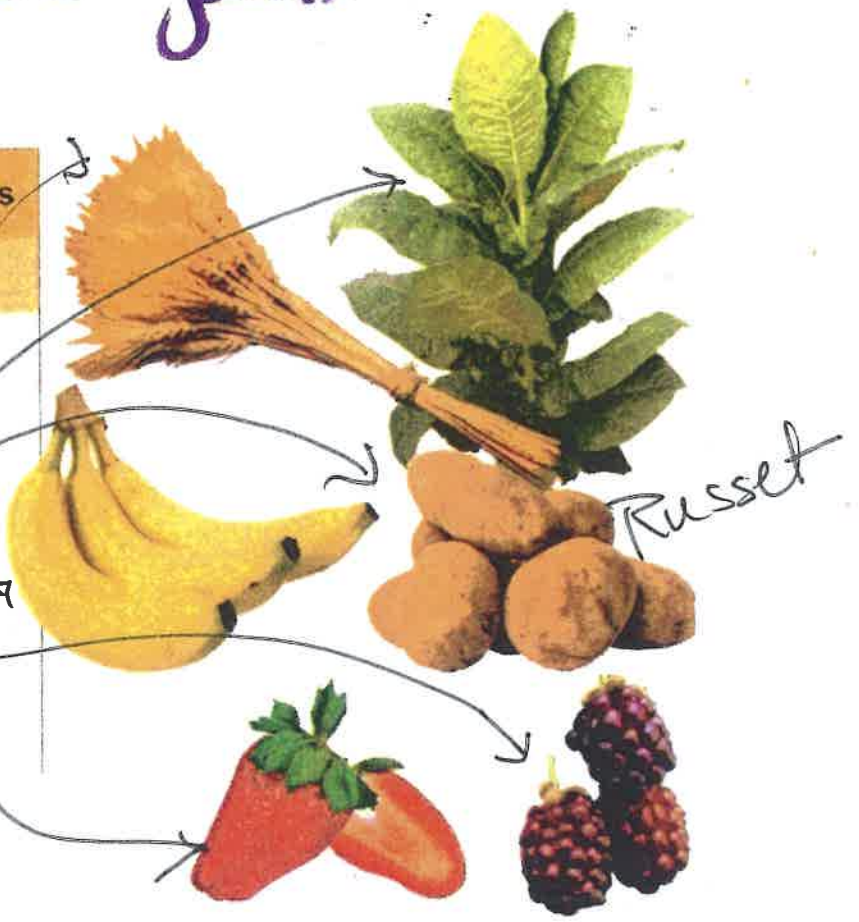
# 2. Ploidy in Organisms

| Examples of Polyploid Plants | |
|---|---|
| **Name** | **Number** |
| Common wheat | **6N** = 42 |
| Tobacco | **4N** = 48 |
| Potato | **4N** = 48 |
| Banana | **3N** = 27 |
| Boysenberry | **7N** = 49 |
| Strawberry | **8N** = 56 |

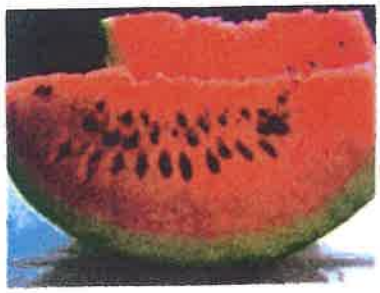
Many **ferns** are polyploid with chromosome number up to 400N



Russet

* We artificially produce why?
↓
Polyploidy in plants tends to lead to larger vegitative & reproductive structures

Monoploid(n) & Triploid(3n) plant lines usually sterile & sometimes seedless



* How we artificially select for seedless fruits

Fr.

30's

= Know = Kinda know = ??

# Meiosis & the Cell Cycle

summary/reflection

nuclear ÷ : PI, MI, AI, TI

= diploid
= haploid

# L2 Meiosis I: Genetic Variation

Interphase (Cell Cycle)
- $G_1$, S, $G_2$ Phases

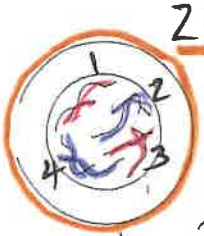
Synthesis Phase = DNA Replication

Meiosis = produces 4 haploid genetically different gametes (gametic cells)

2n=4

= Maternal chromosome

= Paternal chromosome






## Prophase I

- nuclear envelope & nucleolus reabsorbed
- Homologous chromosomes, same size, same shape, same genes
- mitotic spindle fibers
- kinetochore protein at centromere

Chromosome = 2 sister chromatids

## Prophase I

Synapsis = pairing up of homologous chromosomes (AKA Homologues)

shape = tetrad

## Metaphase I

equator

Homologues orient on either side of equator randomly

spindle fibers from opposite poles attach to each homologue at kinetochore protein

## Prophase I

shape = chiasmata

Homologues do crossing over = process of non-sister chromatids of homologues exchange genetic material

## Anaphase I

Homologues separate & migrate to poles (spindle fibers contract)

sister chromatids still attached!

