

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,
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 & tangle
together 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 form
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

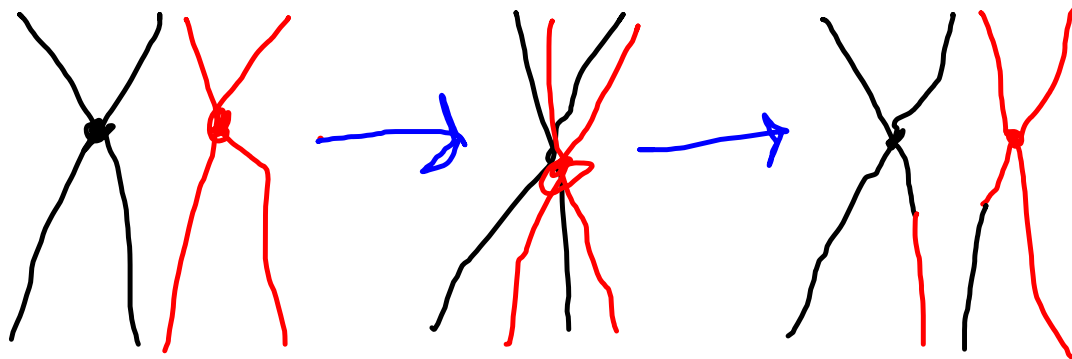
when homologous chromosomes pair up
they wrap around each other forming a
tetrad

then crossing over can occur

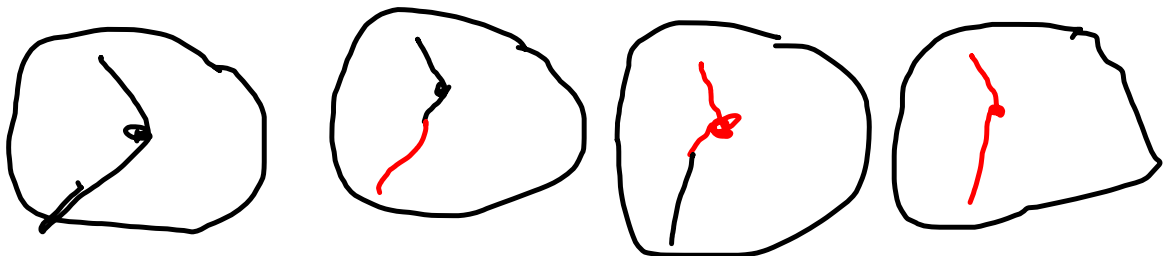
crossing over: parts of chromosomes
break off & are exchanged with
homologue

this leads to greater variation in offspring

Crossing Over



at end of Meiosis II



results in variety in every cell

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 development
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
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?

put all cytoplasm & cellular organelles in one large cell, gives fertilized egg E for cell divisions

Fertilization: union of egg & sperm

restores chromosome number

zygote: fertilized egg

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 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

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