# 7.013 Problem Set 2- 2018

## Question 1

After receiving many bouquets of roses on Valentine's Day this year, you become very interested in studying the traits of different plants. Given your surplus of roses, you decide to focus on them first.

You decide to study petal color (red or white) in a variety of rose plants. An autosomal Gene A regulates petal color.

You cross a plant with red roses (P1) to another plant with white roses (P2) and get 100 plants in the F1 generation, all of which have red roses.

**a)** Based on this information, give the **genotype(s)** of P1, P2 and F1 plants for petal color. ***Note:*** *Use **"A"** to represent the allele of Gene A that is associated with the dominant phenotype and **"a"** to represent the allele of Gene A that is associated with the recessive phenotype.*

**P1: _____ P2: _____ F1: _____**

**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 with which you would cross 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 2**
After running out of roses, you decide to study tulips. In tulips, an autosomal Gene D regulates the leaf shape and an autosomal Gene H regulates flower color.

**a)** You cross **true-breeding** P1 (**narrow leaves/ dark blue flowers)** and P2 **(wide-leaves/ white flowers)** plants to get the F1 plants (**narrow leaves/ pale blue flowers)**. ***Note:*** *You should assume that "blue" is the dominant trait.*

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/ dark blue flowers): _____**

ii. True breeding **P2 plant (wide-leaves/ white flowers): _____**

iii. F1 progeny (**narrow leaves/ pale blue flowers): _____**

**b)** Briefly **explain** why the flower color in F1 is different from that in P1 and P2 plants.

**c)** You cross an F1 plant with a tulip plant that has the same genotype as the P2 plant above. You obtain 1600 F2 progeny. Fill in the table below for F2 progeny based on the assumption that the two genes are unlinked and therefore assort independently as per Mendel's law of Independent assortment.

| **Genotypes?** | **Corresponding phenotype?** | **Corresponding estimated number?** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

**d)** You also cross two F1 plants to each other and obtain 1600 F2 plants. How many F2 plants will have…

i. **Narrow leaves** and **dark blue tulips? _____**

ii. **Wide leaves** and **white tulips? _____**

iii. Your friend says that the phenotype ratios of phenotypes in the F2 generation are different from those that would be expected from a dihybrid cross that followed Mendel's laws. Is your friend right? If so, **why**?

**Question 3**
Many plants are often the source of traditional herbal medicines. For example, the roots of the Kava plant, *Piper methysticum,* are often used to treat insomnia (the inability to fall asleep). Remember, we talked about sleep and wakefulness in problem set 1!

You cross a variety of Kava plant that is true breeding for **wide-round leaves (P1)** with another kava plant that is true breeding for **narrow-pointy leaves (P2)**. You obtain F1 plants all of which have **narrow-pointy** leaves.

**a)** Assume that **Gene A regulates leaf width** (wide or narrow) and **Gene B regulates shape** (round or pointy). Give the genotypes of the following plants for both traits, using "A" and "B" for the alleles regulating the dominant phenotypes and "a" and "b" for the alleles regulating the recessive phenotypes.

**P1: _____ P2: _____ F1: _____**

**b)** Assuming that Gene A and Gene B were **absolutely linked,** give the phenotypes, genotypes and the corresponding ratios of the F2 plants you would expect by **crossing two F1 plants**.

i. **Genotypes** and **corresponding ratios: _____**

ii. **Phenotypes** and **corresponding ratios: _____**

**c)** You cross an **F1 plant** with another plant that has the genotype **"aabb"**.

i. If Gene A and Gene B are **4cM apart**, complete the table below for each class of F2 plants. Assume there are 100 F2 plants in total.

| Genotypes? | Corresponding phenotype? | Corresponding number? |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

ii. In the table above, circle the **recombinant (non-parental) F2 phenotypes**

**d)** You also study Gene D, which regulates root color: brown (dominant, associated with allele D) or green (recessive, associated with allele d). Gene D and Gene A are 10cM apart.

