

Group Practice Final Exam BIOL121-123 – Dr. Brett Couch

1) You are studying inheritance of a flower color and size in cultivated peas. Peas are $2N$ and imagine that in this species $2N=4$. You begin your experiment with pure breeding parents with the following phenotypes: parent 1 had large purple flowers; parent 2 had small white flowers.

The gene for color you designate as “C” and the gene for flower size you designate “S”.

The alleles of the genes are: C^P (purple); C^W (white); S^L (large); S^S (small).

The all individuals in the F_1 generation have small purple flowers. Reciprocal crosses give the same outcome (e.g. using parent 1 as the pollen parent and using parent 2 as the ovule parent then performing the reciprocal cross where parent 1 is the ovule parent and parent 2 is the pollen parent).

1a) Diagram a cell from an F_1 individual at anaphase 1 of meiosis where the C and S genes are tightly linked and crossing over has not occurred. Indicate the spindle and direction of chromosome movement. Use gene and allele symbols provided. **(5 marks)**

1b) For the cell you diagrammed in 1a, where does segregation occur (**1 mark**)? _____

For both of the scenarios below, indicate the possible phenotypes for the F₂ offspring and their expected frequencies. (**4 marks**)

1c) The C and S genes are very tightly linked and you can ignore the effect of crossing over.	1d) The C and S genes are unlinked

1e) For the scenario in “1d”, what process or processes are responsible for genetic variation among the F₂ offspring? (1 mark)

2) Consider a plant species that is diploid ($2n = 4$). An F₁ plant with the genotype Aa Bb was produced by a mating between two pure-breeding parents with the genotypes aaBB and AAbb. From previous experiments you have determined that alleles of the A and B genes do not assort independently. Crossing over does occur in this species.

a) Each diagram represents a single anaphase cell from the F₁ (Aa Bb) plant. For each diagram indicate if the diagram shows chromosomes during anaphase of mitosis, meiosis I, meiosis II or if the arrangement is not possible. (4 marks)

3) Male seahorses in the genus *Hippocampus* are responsible for parental care of offspring. Males have a structure called a brood pouch. Mating involves females transferring eggs to the brood pouch of the male; the male's sperm is also transferred to the brood pouch. Males do not mate with multiple females. The embryos within the eggs develop within the brood pouch. Most of the nutrients for development of the

embryo come from resources in the egg. The brood pouch provides protection and some nutrients for the developing offspring. Females do not contribute to care of offspring following fertilization. In females, larger individuals produce more eggs, larger eggs and larger offspring. Females vary in size within populations.

3a) In some situations, males preferentially select larger females to mate with. Based on the information above, briefly explain the reasoning underlying the hypothesis that male seahorses may prefer to mate with larger females. Your answer should be logical and make specific reference to the fitness effect of male choice on male fitness. **(5 marks)**

3b) Imagine that subsequent studies have shown that in a common environment in the lab, large females consistently have larger offspring regardless of the size of the male parent and the survival rate for large offspring is higher than for smaller offspring. Your friend suggests that female size may be a trait that could experience sexual selection. Do you agree with his claim? **(1 mark)**

Yes / No (circle one)

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3c) Explain why or why not with specific reference to each of the three main criteria required for selection.
(3 marks)

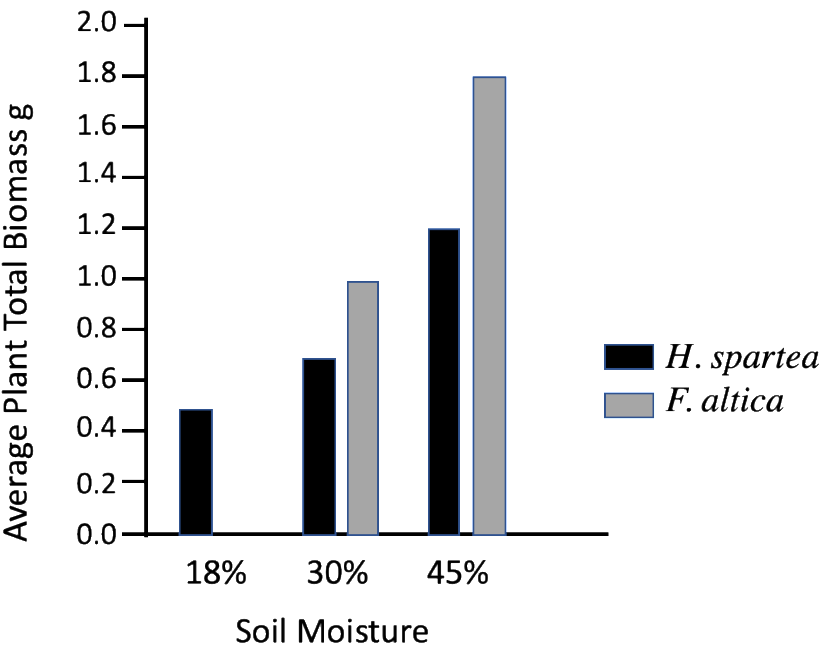
Criteria for Selection	Explanation

4) *Hesperostipa spartea* (*H. spartea*) or porcupine grass, grows in grasslands of south-eastern British Columbia. Another common grass species, *Festuca altaica* (*F. altaica*), also grows in this habitat. Small hills are present in this habitat, with soil moisture and nitrogen varying consistently from the top of the hill to the bottom (Table 1A).

Table 1A. Average soil moisture and nitrogen levels in grassland habitats in south-eastern British Columbia

Location on hillside	Soil Moisture Level (%)	Soil Nitrogen mg/kg
Top of hill	< 20	660 mg/kg
Side of the hill	20 – 40	740 mg/kg
Hollows between hills	> 40	880 mg/kg

In the grassland you are studying, *H. spartea* occurs almost exclusively on the tops of hills while *F. altaica* is found exclusively on the sides of the hills and in the hollows between the hills. Greenhouse experiments, where plants were grown in individual pots, were performed to assess the influence of water on productivity. In this experiment nitrogen was provided in excess so was not limiting. All differences in growth were statistically significant at (P=0.05).



4a) Why do you think *H. spartea* occur almost exclusively on the tops of hills? Briefly explain your reasoning. **(2 marks)**

4b) Why do you think *F. altica* only occurs on the sides of hills and in the hollows between hills? Briefly explain your reasoning? **(2 marks)**

4c) You set up an experiment to determine the factor(s) that influence the distribution of *H. spartea* and *F. altica*. You create plots at the top and bottom of the hills. For both the top and bottom of the hill, you have three treatments: *H. spartea* alone, *F. altica* alone and plots with a mixture of *H. spartea* and *F. altica*. You plant the same number of individuals in each plot and measure the biomass at the end of the experiment.

Given your explanations for the distribution of each species in 4a and 4b, generate a figure showing the expectations of the average plant total biomass for this experiment. **(5 marks)**

4d) Thinking back to the experiment we discussed in class on the effect of changes in rainfall frequency on grasslands, how do you think changes in rainfall frequency could affect the distribution of *H. spartea* and *F. altica*. (2 marks)

Commented [MOU2]: Other sections may want to remove if you did not discuss the manipulated watering-grassland experiment.