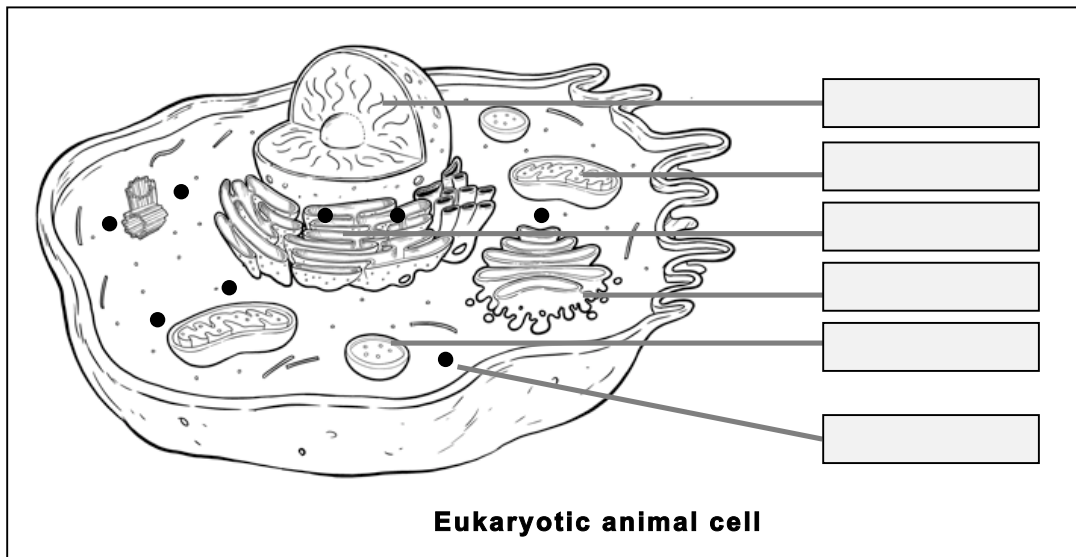


7.016 Problem Set 3- 2018

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Question 1

a) The following is the schematic of a **eukaryotic animal cell**. Use the following keywords to fill in the boxes: *Ribosome, Nucleus, Lysosome, Endoplasmic reticulum (ER), Golgi apparatus and mitochondrion*.



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b) The human microbiome is a collection of different bacteria, viruses and other microorganisms that inhabit us and form a micro ecosystem. Circle **ALL** correct options for each of the following.

- i. Which of the given options are self-replicating cells: **Bacteria/ viruses/ skin cells?**
- ii. Which of the given options are prokaryotic cell: **Bacteria/ viruses/ skin cells?**
- iii. Which of the given options contain membrane bound subcellular organelles: **Bacteria/ viruses/ skin cells?**

c) Identify the organelle within a human cell that generates energy in the form of ATP: _____

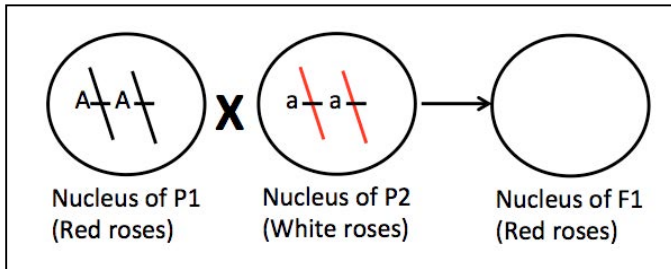
d) According to the endosymbiotic theory, the organelle that you identified in **part (c)** is often regarded as a prokaryotic cell that was engulfed by a eukaryotic cell during the course of evolution. List **two features** of this organelle that characterize it as likely to have been derived from a prokaryotic cell.

Note: Your answers may vary.

Question 2

After receiving many bouquets of flowers on your high school graduation day, you become very interested in studying the traits of different plants. You decide to study petal color (red or white) in a variety of rose plants. Gene A regulates this trait.

a) You cross the P1 and P2 plants, which have the following genotypes. You obtain 100 F1 all of which have red roses. On the diagram below, draw the chromosomes and fill in the genotypes of F1 plant.



b) You cross two **F1 plants** and obtain 100 plants in the F2 generation.

i List the **genotypes and corresponding ratios** of the F2 plants for petal color.