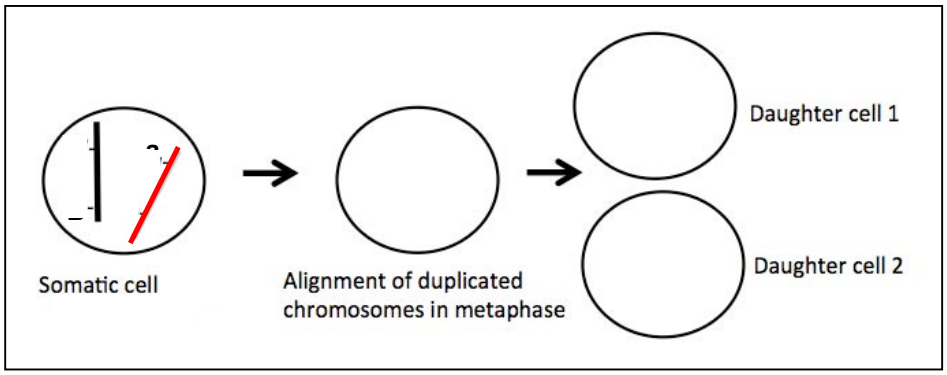
i. Draw the two possible chromosomal maps between Genes A, B and D and specify the distance (in cM) between them.

**Map 1:** **Map 2:**

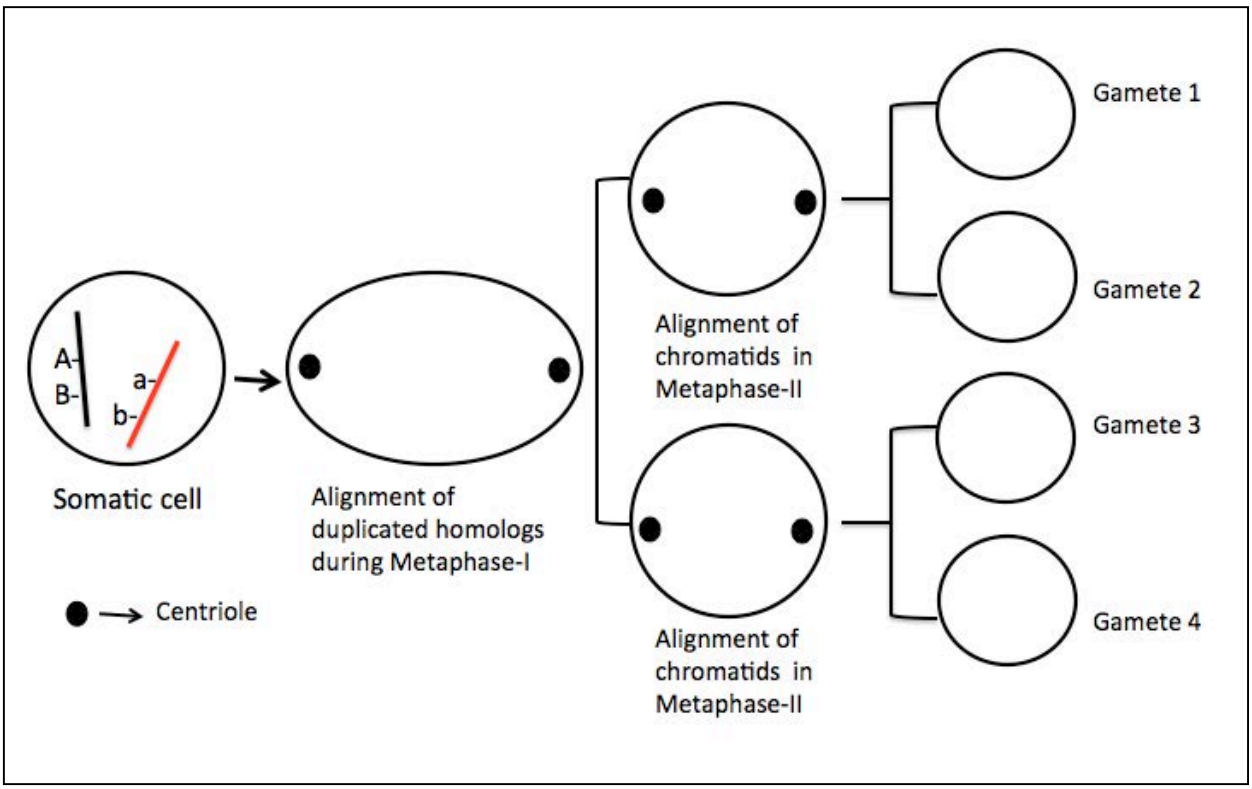
ii. Design a cross that can help you identify which of the above chromosomal maps is correct. ***Note:*** *Specify the genotypes of the Parental (P1 and P2), F1 and F2 plants that you will use in your crosses. Also specify the corresponding % of F2 progenies.*

