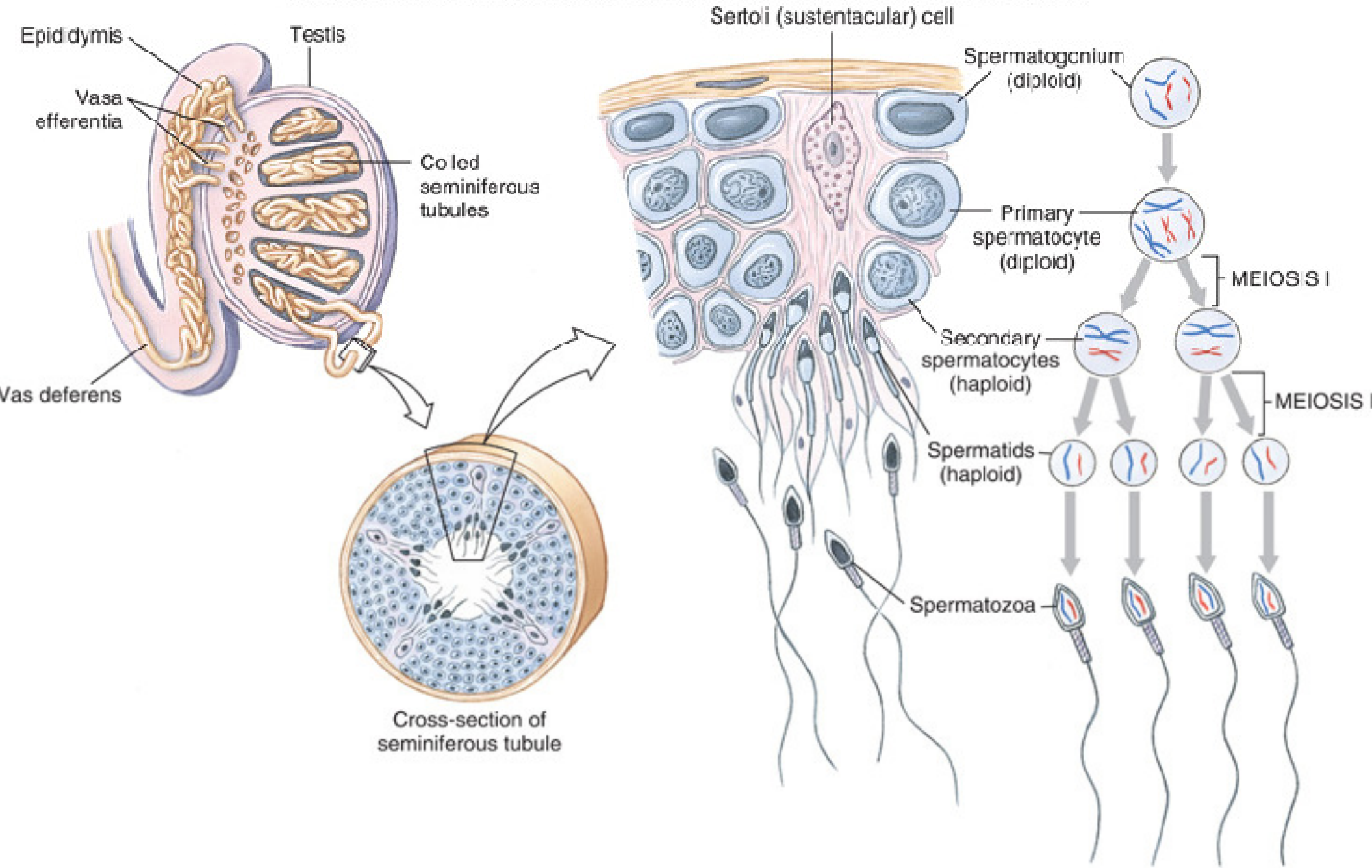
Gametogenesis

- **Gametogenesis** – the production of gametes.
  - **Spermatogenesis** – each primary spermatocyte divides to form 4 sperm.
  - **Oogenesis** – each primary oocyte divides to form 1 ovum and 2-3 polar bodies.
    - In oogenesis, cytokinesis is unequal, most of the cytoplasm goes to one daughter cell which becomes the ovum. The other cells, **polar bodies**, degenerate.

Spermatogenesis

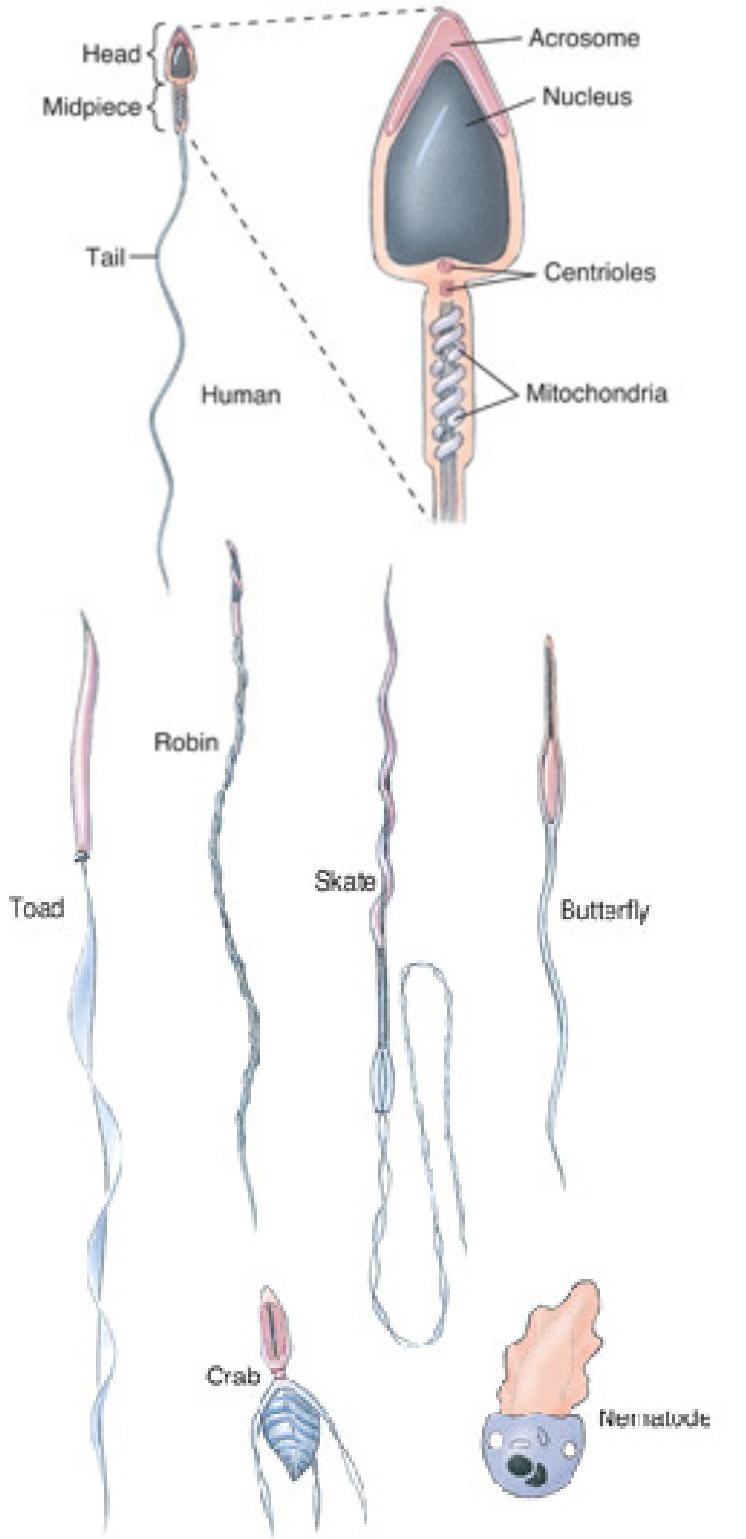
- Outermost layer of the **seminiferous tubules** contain **spermatogonia**, diploid cells that grow to become **primary spermatocytes**.
- After the first meiotic division, they are called **secondary spermatocytes**.
- When meiosis is complete the haploid cells are **spermatids**.

