

BIOL 121 Section 123 2022T1 Evolution Group Midterm Answer Guide

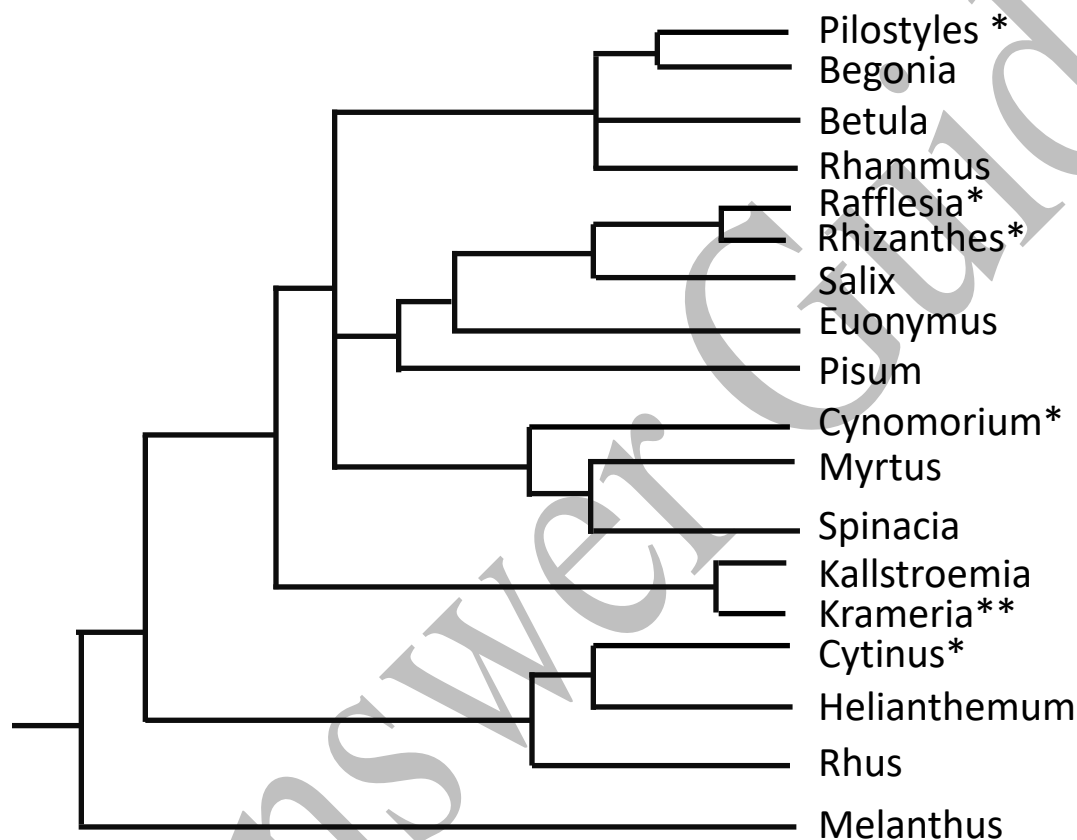
Group Number from Canvas _____ Max Group Members = 6

- 1) Don't take the test booklet apart.
- 2) Answer all questions in the space provided.
- 3) Writing can be in pencil or ink, but pencil, erasable ink or answers with white-out **cannot** be remarked.
- 4) Answers may be in sentences or point form. Illustrations are acceptable but must be annotated.
- 5) Students suspected of any of dishonest practices will be immediately dismissed from the examination and will be subject to disciplinary action.
- 6) Other than a **one-page** (double-sided) study sheet, no other memory devices are permitted. Study sheets that exceed the size limit may be confiscated and may be considered as cheating.
- 7) Students may speak with group members but not other groups.
- 8) Make sure you have 6 pages (3 pieces of paper) including this cover page.

Question	Value	Score
#1	16	
#2	9.5	
#3	14	
Total	39.5	

Question 1 – 16 Marks

- 1) There are a number of groups of plants that are parasitic on other plants. Some parasitic plants are obligately parasitic; they lack chlorophyll, don't produce sugars by photosynthesis and are completely dependent on another host plant for nutrition. Other parasitic plants are hemiparasitic (half-parasitic); they possess chlorophyll, produce sugars by photosynthesis and get some nutrition from another host plant. The phylogeny below shows the relationships among a large group of plants called the Rosids. Parasitic genera are indicated with a *, hemiparasitic genera are indicated with a **. In plants, once photosynthesis is lost, the trait is not regained.