**Question 4**
The following schematic shows the orientation of Genes A and B located **on chromosome 18 in humans. Note:** Trisomy of Chromosome 18 can result in Edwards's syndrome, an inherited genetic disorder.

**a)** On the schematic below, draw the alignment of replicated chromosomes during **metaphase of MITOSIS** and in the resulting daughter cells and show the arrangement of the alleles of Genes A and B on **all** the chromatids.

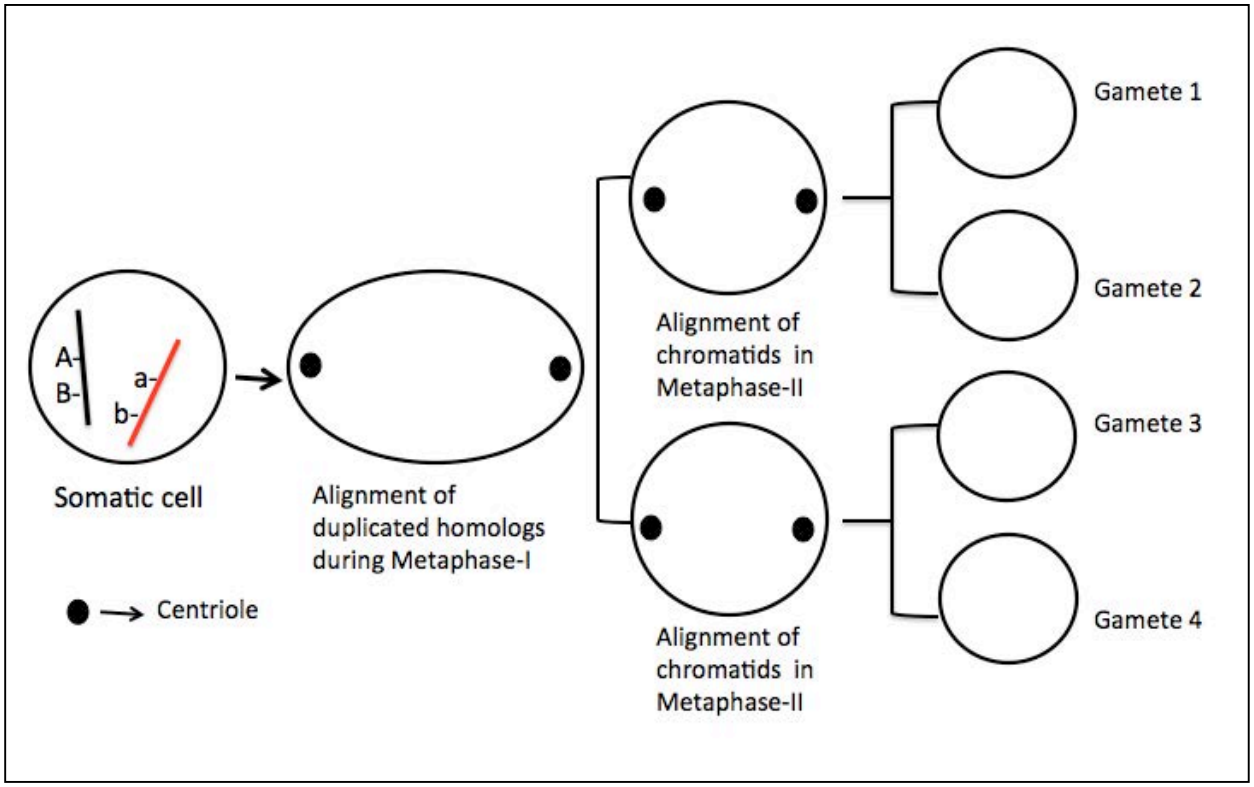



**b)** If the germ cell (reproductive cell) drawn below undergoes **MEIOSIS,** draw the alignment of replicated chromosomes during each phase of meiosis on the schematic below. Also show the arrangement of the alleles of Genes A and B on **all** the chromatids in each phase. **Note:** Assume **NO recombination** between the alleles of Genes A and B.



