Introduction to Biology. Lecture 29

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Outline

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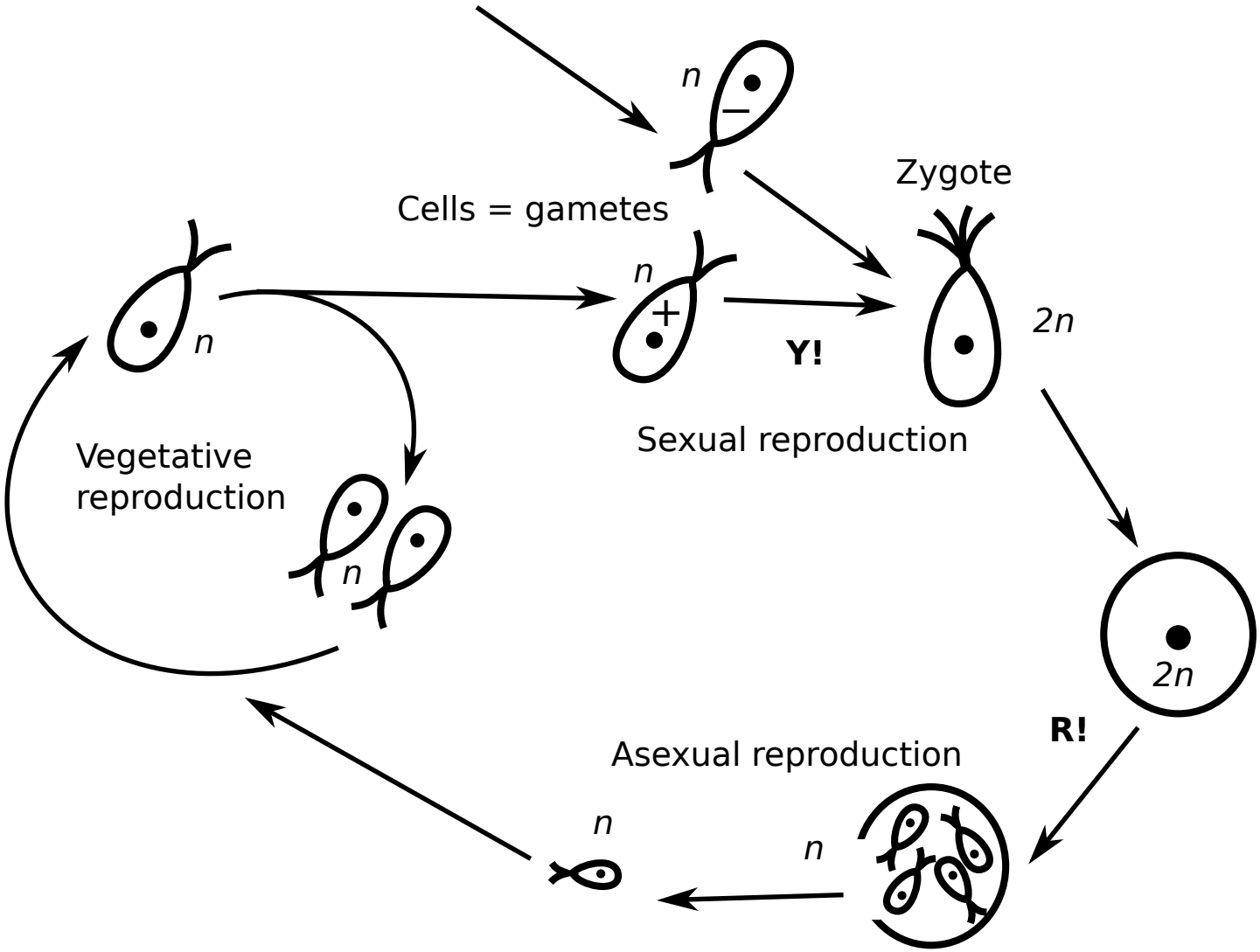
Where we are

Inheritance

Life cycle of unicellular organism



The goal of meiosis (R!) is to counterbalance the syngamy (Y!)

Mendel's peas: one character, 1st and 2nd generations

- Parents: pure lines
- First: all the same
- Second: 3/4 like one parent and 1/4 like another parent

Check also the "Genetics and Inheritance" lab materials.