Spermatogenesis



Spermatogenes

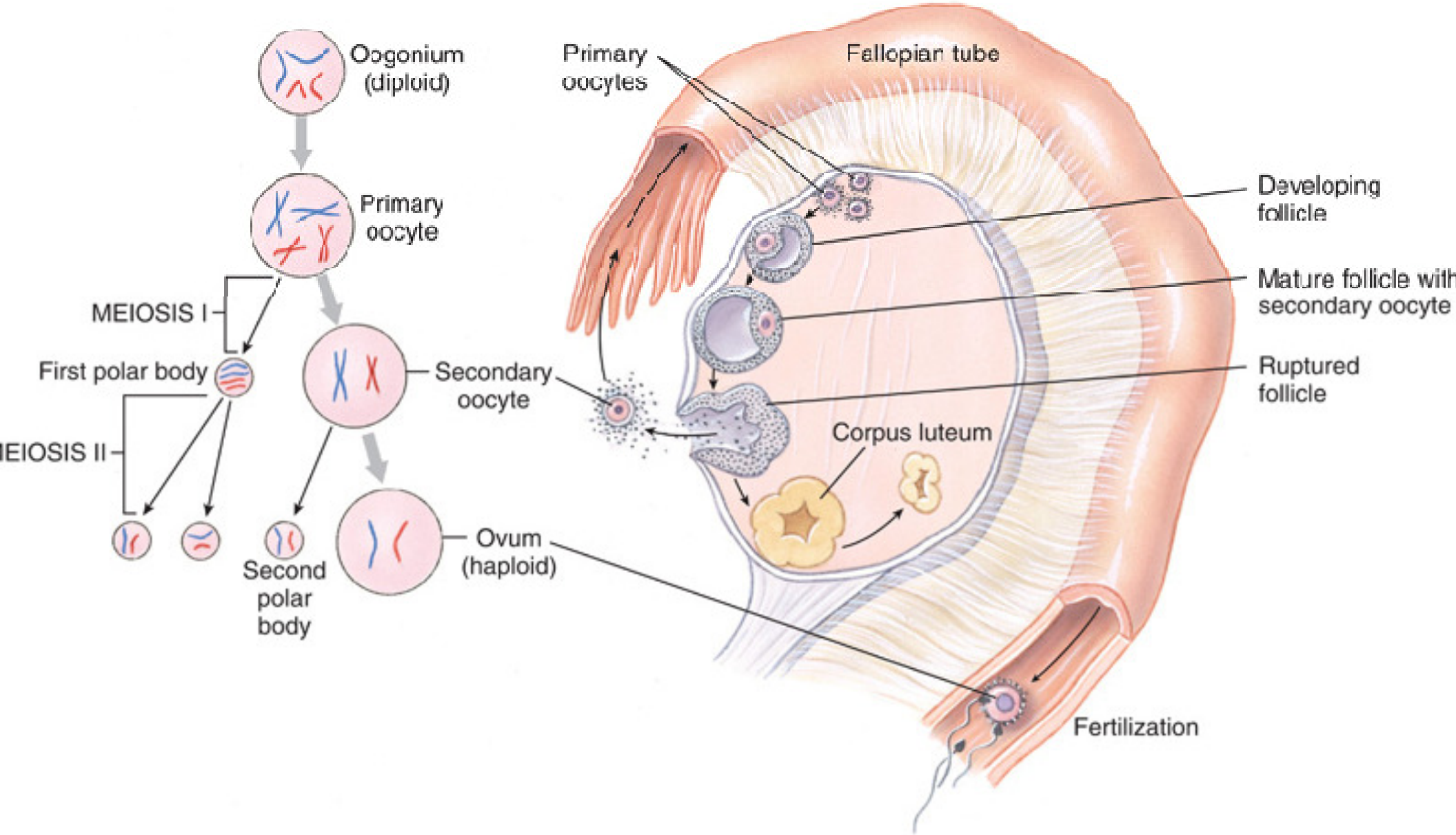
- Spermatids mature into motile sperm with a tail for locomotion, and a head containing an **acrosome** as well as the nucleus.



Oogenesis

- In the ovary, early germ cells called **oogonia** are diploid.
- Oogonia grow to become **primary oocytes**.
- After the first meiotic division, the cytoplasm divides unequally and only one **secondary oocyte** and one **polar body** result.
- Following the second meiotic division, one **ootid** and another polar body result.
- The ootid develops into a functional **ovum**.

