Genetics Group Practice Midterm 2021W2 222 and 223 - Key

Question 1

In plants, flowers are important for attracting pollinators. You have identified phenotypic variation in a population of plants that normally produce yellow flowers with red spots. Some individuals have yellow flowers that lack red spots. In plants, red coloration is produced by a group of pigments called anthocyanins. As well, some of the plants live in locations with high concentrations of copper in the soil; copper is generally toxic to plants.

You want to determine if the spot phenotype and copper tolerance have a genetic basis and how these traits are inherited. You collect a number of plants from a wild population and perform a series of crosses in the lab. The parents are given numbers in addition to phenotypes since the same individual may be used in multiple crosses (e.g. different flowers of the same individual serving as the source or pollen or ovules). The results are outlined in the table below.

Cross #	Ovule Parent	Pollen Parent	Offspring
A	#1 Spots; copper tolerant	#1 Spots; copper tolerant	40 plants with spots and copper tolerant 13 plants with spots and copper intolerant
B	#2 No spots; copper intolerant	#2 No spots; copper intolerant	67 plants with no-spots and copper intolerant
C	#1 Spots; copper tolerant	#2 No spots; copper intolerant	34 plants with spots and copper tolerant 32 plants with spots and copper intolerant
D	#3 Spots; copper intolerant	#3 Spots; copper intolerant	54 Plants with spots and copper intolerant 18 Plants with no-spots and copper intolerant

1.1 How many genes appear to be involved in copper tolerance. Briefly explain your reasoning based on evidence from the crosses.

(one gene with two alleles; in cross 4 we see a 3:1 phenotypic ratio of tolerant to intolerant plants suggesting that the parents are heterozygous for a single gene with two alleles)

1.2 Generate gene and allele symbols for the traits under consideration in the cross. Clearly indicate gene and allele names. Please use a capital letter for the gene name and superscripts (indicated with a ^) for the allele (e.g. Q^1, would be allele 1 of the Q gene).

Gene for Spots = S

Spot allele = S^s

No-spot allele = S^n

Gene for Copper tolerance = C

Tolerant allele = C^t

Intolerant allele – C^i

1.3) Using the allele symbols you generated, indicate the complete genotype for the following individuals:

#1) S^s S^s ; C^t C^i

#2) S^n S^n ; C^i C^i

#3) S^s S^n; C^t C^i

1.4) You have collected additional plants from the population and want to determine their genotypes, which individual from your original cross could you cross with your new plants to determine their genotype?

#2

1.5) In the lab, you have bred plants that are pure breeding. The phenotypes of these plants are: a) no-spots and copper tolerant and b) spots and copper intolerant. You cross these plants and generate an F1 generation. You take two F1 individuals and cross them to generate an F2 generation. What phenotypes would you expect in the F2 generation and in what would be the frequency of each phenotype if the genes are unlinked?

This is a typical dihybrid cross

Spots + copper tolerant = 9/16

Spots + copper intolerant = 3/16

No-spots + copper tolerant = 3/16

No-spots and copper intolerant = 1/16

1.6) In the lab, you have bred plants that are pure breeding. The phenotypes of these plants are: a) no-spots and copper tolerant and b) spots and copper intolerant. You cross these plants and generate an F1 generation. You take two F1 individuals and cross them to generate an F2 generation. What phenotypes would you expect in the F2 generation and in what frequency if the genes are completely linked (i.e. can't be separated by crossing over)?

Parents: No-spots + tolerant (S^n S^n ; C^t C^t) x Spots + intolerant (S^s S^s; C^i C^i)

F1 S^n C^t / S^s C^i

F2

	S^n C^t	S^s C^i
S^n C^t /	S^n C^t / S^n C^t No spots/ tolerant	S^s C^I / S^n C^t Spots / tolerant
S^s C^i	S^n C^t / S^s C^i Spots - tolerant	S^s C^I / S^s C^i Spots - intolerant

¼ no-spots tolerant

½ spots tolerant

¼ spots - intolerant

Q2 Probability and Frequency

2.1 You have a diploid plant with the following genotype: Aa BB Gg Rr. How many different haploid genotypes can this individual produce if you consider cells produced from many meiotic divisions?

