

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 H₂O, 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 chromosome #,
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, meaning there are no males & females, but they can exchange genetic info btw strains to get variety

for organisms who can do both sexual & asexual reproduction, **when is one type preferred over other?**

when **environment is stable**, unchanging, if parent is thriving, then so will clones thus **asexual reproduction** is good because it takes less E and 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** are produced

Back to **Prophase I**

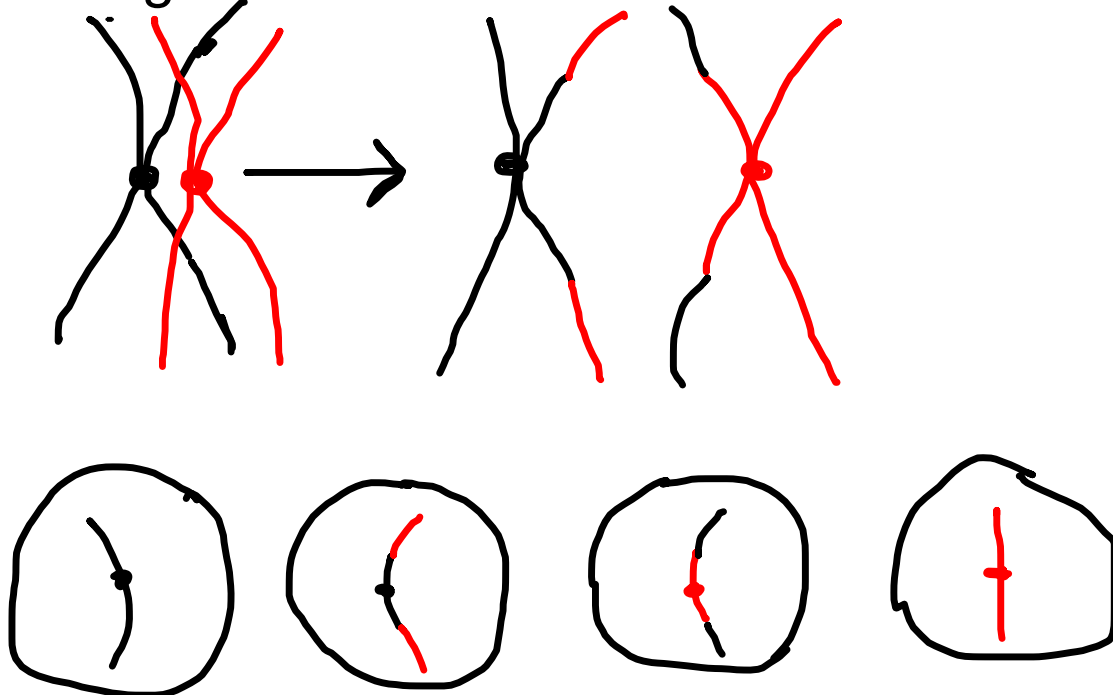
when homologous chromosomes pair up
they wrap around each other forming a
tetrad

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

for mammals, spermatogenesis takes place in
testes, testes located in scrotum, the sac
suspended outside of body
the scrotal sac has a lower temperature
98.6 F (humans) is too hot for proper sperm
development

spermatocytes are made as we diagrammed
meiosis

spermatogenesis **creates 4 equal-sized,
small cells**

there is 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

in mammals, **meiotic division is unequal**

begin meiosis w/primary oocyte

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

both cells proceed through Meiosis II

at **end of Telophase II**, **4 cells** are made,
one large cell, the ovum
& 3 small cells, the polar bodies
polar bodies disintegrate, ovum is
released

why the difference between the 2 sexes?

the sperm become a fast swimming
machine with very 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

Human female cycles

regulated by hormones

hormones are proteins that act as chemical messengers

they are made in one part of the body and are carried to a target organ where they deliver their message

the major hormones involved are **LH** (luteinizing hormone) and **FSH** (follicle stimulating hormone) and **estrogen** and **progesterone**

LH & FSH are made in the pituitary gland of the brain and travel to the ovaries where they exert their effects

estrogen and progesterone are made by the developing egg follicles in the ovary and travel to the uterus where they exert their effects

a 28 day cycle is the average

there are actually 2 cycles going on each month: ovarian cycle & uterine cycle

Human cycle

day 1: first day of period

day 1-5: menstruation occurs due to low levels of estrogen & progesterone, uterine lining sloughs off

meanwhile, egg follicles begin developing in ovary due to hormones from the brain, LH and FSH

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 due to a surge in LH & FSH the follicle tissue remains in the ovary as the corpus luteum which continues to make progesterone resulting in the lining of the uterus building up more, the other egg follicles disintegrate

day 14-24: uterine lining still builds up due to more progesterone and estrogen

day 24-28: if there is no implantation, the lining maintains but estrogen & progesterone levels begin dropping off

back to day 1: lowest levels of estrogen & progesterone, lining of uterus is expelled menses (menstruation)