Oogenesis



Oogenesis

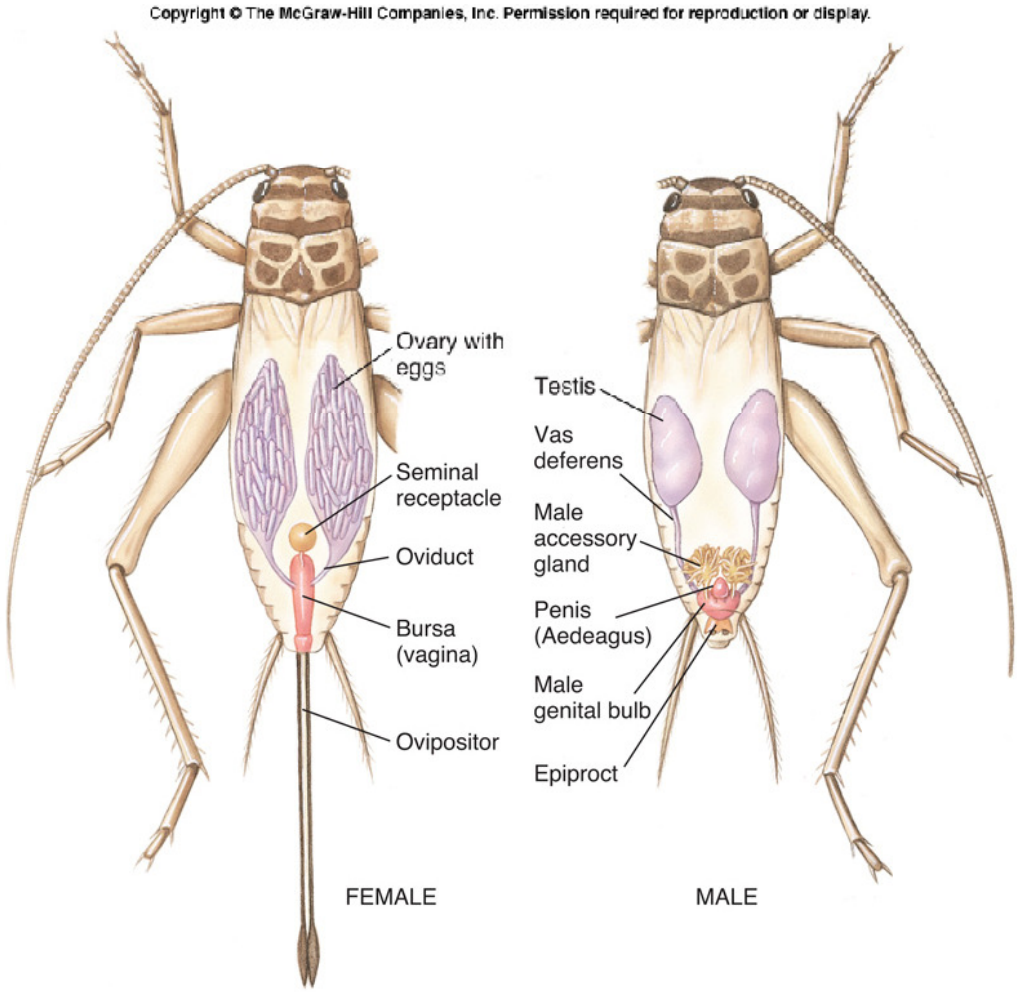
- Meiosis is usually arrested at the beginning of meiosis and is not completed until ovulation or fertilization.

Reproductive Patterns

- **Oviparous** – animals that lay eggs.
  - Most invertebrates, many vertebrates
- **Ovoviviparous** – animals that retain the eggs within their bodies. Nourishment comes from the egg.
  - Some annelids, insects, some fishes, reptiles.
- **Viviparous** – eggs develop in oviduct or uterus, nourishment from mother.
  - Mammals, some sharks, scorpions.

Invertebrate Reproductive Systems

- Many insects have separate sexes, internal fertilization and have complex reproductive systems.
  - Female crickets use long ovipositors to deposit eggs.

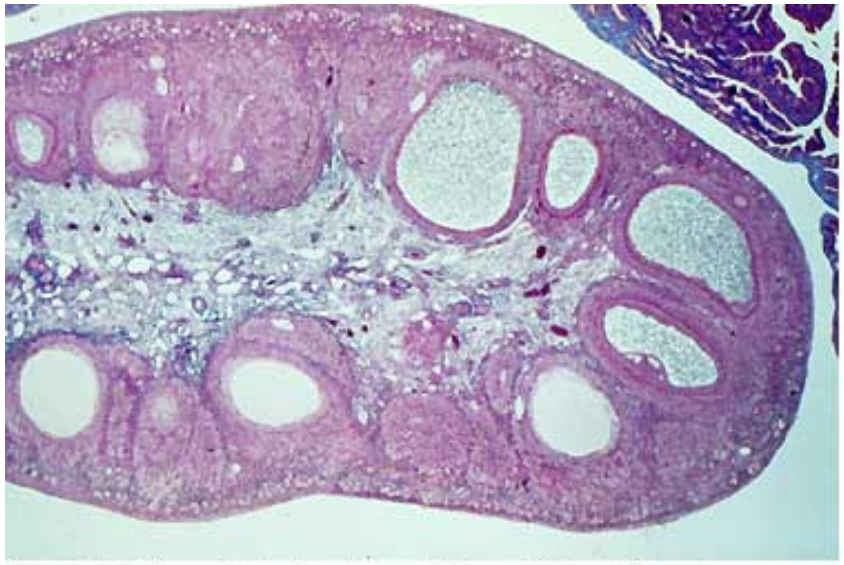


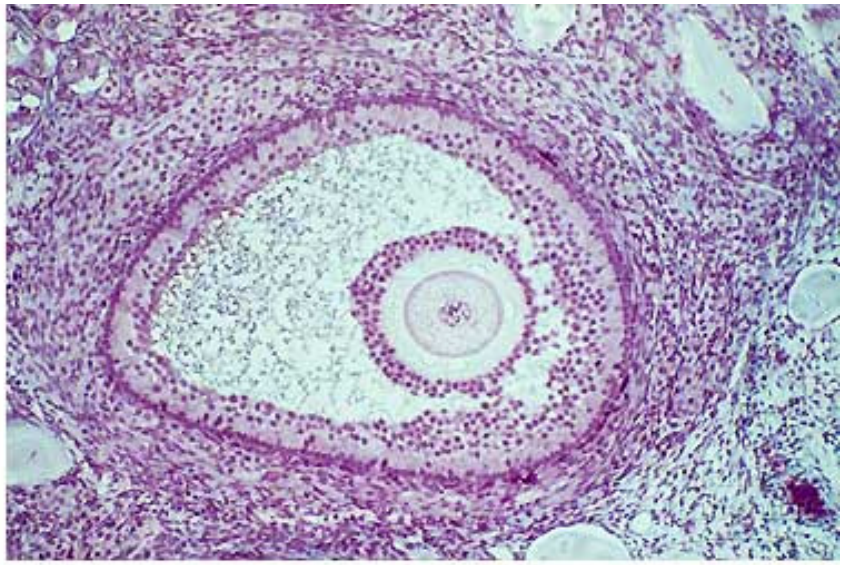
Gamete Production & Delivery

- In vertebrates, reproductive systems are similar with a few important variations.
  - Nonmammalian vertebrates usually have one combined opening, the **cloaca**, for the digestive, excretory, and reproductive systems.
  - The uterus is partly or completely divided into two chambers in most vertebrates.
    - Humans & other mammals with few young, birds & snakes have a single structure.