Gamete types = 2^3 = 8

2.2) You have a diploid plant with the following genotype: Aa BB Gg Rr. How many different haploid genotypes can this individual produce if you consider cells produced from a single meiotic division?

Only four products are produced from a meiotic division so the max = 4

2.3) You have a diploid plant with the following genotype: Aa BB Gg Rr. This plant is capable of self-fertilization. What is the probability of an offspring with the genotype AA BB gg Rr

Prob = ¼ x 1 x ¼ x 2/4 = 2/64 = 1/32

Genetic Variation and Chromosome Drawing / Diagrams

You have a two pure breeding, diploid, pea plants. One plant has white flowers and round seeds. One plant has purple flowers and wrinkled seeds. In this species, purple (P) is dominant to white (p) and round (R) is dominant to wrinkled (r). Please note the "p" allele is underlined for clarity. In this example, these genes occur close together on the same chromosome and are on the same side of the centromere. You cross the parents to generate an F1 individual. The following images relate to cells or stags of cell division in the F1 individual. Only the chromosome or chromosomes containing genes of interest are diagrammed.

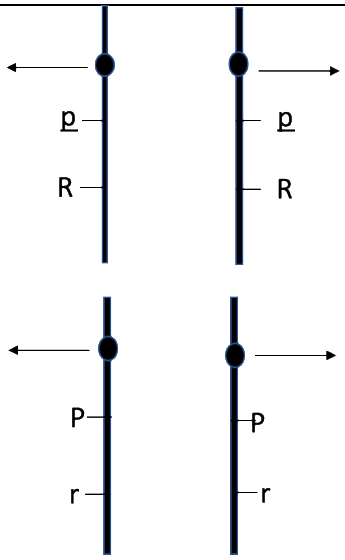
Evaluate the following statements as True or False:

3.1) T/F All four possible haploid genotypes will occur with equal frequency.

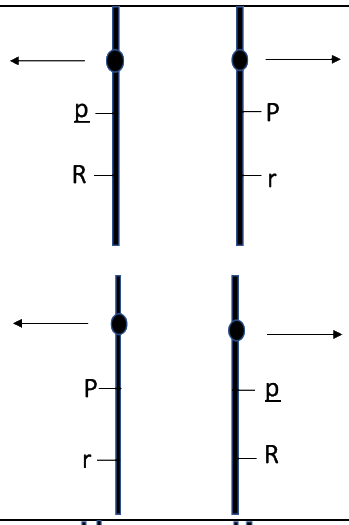
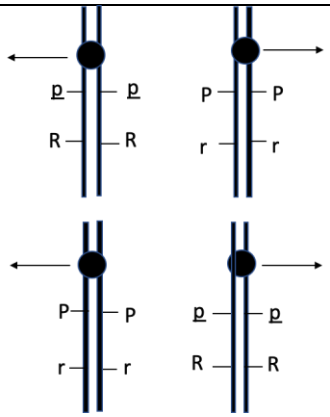
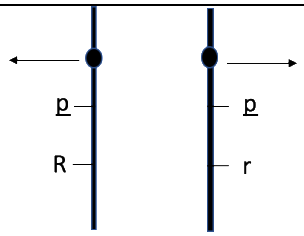
3.2) For the flower colour and seed shape genes, which processes will result in genetic variation among offspring if an F1 individual is self-pollinated. Choose all that apply.

Crossing over and random fusion of gametes

3.3) Each of the images represent chromosomes in a single anaphase cell. Indicate if the diagram represents anaphase of meiosis I, meiosis II, mitosis or is not possible. Please note that crossing over does occur in this species.



Mitosis

	Not possible
	Not possible
	Meiosis II