Human Reproduction

the ovaries take turns releasing eggs, one month the left ovary releases eggs, next month the right ovary releases eggs, the norm is for only one egg to be released when sperm are released into the female tract, they swim up the vagina, up through the uterus, then half go up one oviduct, half travel up the other oviduct the norm is for males to release 100 million sperm in an ejaculation, if the number is below 20 million there are problems with fertility

if the sperm encounter an egg, they begin beating on the egg to get in, when one enters, there is a chemical reaction over the surface of the egg so no more can enter

the fertilized egg then finishes its journey down the oviduct to the uterus where implantation occurs

when implantation occurs (around day 24), the corpus luteum in the ovary continues to make progesterone which maintains the pregnancy, maintains the placenta

in addition, progesterone feeds back to the brain to tell the pituitary NOT to make LH & FSH, so while pregnant you will not release any eggs, the cycle is stopped until after birth

Sexual Reproduction in Other Life Forms

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

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

However, there is genetic recombination in all life forms

bacteria and protists 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 and Plants 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 fungi and lower plants (mosses & ferns) may spend more of their life in the haploid state than in the diploid state.

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)

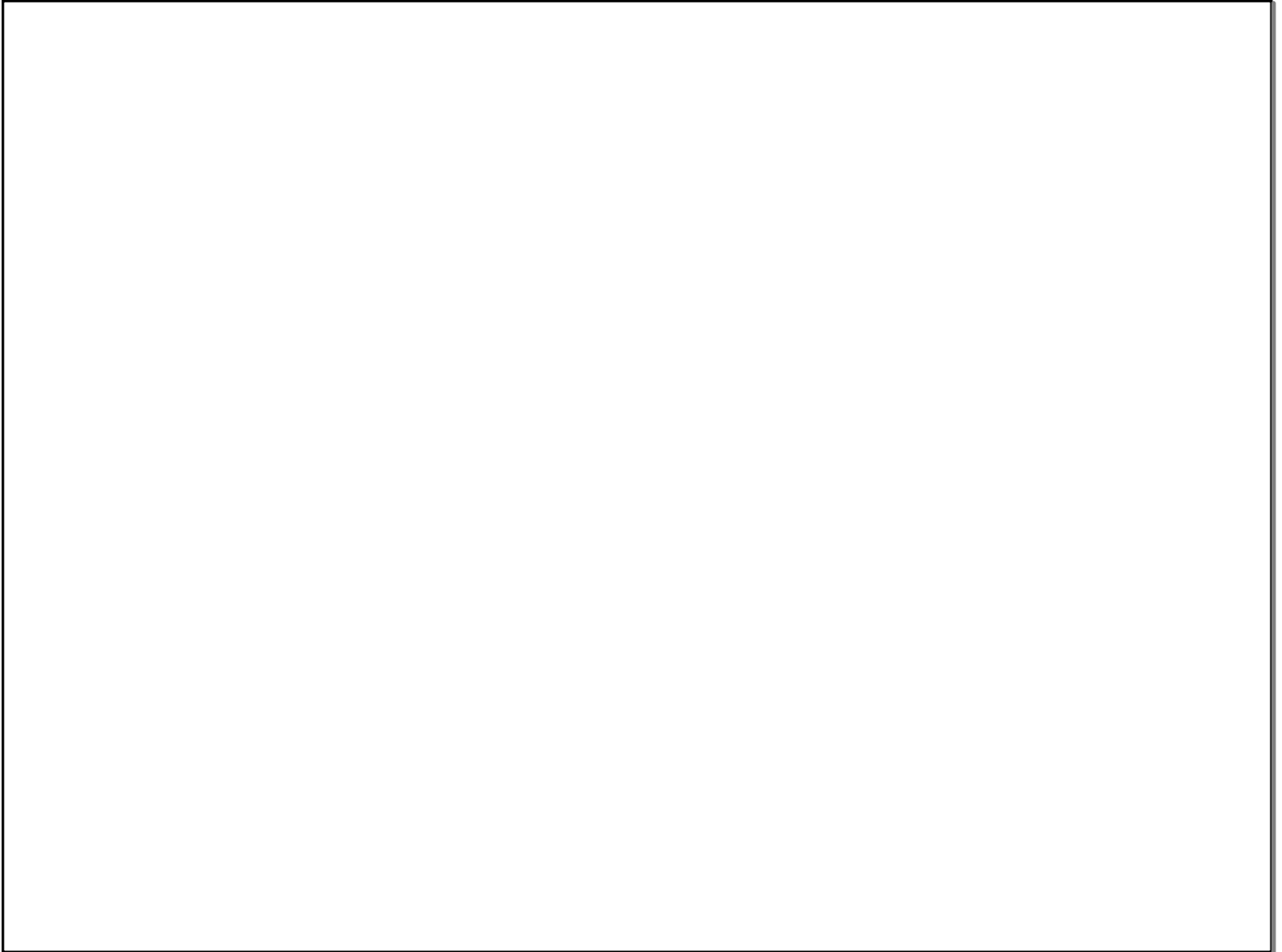
fertilization: when the cell inside the pollen,
the sperm, unites with ovule in ovary

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 echidna

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

Fungi show alternation of generations
they produce by spores by meiosis
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