Genotype(s) and corresponding ratios: _____

ii List the **phenotypes and corresponding ratios** of the F2 plants for petal color.

Phenotype(s) and corresponding ratios: _____

c) You want to determine whether a red rose plant is homozygous or heterozygous for the alleles of Gene A. You therefore subject it to a test cross.

i. Give the genotype and the phenotype of the plant you would use in the test cross with the red rose plant.

Genotype: _____

Phenotype: _____

ii. If the red rose plant was **homozygous** for the allele A of Gene A, what would be the...

• **Genotype(s) and ratio** of the resulting plants? _____

• **Phenotype(s) and ratio** of resulting plants? _____

iii. If the red rose plant was **heterozygous** for the allele A of Gene A, what would be the...

• **Genotype(s) and ratio** of the resulting plants? _____

• **Phenotype(s) and ratio** of resulting plants? _____

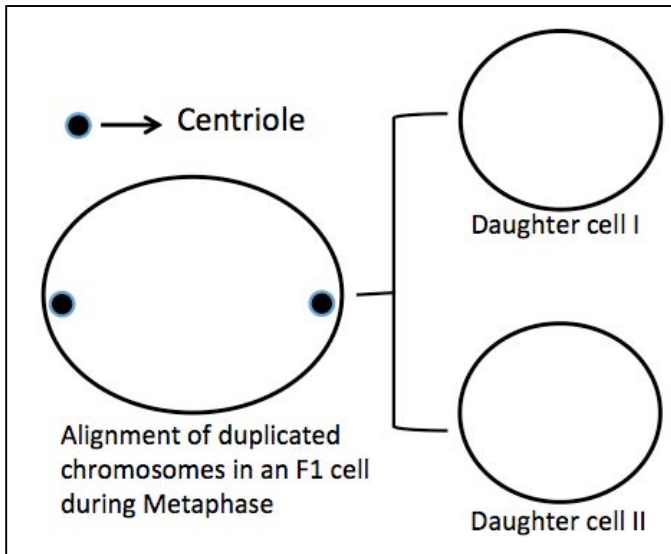
Question 3

In a variety of tulips, Gene D regulates the leaf shape and Gene H regulates flower color. **Gene D and Gene H are located on different autosomes.**

a) You cross **true-breeding P1 (narrow leaves/ blue tulips)** and **P2 (wide-leaves/ white tulips)** plants to get the F1 plants (**wide-leaves/ blue tulips**). Using “**D**” or “**H**” for the allele for the dominant phenotypes and “**d**” or “**h**” for the alleles for the recessive phenotype, give the genotypes of...

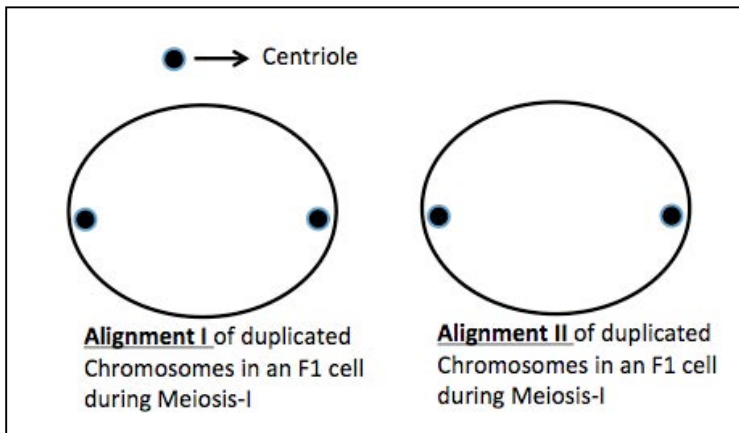
- i. True breeding **P1 plant (narrow leaves/ blue tulips)**: _____
- ii. True breeding **P2 plant (wide-leaves/ white tulips)**: _____
- iii. F1 progeny (**wide-leaves/ blue tulips**): _____

b) On the schematic below, draw the alignment of replicated chromosomes during **metaphase of MITOSIS** of an F1 cell and in the resulting daughter cells and show the arrangement of the alleles of Genes D and H on their corresponding chromatids.



c) If an F1 germ cell (reproductive cell) undergoes **MEIOSIS**...