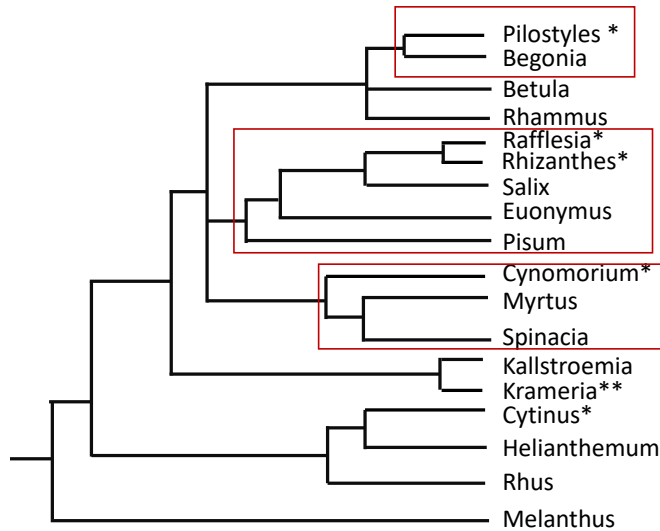


- 1a) What is (are) the most closely related genus (genera) to Rhus (2 marks).

Cytinus and Helianthemum

- 1b) On the phylogeny, circle a monophyletic group of your choice that contains more than one genus (2 marks).

- Any monophyletic group some examples are shown in the image below.
-



1c) Briefly explain why the group you chose is monophyletic. (2 marks)

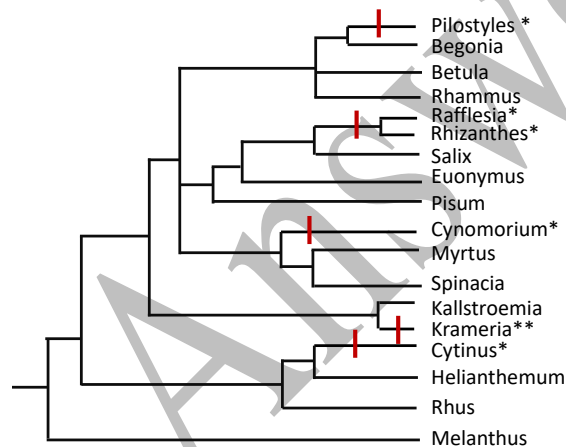
The group contains an ancestor and all of its descendants. These can be listed but not necessary.

1d) What is the minimum number of times that parasitism has evolved in the Rosids? (1 mark)

Five

1e) On the phylogeny indicate where parasitism has evolved (2 marks).

Origins of parasitism indicated with red marks on branches. Marks must be along branches.



1f) Are Euonymus, Salix and Rhizanthus transitional forms between Pisum and Rafflesia? Briefly explain your reasoning. (2 marks)

No, these are all extant (existing today) taxa. Taxa living in the present can't be transitional between other extant taxa.

1g) In the Rosids, parasitism is (**1 mark**):

- a) An analogous trait.
- b) A homologous trait.
- c) A vestigial trait.
- d) Ancestral trait
- e) Not possible to determine with the information provided.

1h) Provide a brief written justification to your answer to 1g explaining why you concluded that parasitism was an analogous, homologous, vestigial or ancestral trait. (**2 marks**)

Parasitism is an analogous trait as it is present in taxa that do not share a parasitic ancestor.

1i) Was the ancestor of the Rosids parasitic? Briefly explain your reasoning. (**2 marks**)

No, most of the descendants of the common ancestor are not parasitic. Since parasitism is associated with loss of photosynthesis, a parasitic ancestor lacking photosynthesis would not give rise to descendants that were non-parasitic and photosynthetic.

Question 2 – 9.5 Marks

2a) List three specific characteristics that support the conclusion that all living organisms share a common ancestor. (**1.5 marks**)

DNA as genetic material
Organisms are cellular
Common genetic code
Common information flow (DNA to RNA to protein)
Common amino acids used to make proteins.

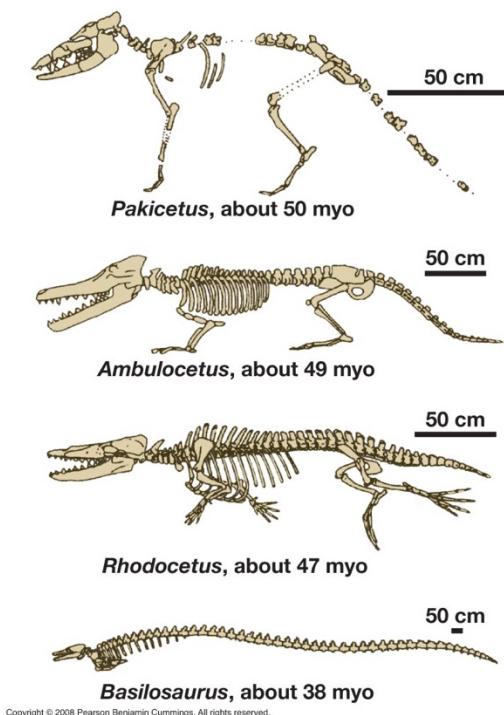
Other characters are possible but must not be general classes of evidence (e.g. genetic homology)

2b) For the characteristics you listed in 2a, explain how they support the conclusion that all living organisms share a common ancestor. (**3 marks**)

The presence of characteristics (listed above) shared by all living organisms indicates that they likely inherited these characteristics from a common ancestor (rather than these characteristics evolving multiple times).

