Chpt 5: Meiosis and Sexual Life Cycles

asexual reproduction: only 1 parent
- offspring is clone of parent
- clone is identical copy
- most asexual reproduction is by process of mitosis

types of asexual reproduction in organisms

-Archaea & Eubacteria: prokaryotes, no nucleus, all bacteria
- most have single strand of DNA
- reproduction is by **binary fission**: divide in two
- DNA is copied, cytoplasm splits
- why not called mitosis? no nucleus

-Protistans: mostly single-celled organisms
- reproduction by dividing in 2, **mitosis**
- Paramecium, Amoeba

-Multicellular Organisms: Plantae, Animalia

budding: growth occurs off body, by mitosis, new growth breaks off, grows into new organism
- done by sponges, hydra

fragmentation or regeneration:
- organism constricts body part, breaks off into 2 pieces, each part grows into new organism
- again, this process is mitosis
- done by Planaria, sponges, starfish

vegetative propagation: sprouting, growth of new plants from horizontal runners, process is mitosis
- trees can sprout, many plant parts can be placed in H_2O, they grow roots, can be planted

Chromosome #

each species has distinct chromosome #
humans 46, turkeys 82, corn 20,
fruit fly 8, black mollies 46
chromosomes are arranged in matching pairs
called **homologous chromosomes**
these are similar in structure, same size,
centromere in same place
they carry genes for same traits (may not
be the same genes)

your **somatic cells**: all body cells except sex
cells carry whole complement of
chromosomes, 46 in 23 matching pairs
since these are found in matching pairs,
it is considered to be double set of
chromosomes called **diploid # or 2n**

your **sex cells or gametes**: egg & sperm
these carry a single set of
chromosomes called **haploid # or 1n**

humans diploid #, 2n=46, haploid #, 1n=23

the goal is to maintain same chromsome #,
so when egg & sperm unite, we get
diploid # back, 46

in **sexual reproduction**: 2 parents make special cells called gametes, each parent gives one set of chromosomes to gamete, these gametes combine in fertilization this produces variety in species

many organisms can do both sexual & asexual reproduction

bacteria & single-celled org: there is no sex, no males & females, but can exchange genetic info btw strains to get variety

for org who can do both, when is one type preferred over other?

when environment is stable, unchanging, parent thrives, then so will clones thus asex reprod is good, it takes less E also don't spend time searching for mate

when environment is unstable, changing sexual reproduction is better

organisms may produce offspring that are better adapted to environment due to variety, thus greater chance of survival

so, sexual reproduction takes more E, but it is worth it

Meiosis: reduction division
special division to produce gametes, sex cells
differs from mitosis
1-cells divide 2x
2-produce new cells not identical to parents
3-homologous chromosomes pair up & can exchange parts

Interphase: precursor egg & sperm cells start here
precursor cells have 2n chromosome #
in mammals, precursor egg cells sit in ovaries
human females, at birth, have ovaries full of cells, they wait until puberty
under influence of hormones, they are told to start getting ready for meiosis

human males, precursor cells in testes
make sperm throughout life

Meiosis I

Prophase I: nuclear membrane disappears, nucleolus disappears, DNA thickens & condenses into chromosomes
homologous chromosomes pair up & wrap around each other
called tetrad (4 pieces)
centrioles migrate to opposite poles

Metaphase I: homologous chromosomes unwind & separate from each other
homologous chromosomes line up on central plate
centrioles send out spindle fibers
spindle fibers attach to centromeres of homologous chromosomes

Anaphase I: homologous chromosomes separate, pulled to opposite poles of cell by spindle fibers

Telophase I: cytokinesis, cell membrane pinches in & cells pull apart
nuclear membrane may or may not reform
reduction division has been accomplished
2 cells at end of Meiosis I are haploid, 1n

So **why do Meiosis II**? we have already accomplished our goal: haploid cells have been made, why divide again?

there is some variation from species to species inbetween Meiosis I and II

-for some organisms, the cells go into Interphase and stay there until a chemical signal tells them to proceed into Meiosis II

-for some organisms, the cells go right into Prophase II after Telophase I

cells do copy the centrioles between Prophase II &Telophase I

Meiosis II

Prophase II: very brief for organisms that pass directly into Meiosis II
nuclear membrane is not present
chromosomes already condensed
centrioles do migrate to opp poles
this division takes place at right angles from first division