Female Reproductive System

- **Ovaries** are where female gametes, egg cells, are produced.
  - A **follicle** contains one egg cell as well as follicle cells that nurture the developing egg.
  - Most/all of the follicles a woman will produce have formed before birth.



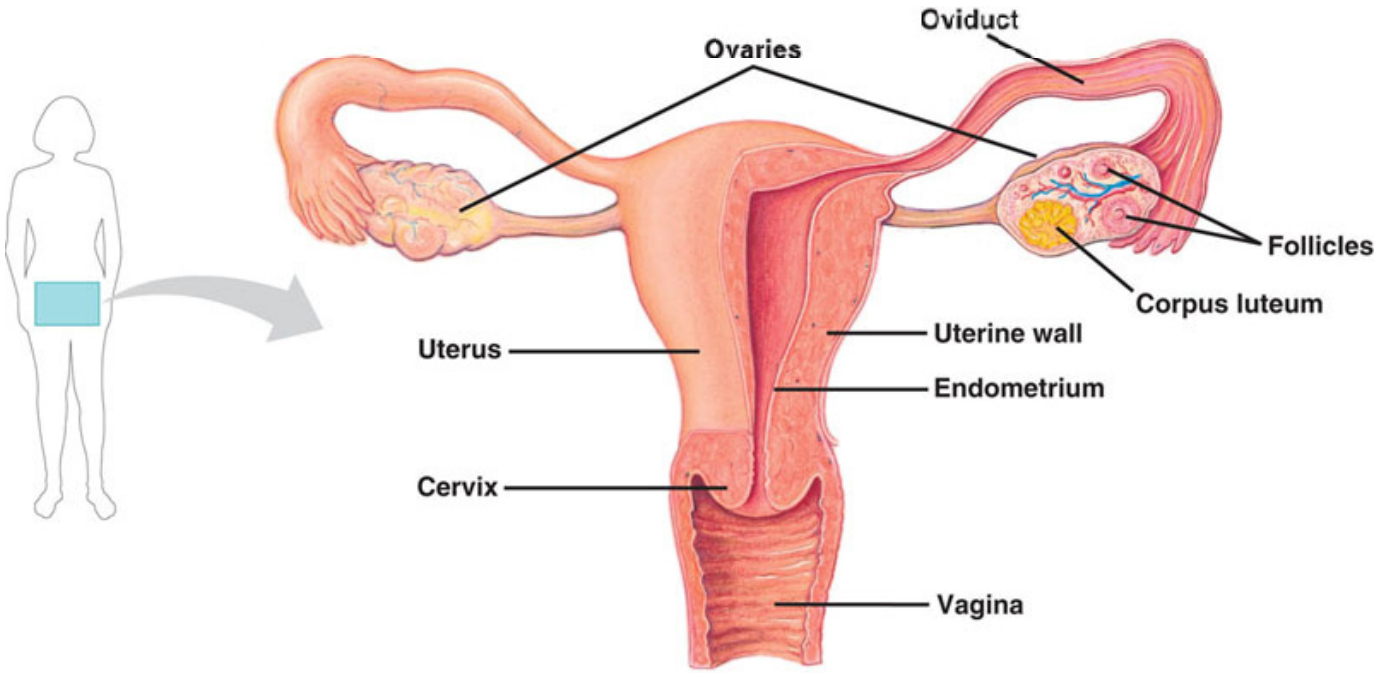


Female Reproductive System

- Each month from puberty through menopause one follicle ruptures and releases its egg cell – **ovulation**.
  - The **corpus luteum** forms from the ruptured follicle and secretes **estrogen** and **progesterone** to help maintain the uterine lining during pregnancy. If the egg is not fertilized the lining disintegrates.

Female Reproductive System

- After ovulation, the egg leaves the ovary and enters the **oviduct**, which it follows to the **uterus**.

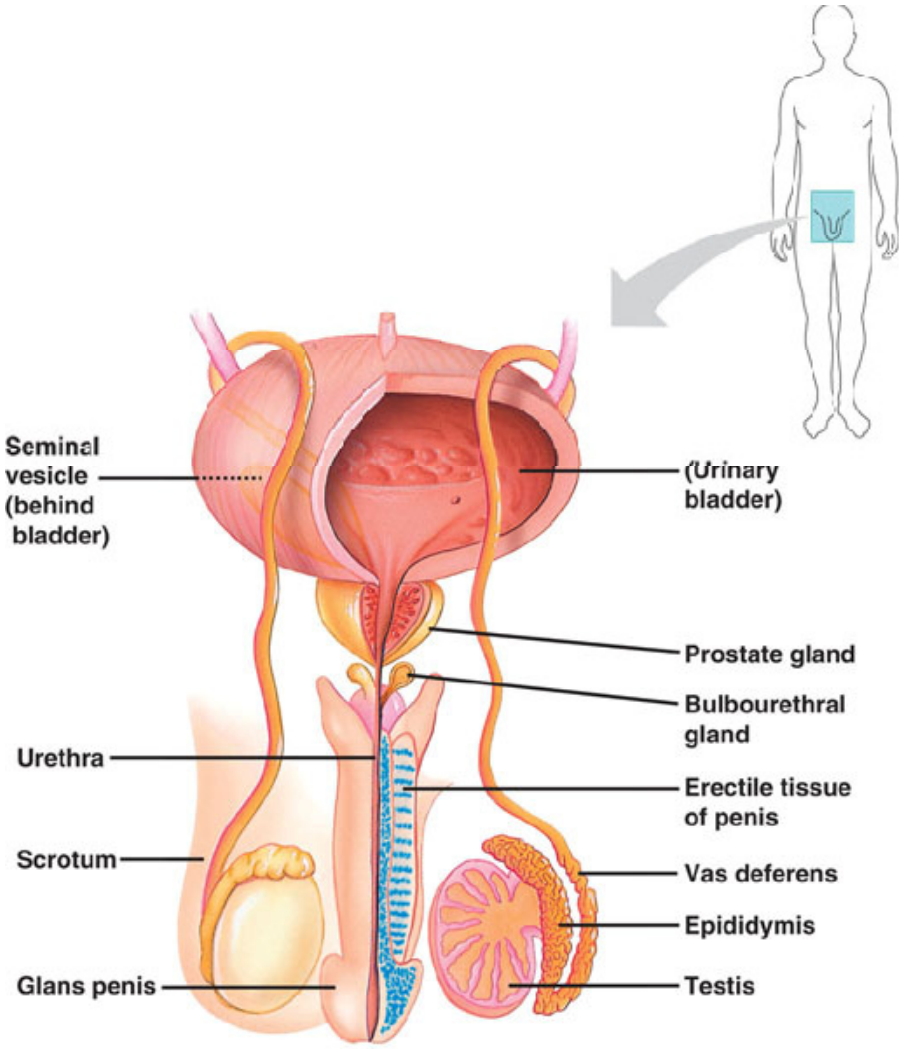


Male Reproductive System

- **Testes** are where male gametes, sperm cells, are produced.
  - Testes contain the **seminiferous tubules** where sperm are formed.
  - **Leydig cells** scattered between the tubules produce **testosterone** & other androgens.
  - Sperm production can't occur at normal body temperature in mammals, so the testes are held outside the body abdominal cavity in the **scrotum**.