Genetics and inheritance

Mendel, peas and life cycle

Mendel's peas: 2 characters, 1st and 2nd generations: theory

- 1st generation all the same

- Second generation: 9/16 like one parent, 1/16 like another parent, and two groups (3/16 and 3/16) with *new combinations* of characters—**recombinants**

Gregor Mendel discovered genes, chromosomes and meiosis "on paper", not knowing cell division and without microscope!

Mendel's peas: 2 characters, 1st and 2nd generations: theory and explanation

- 1st generation all the same: genes are paired (*diploid*); there are two variants (*alleles*) of each gene, one is working (*dominant*), another (*recessive*) is not; in 1st generation they mixed (*heterozygous*) and only dominant effects are visible in *phenotype*; recessive are visible only if they doubled (*homozygous*)
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- *Genes recombine freely* because genes from different chromosomes separate between gametes independently in the *anaphase I of meiosis*

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Anaphase I and recombinants

Imagine that parent is fully heterozygous, like in Mendel's first generation. It has red flowers (Rr) and long stems (Ll), the whole genotype is then "RrLl". There are **two possibilities** in the anaphase I:

A. Either "R-chromosome" and "L-chromosome" come to one pole (consequently, "l-chromosome" and "r-chromosome" to other pole)

B. Or "R-chromosome" + "l-chromosome" come one way, and "r-chromosome" + "L-chromosome" another way

Each variant has 1/2 (50%) probability, like in throwing a coin.
Four gamete types are possible:

A. RL

B. rl

C. Rl

D. rL

Four gametes give 16 combinations (**check it yourself** with Punnett square). As R and L are dominant, only 4 phenotypes appear (again, **check it yourself**), and 2 of them are **recombinants**, phenotypes unlike parents.

Peas and life cycle

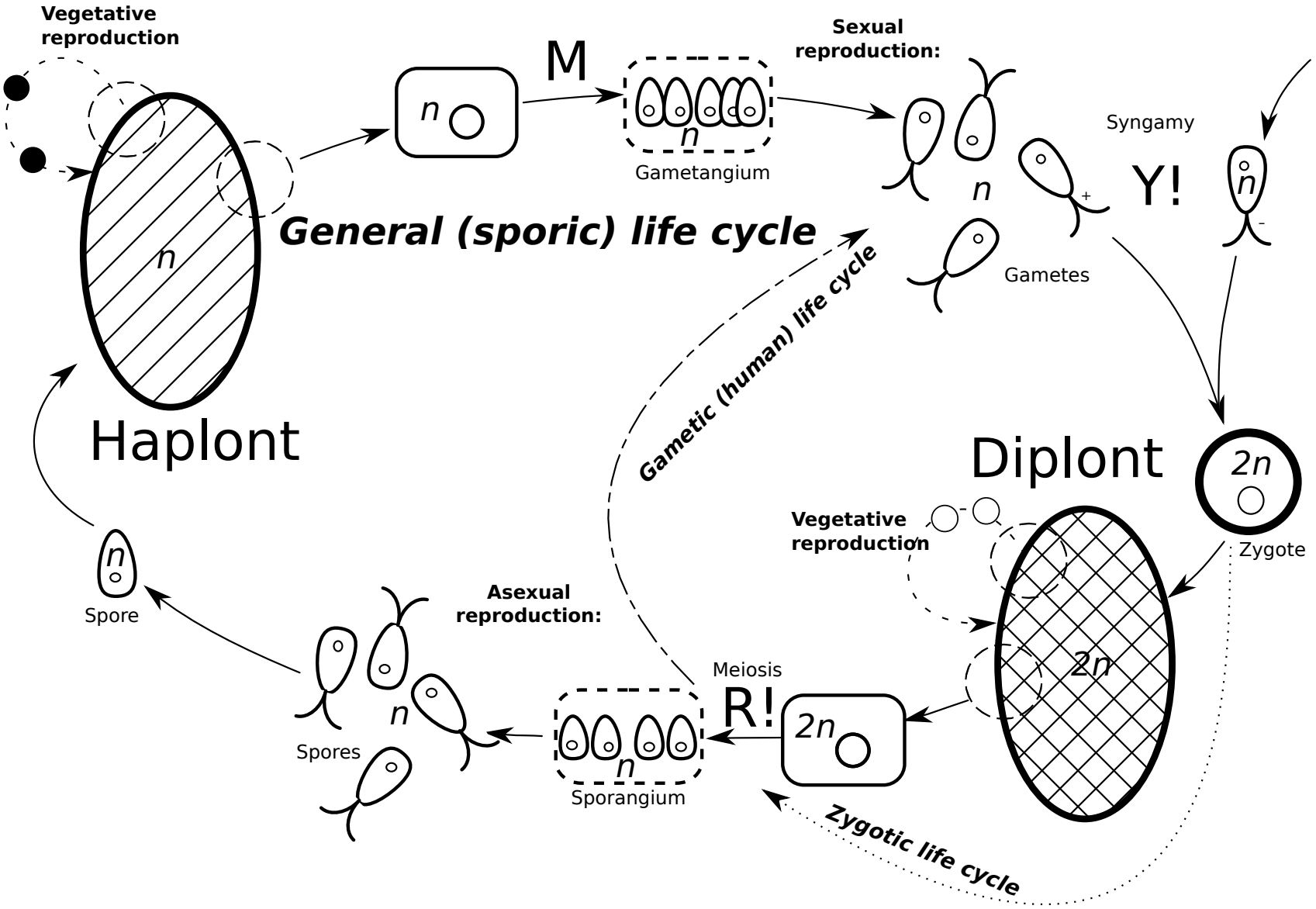
- Mendel “saw” genes mixed, segregated and then immediately mixed/recombined again
- In life cycle above, they are segregated, then mixed/recombined and immediately segregated again