2c) The figure from your text outlines the current understanding of the evolution of whales. Given the figure and your knowledge from class, explain how transitional forms are evidence that organisms have changed through time. (5 marks)

(b) Transitional forms during the evolution of whales



These organisms are related based on shared features of their skulls (specifically the temporal bone) and occurred at different times. The oldest (earliest) fossil, *Pakicetus* had skeletal features associated with a primarily terrestrial habitat close to a marine environment. Fossils occurring later show evidence of adaptation to marine environments – reduction of limb length and change in placement of nostrils. The latest fossils in the series show adaptations to a completely marine environment – loss of rear limbs. Since these organisms are related and there has been an observable change in characteristics through time, this supports the conclusion that organisms have changed through time.

Question 3 – 14 Marks

3a) You are studying a population of four o'clock flowers. You know from BIOL121 that flower color is determined by a single gene with 2 co-dominant alleles: AA individuals have purple flowers; Aa individuals have pink flowers; aa individuals have white flowers. Consider a population of 123 plants with the frequency of the A allele of 0.38. Fill in the table below for genotype frequencies and numbers of individuals. Report frequencies to two decimal places; numbers of individuals must be integers. You can use the next page for rough work. (6 marks)

Genotype	Expected frequency of genotypes if the population is in	Expected Number of Individuals if the Population is in	Possible Frequency of Individuals if the Population is NOT in	Possible Number of Individuals if the Population is NOT in Hardy

	Hardy Weinberg Equilibrium	Hardy Weinberg Equilibrium	Hardy Weinberg Equilibrium	Weinberg Equilibrium
AA	0.14	18	0.38	$0.38 * 123 = 47$
Aa	0.47	58	0	$0 * 123 = 0$
aa	0.38	47	0.62	$0.62 * 123 = 76$

For the initial population:

Frequency of A = $p = 0.38$

Frequency of a = $q = 1 - .38 = .62$

If the population is in HW equilibrium then the genotype frequencies are:

Frequency of AA = $p^2 = 0.38^2 = 0.14$

Frequency of Aa = $2pq = 2 * .38 * .62 = 0.47$

Frequency of aa = $q^2 = 0.62^2 = 0.38$

Number of individuals

AA = $0.38^2 * 123 = 18$ (Note: you should do this calculation before rounding the frequency of AA – only round the final answer; grading will take into account variations in rounding)

Aa = $2 * .38 * .62 * 123 = 58$

aa = $.62^2 * 123 = 47$

For the population not in HW equilibrium, the allele frequencies must remain the same but the genotype frequencies are not as expected. The simplest way of approaching this is to consider a case with only homozygous individuals.

Let X be the frequency of AA individuals

The frequency of the A allele = (Frequency of AA individuals + $\frac{1}{2}$ Frequency of Aa individuals)/total frequency of

$$0.38 = (X+0) / 1 \quad x = 0.38$$

Frequency of aa individuals = 0.62

Do Not Take Test Booklet Apart.
BIOL121-123 Group Midterm 2

Other values for genotype frequencies are possible but must result in allele frequencies of 0.38 and 0.62

Answer Guide

3b) Studying the population you determine that bees visit plants with purple flowers more frequently than plants with pink or white flowers. Bees also tend to move from one purple flowered plant to another rather than between plants with different flower colors. You also measure the number of seeds produced by each plant; all plants regardless of flower color produce the same number of seeds on average and seeds have the same germination rate (i.e. the same proportion of seeds germinate). Would you expect this population to be in Hardy-Weinberg equilibrium? Briefly explain your reasoning with specific reference to all of the relevant assumptions of Hardy Weinberg equilibrium. **(4 marks)**

The population would not be in HW equilibrium as two assumptions are violated:

- 1) The population is small so changes in genotype frequencies from expected can occur as a result of sampling – this would be an example of change in genotype frequencies due to genetic drift.
- 2) The population is not randomly mating. Since bees are preferentially visiting purple flowers and moving from purple flower to another purple flower, movement of pollen is dependent on the flower color and will result in a higher frequency of pollination of purple flowers with pollen from other purple flowered plants than would be expected if mating were random. This would result in an excess of homozygous AA than expected.

The points below are not required for the answer but are included to address other possible mechanisms students may discuss.

- 3) Selection is not acting on this trait as all plants have equal fitness (they produce the same number of seeds and have the same germination rate)
- 4) There is no mention of mutation so not relevant for this scenario – mutation has little impact on allele frequencies so is not a powerful enough evolutionary force to affect allele frequencies in this population.
- 5) No discussion of gene flow so not relevant to this scenario.

3c) Plants in the original population mated randomly, if you collected seeds from the plants and established 10 new populations of 75 individuals each, would you expect the frequencies of the A and a alleles in each of these populations to be the same as the original population or different? Explain your reasoning with specific reference to relevant evolutionary mechanisms. **(4 marks)**

You would not expect the allele frequencies to remain the same in the new populations. Genetic drift due to sampling of seeds to establish the new populations would alter allele frequencies in the new populations. This would be an example of the founder effect.

Answer Guide