Male Reproductive System

- After leaving the testes, sperm pass through the **epididymis** where they become motile and gain the ability to fertilize an egg.
- Sperm leave the body through the **vas deferens** and **urethra**.



Reproductive Cycles

- Males produce sperm continuously, whereas females only release one or a few eggs at certain intervals.

Reproductive Cycles in Female Mammals

- Humans & some other primates have a **menstrual** cycle while other mammals have an **estrous** cycle.
  - In both, ovulation occurs at a time when the endometrial lining of the uterus is ready for an embryo to implant.
  - If no egg is fertilized, the lining is shed (menstruation) in humans & other primates and is reabsorbed in other mammals.

Reproductive Cycles in Female Mammals

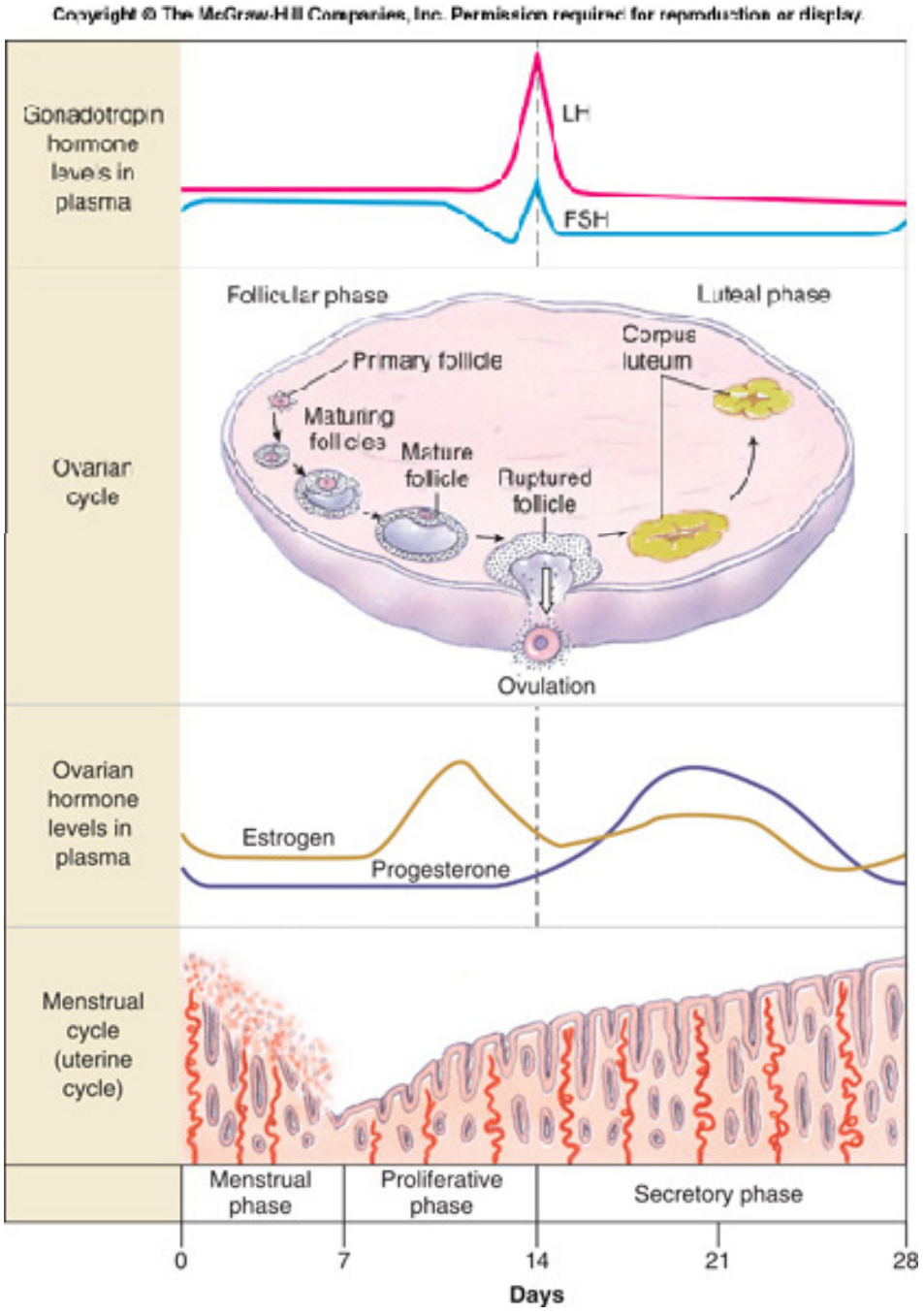
- Female mammals that have estrous cycles may have more behavioral changes.
- Estrous cycles may be more closely tied to season and climate.
- Females will usually only mate when in **estrus** – the time surrounding ovulation.

Female Reproductive Cycle

- The female reproductive cycle in humans contains two parts:
  - Uterine (menstrual) cycle
  - Ovarian cycle
- One integrated cycle involving the uterus & ovaries.

Female Reproductive Cycle

- The ovarian and uterine cycles are regulated by changing hormone levels in the blood.



The Ovarian Cycle

- **GnRH** (gonadotropin-releasing hormone) is released from the hypothalamus which stimulates the release of **LH** (luteinizing hormone) and **FSH** (follicle stimulating hormone) from the pituitary gland.
- FSH stimulates follicle growth, aided by LH.
- The follicle cells start producing estrogen.
  - Rise in estrogen during the **follicular phase**.