- i. Draw the **TWO** possible alignments of replicated chromosomes during **Metaphase of Meiosis-I** on the schematic below. Only show the chromatids carrying the alleles of Genes D and H.



- ii. Give the **genotypes** and the **corresponding ratios** of the gametes produced as per....

Alignment I: _____

Alignment II: _____

Question 3 continued

d) You have two plants that have narrow leaves. An enzyme whose normal function is to make wide-leaves regulates the leaf shape. Do you know for certain that the two narrow leafed plants have the same allele of the gene encoding this enzyme? **Why or why not?** How would you determine if they have the same alleles?

e) You cross an F1 plant with another plant that is homozygous recessive for the alleles of both Gene D and Gene H. You obtain 400 F2 progeny. Fill in the table below for F2 progeny based on the assumption that the two genes assort independently.

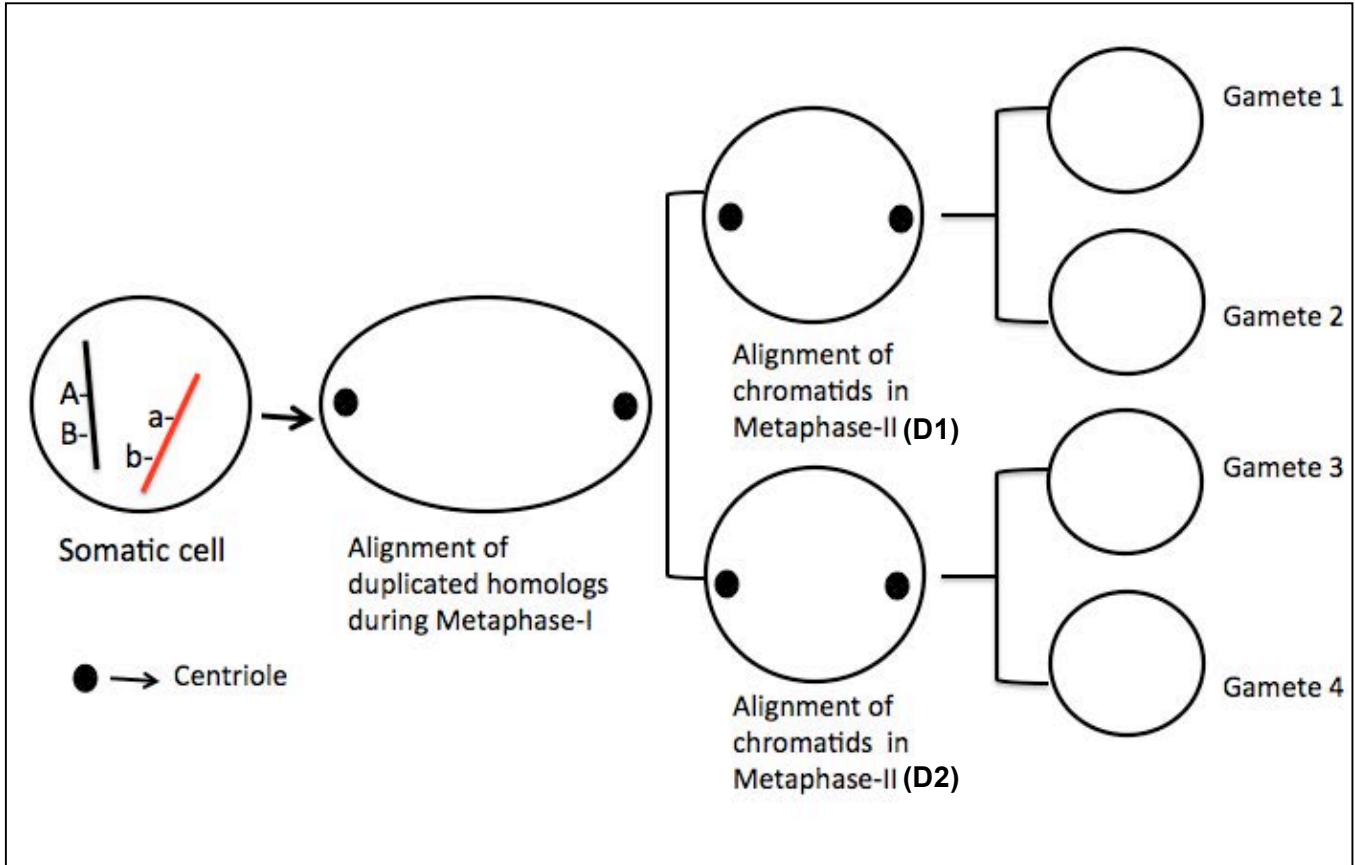
Genotypes?	Corresponding phenotype?	Corresponding estimated number?