This is because for multicellular organism, diploid condition is better. Since not all genes are strictly dominant, then:

- Diploids are broader adapted, due to two variants of gene
- If one copy breaks (mutation), the other still works

There are other pluses as well.

Life cycle of multicellular organism



Terms associated with multicellular life cycles

- mitosis, meiosis (R!), syngamy (Y!)
- vegetative reproduction (cloning), sexual reproduction and asexual reproduction
- result of syngamy: zygote; participant of syngamy: gamete
- smaller gamete: male, bigger gamete: female; movable male gamete: spermatozoon (sperm), motionless female gamete: oocyte (egg cell)
- result of meiosis: spores
- **haplont** (plants: **gametophyte**) and **diplont** (plants: **sporophyte**)
- **sporic** life cycle (like in plants), **gametic** life cycle (like in animals) and **sporic** (only protists)
- sporic: **gametophyte dominance** (mosses) and **sporophyte dominance** (ferns and seed plants)

Inheritance
Genes and chromosomes

Thomas Hunt Morgan and fruit fly

- Grey with normal wings $\times$ black with reduced wings: in first generation, all same (gray normal) but in second generation only two groups: 3/4 gray normal and 1/4 black reduced!
- BUT if you count thousands of fruit flies, few recombinants may be found
- WHY?

Linkage and crossing-over

- If genes are located in the same chromosome, they are **linked** and will not be inherited independently
- However, linkage could be broken in **crossing-over** (it runs in prophase I of meiosis)

Sex and chromosomes

- One gender has the pair where chromosomes are non-equal
- Deviating chromosome is sex chromosome, it contains small number of genes
- Two variants are possible: XY (mammals, fruit fly, ginkgo tree) and ZW (birds, butterflies)
- In both cases, sexes are always 1:1
- The gender where chromosomes are equal often has the second chromosome inactivated (i.e., Barr body in human female cells)
- The gender where chromosomes are non-equal is more susceptible to mutations because all mutations in main chromosome will be manifested (it has no counterpart)

Summary

- Plant body and its tissues is the result of adaptation for the life on land
- The life cycle is the sequence of events between two syngamies
- Gender is the result of division of labor between two gametes: female gametes invest in resources whereas male invest in numbers
- Mendelian (classic) genetics is based on segregation, dominance and independent assortment

For Further Reading

Mendelian inheritance.

`https://en.wikipedia.org/wiki/Mendelian_inheritance`

Punnett square.

`https://en.wikipedia.org/wiki/Punnett_square`

Linkage.

`https://en.wikipedia.org/wiki/Genetic_linkage`

Sex chromosomes.

`https://en.wikipedia.org/wiki/Sex_chromosome`