The Ovarian Cycle

- When the secretion of estrogen begins to rise steeply, the release of FSH and LH rise rapidly as well.
  - Low levels of estrogen inhibit FSH & LH production.
  - High levels of estrogen stimulate FSH & LH production. (Positive feedback)

The Ovarian Cycle

- The maturing follicle develops an internal fluid filled cavity and grows very large.
  - The follicular phase ends with **ovulation**. The follicle ruptures releasing the **secondary oocyte.**

The Ovarian Cycle

- Following ovulation, during the **luteal phase**, LH stimulates transformation of the follicle into the **corpus luteum**.
  - The corpus luteum secretes estrogen and progesterone.
  - As the combination of these hormones rises, GnRH production in the hypothalamus is inhibited. (Negative feedback)

The Ovarian Cycle

- At the end of the luteal phase, the corpus luteum disintegrates and production of estrogen and progesterone drops.
- Now, the hypothalamus will start producing GnRH and the cycle starts over.

The Uterine Cycle

- Estrogen and progesterone secreted in the ovary affect the uterus.
- Increasing amounts of estrogen released by the growing follicles causes the lining of the uterus (**endometrium**) to thicken.
  - The follicular phase of the ovarian is coordinated with the **proliferative phase** of the uterine cycle.

The Uterine Cycle

- After ovulation, estrogen & progesterone stimulate the maintenance of the lining and growth of endometrial glands that secrete nutrient fluid to sustain an embryo before implantation.
  - The luteal phase of the ovarian cycle and the **secretory phase** of the uterine cycle are coordinated.

The Uterine Cycle

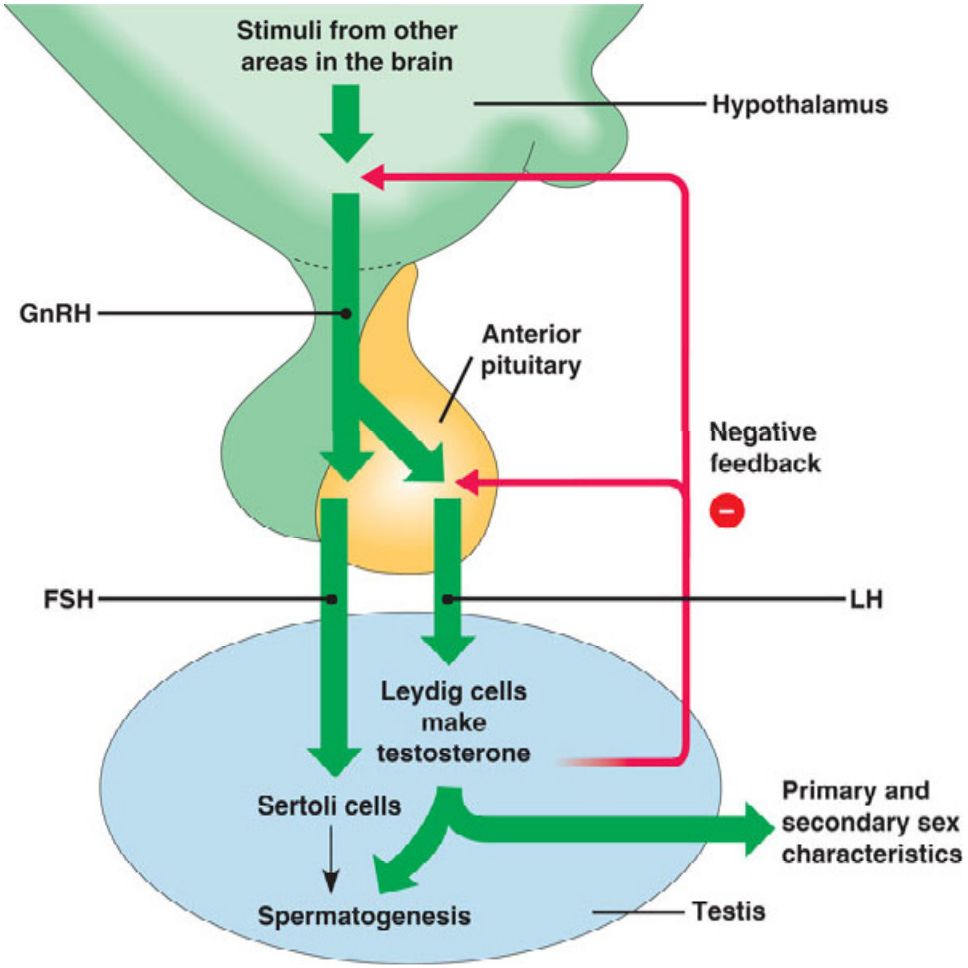
- If the egg is not fertilized, the corpus luteum disintegrates, and production of estrogen and progesterone drops sharply. This triggers breakdown of the endometrium – menstruation.

Male Reproductive System

- In males, the principle sex hormones are **androgens**, including **testosterone**.
  - Produced mainly by **Leydig cells** in the testes.
  - Responsible for secondary sexual characteristics.
  - Important determinants of behavior in vertebrates.
    - Sex drive
    - Aggression
    - Calling in birds & frogs