f) You also cross two F1 plants to each other and obtain 1600 F2 plants. How many F2 plants will have **narrow leaves and blue tulips**?

Question 4

The following schematic represents a **F1** germ cell (reproductive cell).

a) If the F1 (germ cell) undergoing **MEIOSIS**, draw the alignment of replicated chromosomes **during Meiosis** on the schematic below. Also show the arrangement of the alleles of Genes A and B on all the chromatids. **Note:** Assume **NO recombination / NO crossing over**.



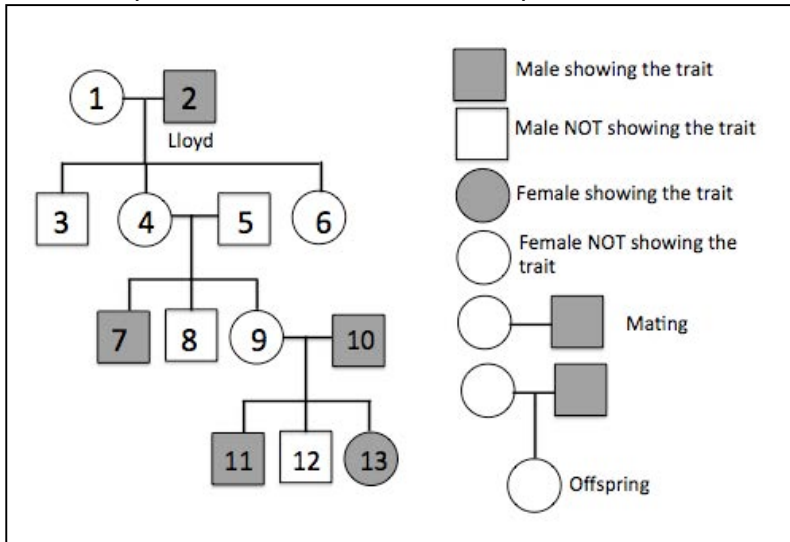
b) Trisomy of Chromosome 21 in humans can result in Down's syndrome, an inherited genetic disorder. If the "daughter cell 1 (D1)" in part (a) undergoes **nondisjunction** of chromosome 21 during Metaphase II, give the possible genotypes of the gametes that would result if **NO recombination** occurs between the alleles of **genes A and B**. **Note:** Answers may vary based on the drawing in part (a).

c) Could the nondisjunction events such as the one described in part (b) account for genetic disorders such as Trisomy 21? **Why or why not?**

Question 5

During your trip from Boston to San Francisco you realize that you are sitting next to Charlie Bean, the Director of Ninjago movie. Being a big Ninjago fan you start chatting with the director who surprisingly enough is willing to answer your questions!

During the conversation the director says the upcoming movie will have the next generation of spinjitzu masters (the trait) starting with Lloyd and his wife. He shows you the following pedigree for which more than one specific mode of inheritance is possible.



If this pedigree is true, does the inheritance of spinjitzu (trait) show an....

a) Autosomal dominant mode of inheritance? If not, give one possible explanation.

b) Autosomal recessive mode of inheritance? If not, give one possible explanation.

c) X-linked dominant mode of inheritance? If not, give one possible explanation.

d) X-linked recessive mode of inheritance? If not, give one possible explanation.

e) Using uppercase “**A or X^A**” as the allele for the dominant phenotype and “**a or X^a**” as the allele for the recessive phenotype give the genotype of **Individual 9** for each possible mode of inheritance for this pedigree.

f) Give **two reasons** why you use model animals such as plants, fruit flies, worms or yeast as opposed to humans to study if a specific gene is inherited as per Mendel’s laws of inheritance. **Note:** *Your answers may vary.*

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