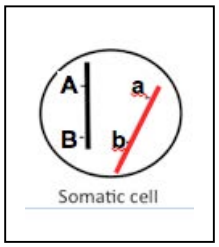
**Question 4 ccontinued**

**c)** If the "daughter cell 1" from Meiosis –I above undergoes **nondisjunction** of chromosome 18, how would the arrangement of the alleles of Genes A and B during different phases change compared to what you showed in **Part (b)?** Show the change(s) on the schematic below. **Note:** Assume **NO recombination** occurs between the alleles of Genes A and B.



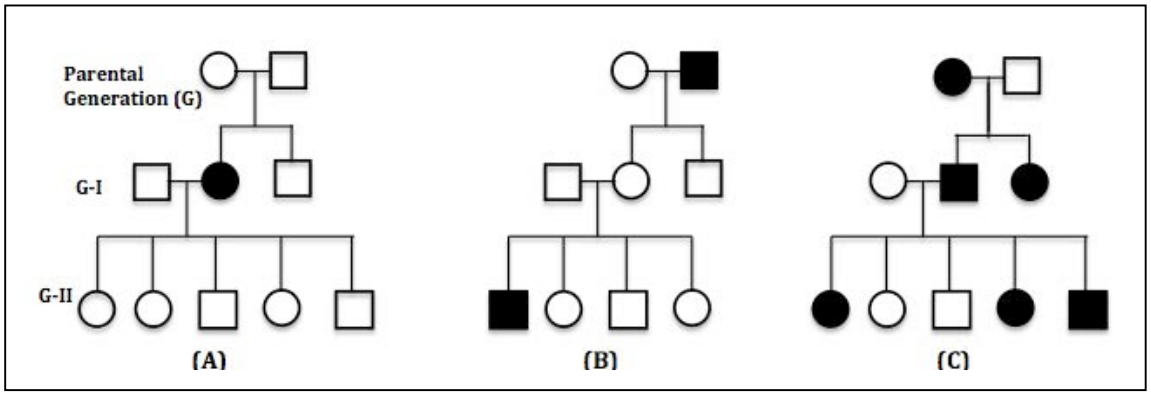

**d)** Could the nondisjunction events such as the one you drew in part (c) account for genetic disorders such as Trisomy 18 or Edward's syndrome? Why or why not?

**e)** If the germ cell drawn below undergoes **MEIOSIS, give the genotypes of the gametes. Note:** Assume **Recombination** between the alleles of Genes A and B.



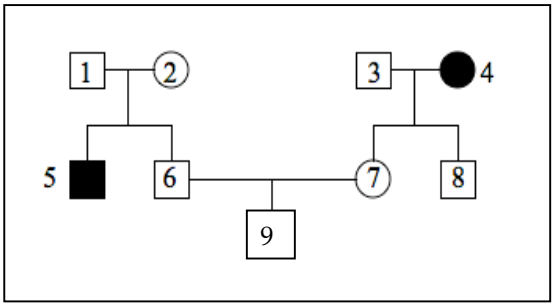
**Question 5**

Color blindness in humans has an **X- linked recessive** mode of inheritance. Prof. Amon draws the following three human pedigrees for you. **Note:** *You may assume that the individuals marrying into the family do not have the disease-associated allele and that no other mutation arises within the pedigree.*




**a)** Which of the above pedigrees shares the same mode of inherietnce as color blindness? **Explain** why you selected this pedigree.

**b)** On the pedigree below, shade in one individual so that the pedigree will show the same mode of **b)** On the pedigree below, shade in one individual so that the pedigree will show the same mode of inheritance as color blindness. **Explain** why you selected this individual specifically.



# 7.013 Introductory Biology

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