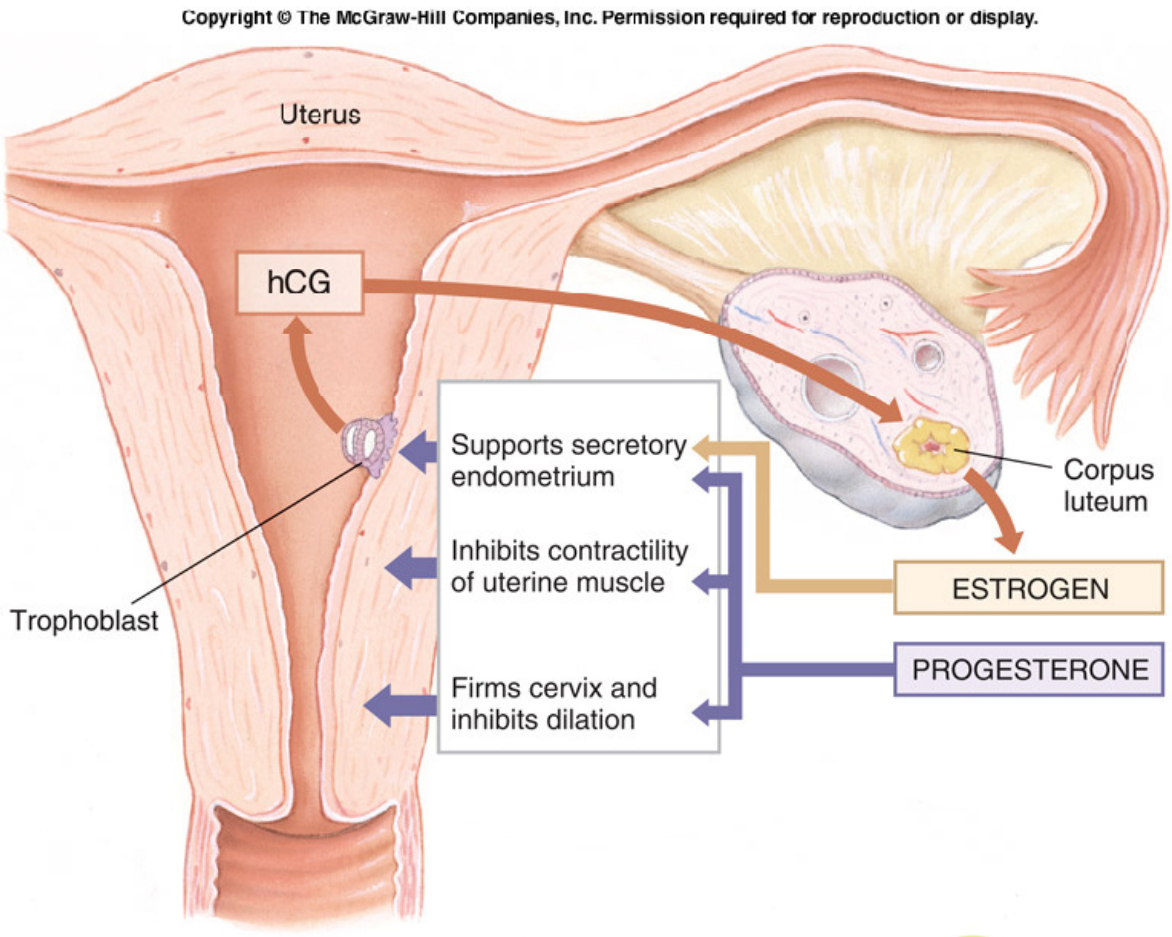
Male Reproductive System

- As in females, GnRH from the hypothalamus stimulates release of FSH and LH from the pituitary.
  - FSH promotes spermatogenesis.
  - LH stimulates Leydig cells to make testosterone.



Pregnancy

- **Conception**, fertilization of the egg, occurs in the oviduct.
  - Results in zygote.
- **Cleavage**, rapid mitotic divisions, starts after 24 hrs.



Pregnancy

- After about a week, the ball of cells produced during cleavage develops a cavity and is now called a **blastocyst**.
- It then implants into the endometrium.

Pregnancy

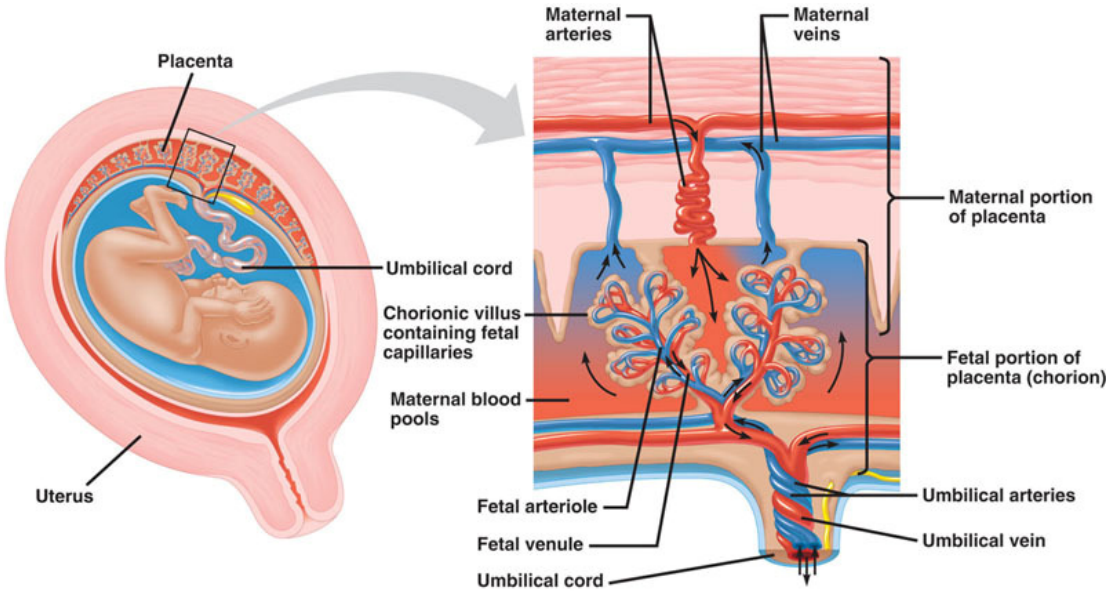
- The embryo secretes hormones including human chorionic gonadotropin (**hCG**) that act like LH to maintain secretion of progesterone and estrogen to maintain the lining of the uterus.

First Trimester

- For the first few weeks the embryo gets nutrients from the endometrium.
- The outer layer of the blastocyst – the **trophoblast** grows into the endometrium and forms the **placenta**.