## Telophase I

- nuclear envelope & nucleolus reform
- Cytokinesis ⊕ growth = 2 haploid gametically different cells
- NO DNA Replication ⊗

Interkinesis

Cytoplasmic ⊗

2n → n

* forms haploid cells (cut chromosome # in 1/2)
* increases genetic variation

R2

3Qs

# Meiosis & the Cell Cycle

summary

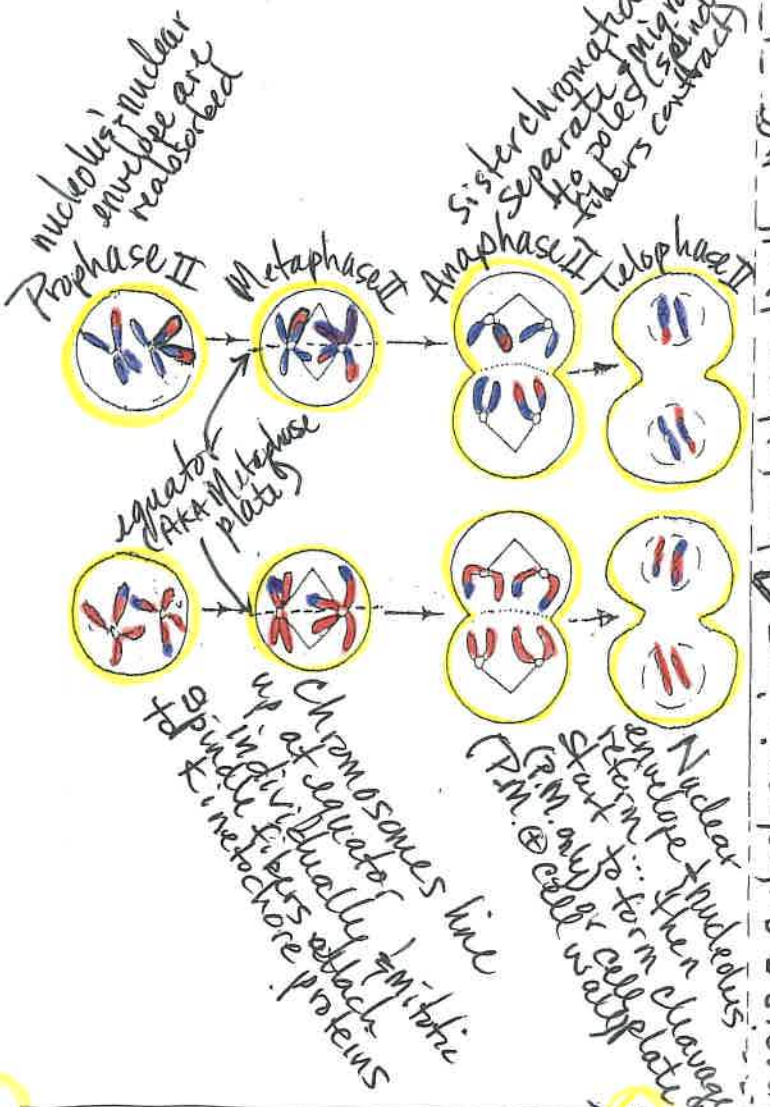
# L3 Meiosis II: Chromatid Separation

**Benefits of Meiosis I + II:**

① Prepares cells for sexual reproduction * Fertilization *

② produces 4 haploid gametic cells → ♂ sperm / ♀ egg + pollen / ova

③ increases genetic diversity in the population of a species




## Spermatogenesis:

- all 4 gametic cells develop into sperm
- 4 viable sperm
- continuous ÷ of germal gametic cells by mitosis to ↑ # of sperm produced

resulting cells have to go through Gametogenesis


## Oogenesis:

- only 1 gametic cell will develop into egg
- 1 viable egg + 3 polar bodies
- long "rest" periods in gametogenesis
- meiosis only reaches final stage when a sperm head enters the cell

R3

# Meiosis & the Cell Cycle

3Q's

summary

# Meiosis & the Cell Cycle

I. Reproduction options:
   A. Asexual:
      1. unicellular organisms (eukaryotic)
         a. mitosis (nuclear division) & cytokinesis (cytoplasmic division)
   B. Sexual:
      1. multicellular organisms in gonads (ovary/pistil & testicle/stamen)
         a. meiosis (nuclear division), cytokinesis (cytoplasmic division) & fertilization (combination of gamete haploid nuclei)

II. Types of cells:
   A. Somatic cells:
      1. body cells
      2. typically diploid
         a. double set of chromosomes (2n)
            1) 1st set from 1 biological parent & 2nd set from other biological parent
   B. Gametic cells:
      1. gametes/sex cells (sperm & egg/ova)
      2. haploid
         a. single set of chromosomes (n)
            1) parental homologous chromosomes separated so only a single set of chromosomes ends up in gamete