Metaphase II: all chromosomes line up on central plate, centrioles at opposite poles, send out spindle fibers, attach to centromeres

Anaphase II: centromeres divide, chromatids separate, pulled to opp poles by spindle

Telophase II: cytokinesis, cytoplasm splits
nuclear membrane reforms
chromosomes lengthen into chromatin

at end of Meiosis II, 4 haploid cells produced

Back to **Prophase I**

when homologous chromosomes pair up

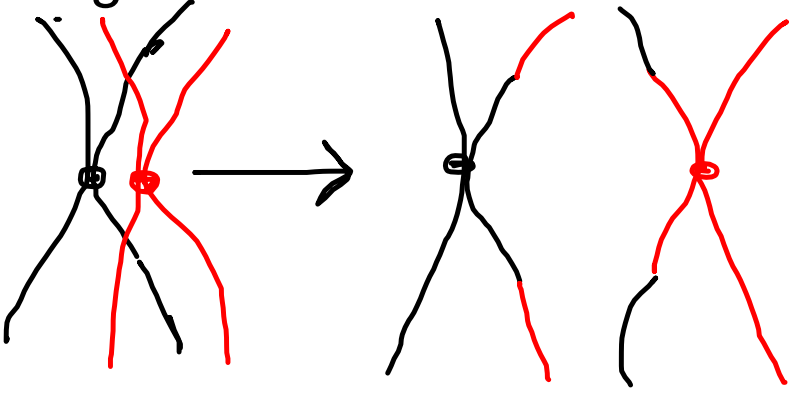
they wrap around each other forming a tetrad

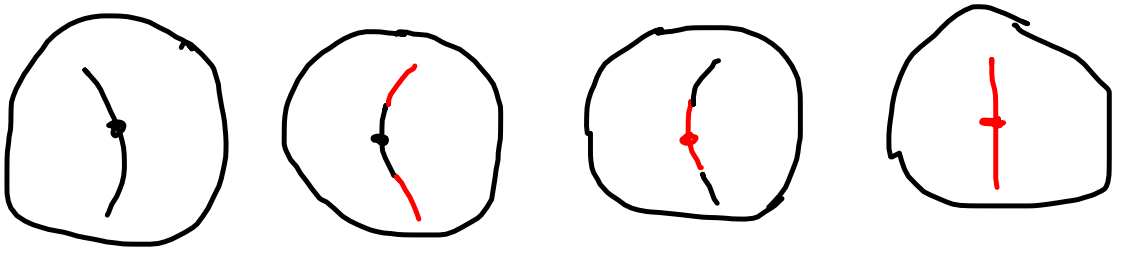
then crossing over can occur

crossing over: parts of chromosomes break off & are exchanged with homologue

this leads to greater variation in offspring

Crossing Over





Spermatogenesis: process of making sperm
- sperm cells: spermatocytes
- takes place in testes, testes located in scrotum
  - outside of body, has lower temp
  - 98.6 F is too hot for sperm developmt
- spermatocytes are made as we diagrammed meiosis
- creates 4 equal-sized, small cells
  - almost no cytoplasm, head of sperm is mostly genetic material
- tails are added in epididymis---->sperm

Oogenesis: process of making egg cells or oocytes

takes place in ovaries

meiotic division is **unequal**

begin meiosis w/primary oocyte

at end of Telophase I, 2 cells are made, one large, secondary oocyte, one small, polar body

both cells proceed through Meiosis II

at end of Telophase II, 4 cells are made, one large cell, ovum, & 3 small cells, polar bodies

polar bodies disintegrate, ovum is released

why the difference between the 2 sexes?

the sperm become a fast swimming machine with so little cellular tissue

with the ovum, we have put all cytoplasm & cellular organelles into one large cell, this gives fertilized egg E for cell divisions

Fertilization: union of egg & sperm

restores chromosome number

zygote: fertilized egg

it takes 100's of 1000's sperm pounding on cell membrane of ovum for one to finally enter

once a sperm enters there is a chemical change and no others can enter

Some organisms show an **Alternation of Generations** life cycle: this means the life cycle of that organism alternates between a diploid state and a haploid state