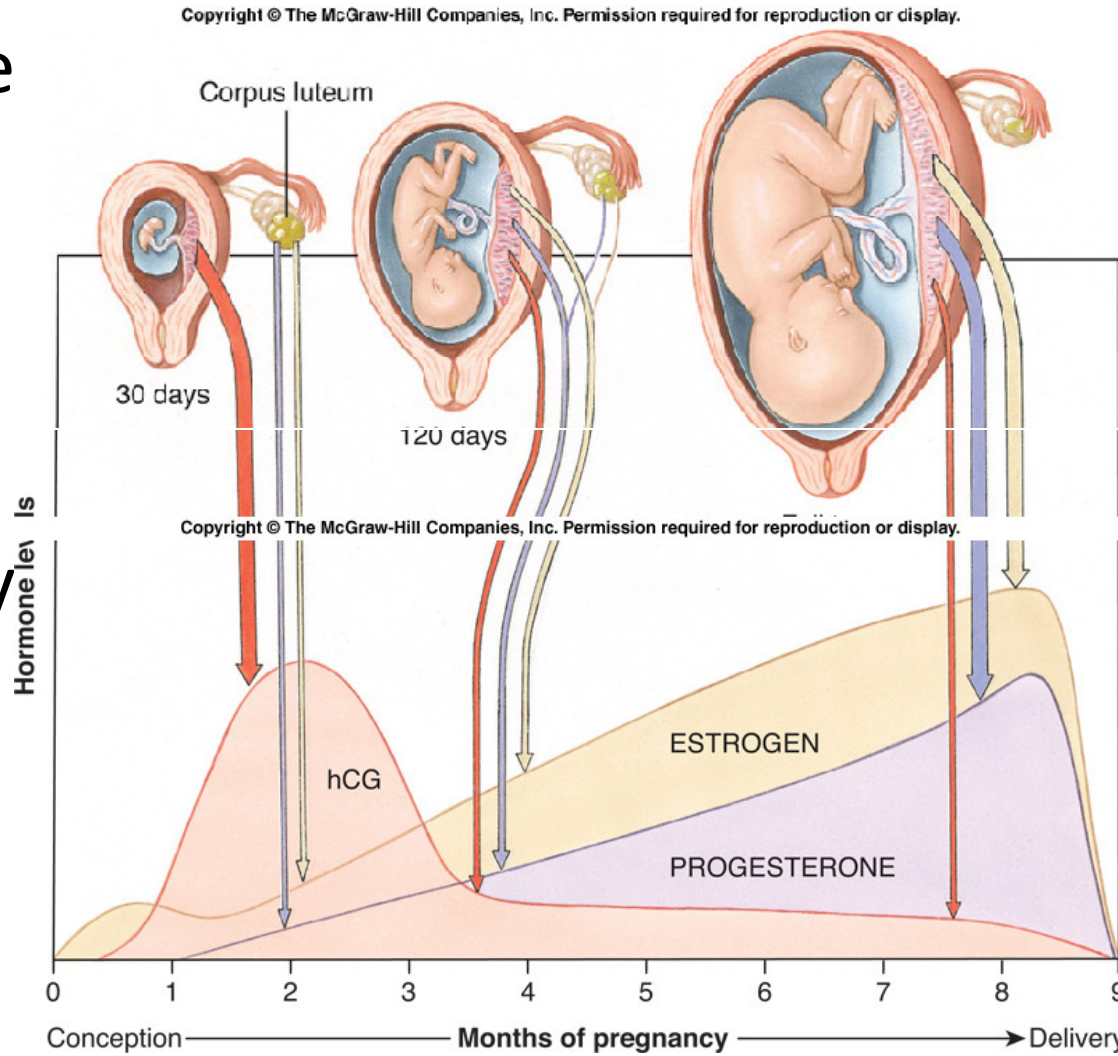
Placental Circulation

- The placenta contains closely entwined embryonic & maternal blood vessels for the exchange of nutrients and wastes.



Hormone Levels

- hCG is produced by the placenta.
- Estrogen and progesterone are produced by the corpus luteum, then by the placenta.



First Trimester

- **Organogenesis** is occurring during the first trimester.
  - The heart starts beating about the fourth week.
  - At 8 weeks, all major organs are present in rudimentary form.
    - Now called a fetus.

Second Trimester

- The fetus grows to about 30 cm and is very active.
- Hormone levels stabilize, hCG declines, the corpus luteum disintegrates and the placenta takes over production of progesterone.

(a) **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.

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

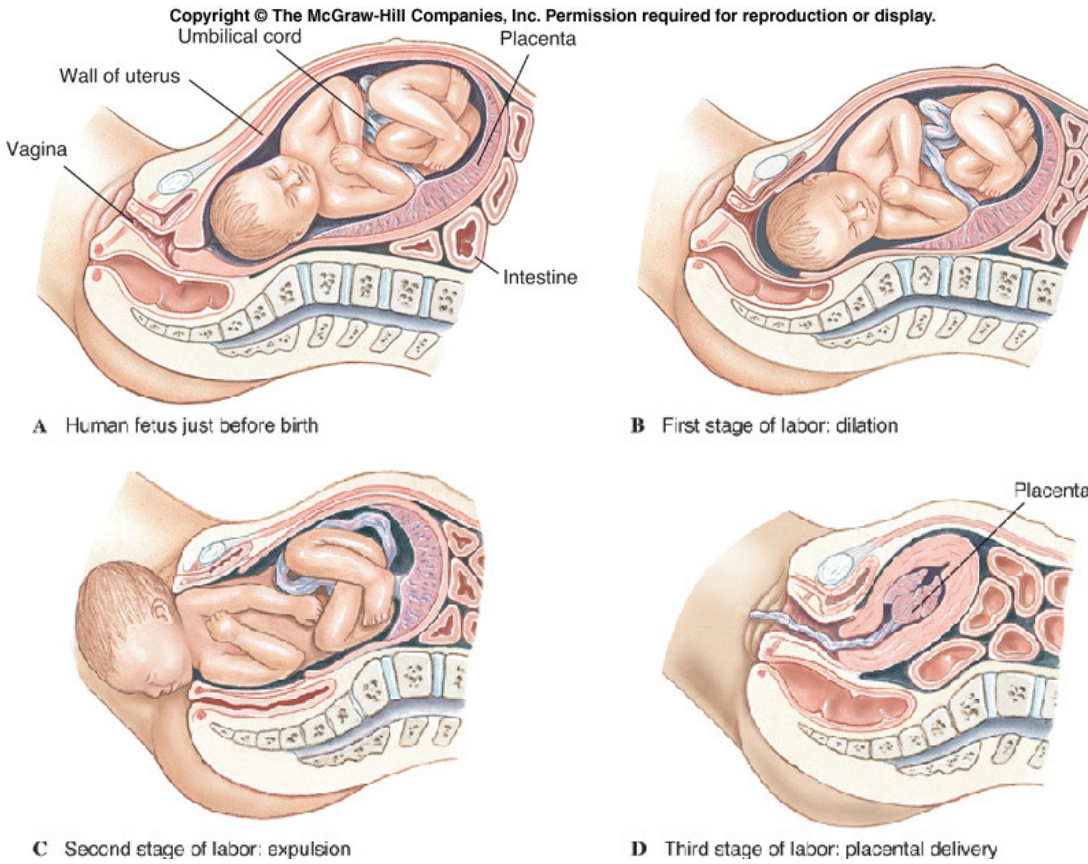
(c) **20 weeks.** By the end of the second trimester (at 24 weeks), the fetus grows to about 30 cm in length.

Third Trimester

- Fetal activity may decrease as space becomes limited.
  - Fetus grows to about 50 cm and 3-4 kg.
- Development of organs is completed.
- Neural development continues even after birth.

Labor & Delivery

- Birth, **parturition**, occurs through strong rhythmic contractions of the uterus.
  - Dilation
  - Expulsion
  - Delivery of placenta



Lactation

- One defining characteristic of mammals is that we have mammary glands.
- After birth, progesterone levels fall stimulating the production of **prolactin** which stimulates milk production.
  - The release of milk is controlled by **oxytocin**.

Multiple Births

- Humans are usually **uniparous** – one offspring at a time.
  - **Multiparous** animals have several.
- **Fraternal twins** result from ovulation & fertilization of two eggs.
- **Identical twins** result from the splitting of one zygote.