III. Chromosome # terminology:
   A. Haploid:
      1. single set (n) of chromosomes that contain all of the genes for that organism
      2. examples:
         a. human = 23
         b. cat = 19
         c. chicken = 39
   B. Diploid:
      1. double set (2n) of chromosomes that contain 2 copies of all of the genes for that organism, that form homologous pairs
      2. examples:
         a. human = 46
         b. cat = 38

c. chicken = 78
d. king crab = 208

C. Polyploid:
1. 3 or more sets (3n, 4n, ...etc) of chromosomes
2. usually only survivable in plants... most typically in flowering plants (angiosperms)
a. ex. strawberries = 8n (octoploid)
b. ex. tobacco = 4n (tetraploid)
c. ex. durum/bread wheat = 6n (hexaploid)
d. ex. cotton = 4n (tetrapolid)
e. ex. dahlia = 8n (octoploid)
f. ex. bananas = 3n (triploid)... odd # polyploidy usually sterile
g. ex. sugar cane = 12n (dedecaploid)
h. ex. kiwi fruit (Chinese gooseberry) = 6n (hexaploid)
i. ex. mandarins = 2n, 3n & 4n
3. common practice in artificial selection of flower & fruit bearing plants by humans

IV. Key terms to know:
A. Homologous chromosomes:
1. same size, same shape, same genes on the chromosome
2. one from each biological parent
B. Tetrad:
1. shape formed when homologous chromosomes line up together (∴ 4 sister chromatids, 2 for each chromosome)
C. Chiasmata:
1. shape formed when **non-sister** chromatids physically connect to each other
D. Non-sister chromatids:
1. sister chromatids from different chromosomes in a homologous pair
E. Crossing over:
1. exchange of genes at a chiasmata
2. leads to increased genetic variation in gametes ∴ also the population for that species
F. Meiosis I:
1. section of meiosis where chromosome number is cut in $\frac{1}{2}$ & results in 2 daughter cells

2. 1 original diploid cell ➡ 2 haploid daughter cells
3. crossing over increases genetic variation

G. Interkinesis:
1. time between meiosis I & II
2. cytoplasmic division + growth of the cells
3. **NO** DNA replication

H. Meiosis II:
1. section of meiosis where the sister chromatids separate
2. 2 haploid cells ➡ 4 haploid daughter cells

V. Meiosis I: Increasing genetic variation
A. synapsis = pairing up of homologous chromosomes (AKA homologues)
B. activities that increase genetic variation:
1. homologues start crossing over = exchange of section of chromosomes after chiasmata (X shape formed where they cross)
2. random orientation of modified homologues at the cell equator
a. when spindle fibers attach to each individual homologue, which homologue of the pair that goes to the pole is randomized, ∴ gene variations (alleles) that end up in the two nuceli is random

VI. Meiosis II: Separating Chromatids
A. Similar process to mitosis:
1. sister chromatids (2 copies) separate so that each resultant nuclei has a single copy of all the genes that the cell needs

VII. Gamete differentiation:
A. Spermatogenesis: differentiation of generic gamete into sperm
1. all cells (spermatogonium →1° spermatocyte→ 2° spermatocyte) formed in the germal epithelium of intersticial (Leydig) cells within gaps (interstices) of seminiferous tubules cytokinesis are **viable**
2. mitosis occurs after meiosis to increase # of spermatids produced by meiotic event, then develop tails (spermatozoa) helped by Steroli cells (AKA 'nurse' cells)
3. organism produces sperm entire lifespan

B. Oogenesis: differentiation of generic gamete into ova/oocytes/egg
1. making ova (egg) starting in ovary as a fetus (4-5months), followed by formation of primary follicle (≈ 400,000) in ovary during puberty followed by release of mature follicle as a ovulated ovum into oviducts (fallopian tubes) when stimulated by FSH, and finishing in uterus (only if fertilized... otherwise sluffed during endometrial lining loss-'period')
2. only one cell (with most of cytoplasm: cytosol, organelles, enzymes, ribosomes, etc) formed by the end of cytokinesis & 3 polar bodies

3. born with the # of egg follicles that will have over lifetime
4. this is why mitochondrial DNA is maternal, not paternal (since only the nucleus of the sperm passes the membrane of the ova)

VIII. Fertilization
- A. Sexual reproduction joining of maternal & paternal gametes to form a zygote
  1. increases genetic variation

IX. Issues with Meiosis & gamete production:
- A. Non-disjunction of homologous chromosomes
  1. homologues do NOT separate during Anaphase I of Meiosis I
     a. leads to:
        1) one cell with one extra chromosome
           a) ex. human with 47 chromosomes... Down Syndrome (Trisomy 21), Trisomy 18, Kleinfelters Syndrome (extra X)
        2) one cell with one less chromosome
           a) ex. human with 45 chromosomes... Turner Syndrome (only one X, not XX)

X. Meiosis & Life Cycles
- A. ex. Bryophytes (mosses)

- B. ex. Humans