- when they create haploid cells by the process of meiosis, those cells grow into a multicellular tissue by mitosis and can live in that form for some time but all cells are haploid
- these haploid tissues eventually make gametes & reproduce sexually, resulting in a diploid zygote that grows into a multicellular organism
- the multicellular form then goes through meiosis & life cycle starts again

Sexual reproduction is defined as 2 parents making special cells through process of meiosis

So, technically, bacteria and single-celled protistans cannot do sexual reproduction because single celled organisms do not make sex cells

However, there is genetic recombination in all life forms

- bacteria and protistans can form cytoplasmic connections between different strains or individuals, combine genetic material and then divide it up and separate
- this is called conjugation
  - it is like sexual reproduction

Fungi show alternation of generations
- they produce by spores by meiosis
- so the spores are haploid, these then grow
  - into a multicellular haploid state
  - the spores eventually make gametes
- the gametes unite to form diploid state, then
  - they make spores again

lower Plants (mosses, ferns) also show an
- alternation of generations life cycle
- many of these plants spend most of their life
  - in a multicellular haploid form

higher plants are more like animals spending
- their life in the diploid state
- these are the evergreen trees (conifers),
  - deciduous trees and all flowering plants

- the flower is reproductive structure of higher
  - plants
  - inside the flower is an ovary which
    - produces ovules by meiosis
  - anthers are the male part of the plant
    - producing pollen by meiosis
  - pollination: is when the pollen grain
    - lands on the female structure (pistil
    - & stamen)
  - fertilization: when the cell inside the
    - pollen unites with ovule in ovary

Sexual Reproduction in Animals

- there is no alternation of generations in animals
- gametes cannot live long outside the body
- in animals, the male gamete swims, so there must be a medium for swimming to occur
- lower animals have mostly external fertilization, both egg and sperm are released outside the body and sperm swim to the eggs, so lower animals live in watery environment
- external fertilization also means external development, fertilized eggs develop into an embryo or larva and they must be kept moist
- sponges, jellyfish, planaria, starfish
- some higher animals, the vertebrates such as fish and amphibians have external fertilization and external development
- fish & frogs have jellylike eggs which must be in a watery environment or they will dry out

Reptiles and birds have internal fertilization
- sperm are released inside the female tract
- this means there is a greater chance of successful fertilization, so less eggs can be produced
- however, these groups still have external development
- these two groups are also adapted to life on land, so how do they manage this?
  - evolution of the shelled egg
- the shelled egg keeps the moisture inside and protects the developing embryo

Mammals are the highest animal life
- they have internal fertilization and internal development
- the zygote and then the embryo develops inside the mother
- this gives the greatest protection to the developing offspring
- this is true for the majority of mammals, but there are 3 major groups of mammals that reflect the evolution from external to internal development

monotremes: egg-laying mammals
- most primitive mammals, only 2 species
- duck-billed platypus & spiny echnida
- both live in Australia
- they have internal fertilization then external development with leathery shelled eggs

marsupials: pouched mammals
- they show internal fertilization then development begins internally, then finishes externally
- babies are born in an embryonic state
  - the most developed features are their forelimbs and their mouths
  - they crawl from birth canal to the pouch where they latch onto nipples and finish development

placental mammals are the most advanced mammals
- they develop inside mom, fed by placenta

human female cycle
- regulated by hormones
- 28 day cycle is the average
- there are actually 2 cycles going on each month: ovarian cycle & uterine cycle
- day 1: first day of period
- day 1-5: menstruation due to low levels of estrogen & progesterone, uterine lining sloughs off
  - meanwhile, follicles begin developing in ovary due to hormones from the brain
- day 6-13: the developing follicles in the ovary make estrogen & progesterone, these hormones then make the lining of uterus build up in preparation for pregnancy
- day 14: ovulation, an egg is released from the ovary, the other follicles slowly disintegrate, but continue to release progesterone, this continues to build up the lining of uterus
- day 14-24: lining still builds up due to more progesterone
- day 24-28: if there is no implantation, the lining maintains but estrogen & progesterone begin dropping off
- day 1: lowest levels of estrogen & progesterone, lining of uterus is expelled menses
- if implantation occurs, the corpus luteum in the ovary continues to make progesterone which maintains the pregnancy, maintains the placenta