(1) MALLARD DUCKS. Male and female mallard ducks differ in their appearance and morphology. The females have feathers that create a color pattern that helps them blend into the background when on land (middle of the picture to the right). The males have bright green heads, and glossy, colorful plumage.

Mallard ducks have a reputation for forming pairbonds which persist until the next breeding season. In one study conducted by Holmber, Edsman and Klint (1989), female mallard ducks chose mates with high social display activity, high plumage status, and intermediate age. Although mallard ducks have a reputation for forming seasonal pairbonds, the reality is much more disturbing. Female ducks are often forcibly mated by groups of males.

Female mallards have oviducts with sacs and dead ends that are able to hold and expel unwanted sperm. In addition, the oviduct corkscrews in the opposite direction of the very large male mallard penis.

(a, 2 pts) In contrast to the males, which are brightly colored and easy to spot,

female mallard ducks exhibit ______cryptic_______ coloration.

(b, 4 pts) Why would the female oviduct have evolved in the way described? I.e., how would the ability to expel unwanted sperm benefit females? Identify the fitness benefit(s) of this adaptation. Be clear and concise in your answer.

Since the mating act is forcible these structures allow females to exert post-copulatory sexual selection. Females with this trait can expel sperm from males they would not choose and retain sperm from ones they would choose, experiencing higher fitness by being able to use sperm from males that exhibit better characteristics (e.g., health, size, etc.)

(c, 4 pts) Why does forcible mating persist in mallard ducks despite the females’ ability to expel unwanted sperm? Identify the fitness benefit(s) of this adaptation. Be clear and concise in your answer.

The post-copulatory sperm selection isn't perfect, nothing is - males that forcibly mate have at least some chance to fertilize the eggs whereas males that don't perform this behavior are guaranteed a lower relative fitness. Males performing this behavior therefore have higher fitness than ones that don't so it persists.
(2) POISON and BIRDS Consider the citation and abstract for a recently published paper below. You will use the information to answer the questions on this page.


Abstract: We present evidence of a possible case of self-medication in a lekking bird, the great bustard Otis tarda. Great bustards consumed blister beetles (Meloidae), in spite of the fact that they contain cantharidin, a highly toxic compound that is lethal in moderate doses. In addition to anthelminthic properties, cantharidin was effective against gastrointestinal bacteria that cause sexually-transmitted diseases. Although both sexes consumed blister beetles during the mating season, only males selected them among all available insects, and ingested more and larger beetles than females. The male-biased consumption suggests that males could use cantharidin to reduce their parasite load and increase their sexual attractiveness. This plausibly explains the intense cloaca display males perform to approaching females, and the meticulous inspection females conduct of the male's cloaca, a behaviour only observed in this and another similar species of the bustard family. A white, clean cloaca with no infection symptoms (e.g., diarrhoea) is an honest signal of both, resistance to cantharidin and absence of parasites, and represents a reliable indicator of the male quality to the extremely choosy females. Our results do not definitely prove, but certainly strongly suggest that cantharidin, obtained by consumption of blister beetles, acts in great bustards as an oral anti-microbial and pathogen-limiting compound, and that males ingest these poisonous insects to increase their mating success, pointing out that self-medication might have been overlooked as a sexually-selected mechanism enhancing male fitness.

(a, 2pts) Which of the words listed below fits in the blank to the right (i.e., is in the actual title of the paper)?

- aposematic
- Batesian
- cryptic
- Mullerian
- polyandrous
- polygynous
- protoandrous
- protogynous

The female choice mechanism described can be argued to fit either of two of the models described in class. Make a pair of arguments, one for each of these. Name the model and describe how it fits the scenario described. Also, describe a model this clearly isn't. Name the model and describe how it doesn't fit the scenario described. Be concise.

(b, 3 pts) This female choice appears to be a case of ...

**Good genes** since a clean cloaca indicates freedom from parasites.

(c, 3 pts) This female choice appears to be a case of ...

**Handicap principle** since a clean cloaca indicates the ability to withstand poisoning from the cantharidin

(d, 3 pts) This female choice clearly isn't a case of ...

**Hybridization avoidance** since no other species are mentioned.
**Direct benefit** since the males aren't giving the females anything.
**Pre-existing bias** since no mention was made of this aspect of female behavior.
**3) RELATEDNESS.** Depicted to the right is a pedigree (family tree) just like the one in class, representing males (squares) and females (circles) that mate to produce offspring.

Compute the Probabilities of alleles being shared between two individuals and write these in the boxes in the table below. The probability you will calculate is the probability of an allele in the individual listed in the leftmost column being in the individual listed in the 2nd column.

For the 3rd column (first column of boxes) consider allele on an autosome.

For the 4th column (second column of boxes) consider alleles on the X chromosome.

Provide all answers to nearest 0.0001.

(1 pt each)

<table>
<thead>
<tr>
<th>allele in individ.</th>
<th>also in individ.</th>
<th>if allele on autosome</th>
<th>if allele on X chromosome</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>( \frac{5}{16} = 0.3125 )</td>
<td>( \frac{1}{8} = 0.1250 )</td>
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<tr>
<td>A</td>
<td>C</td>
<td>( \frac{5}{32} = 0.1563 )</td>
<td>( \frac{1}{16} = 0.0625 )</td>
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<tr>
<td>B</td>
<td>A</td>
<td>( \frac{5}{16} = 0.3125 )</td>
<td>( \frac{1}{8} = 0.1250 )</td>
</tr>
<tr>
<td>B</td>
<td>C</td>
<td>( \frac{1}{2} = 0.5000 )</td>
<td>( \frac{1}{2} = 0.5000 )</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
<td>( \frac{5}{32} = 0.1563 )</td>
<td>( \frac{1}{16} = 0.0625 )</td>
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<tr>
<td>C</td>
<td>B</td>
<td>( \frac{1}{2} = 0.5000 )</td>
<td>( \frac{1}{2} = 0.5000 )</td>
</tr>
</tbody>
</table>
(4). SEMELPARITY AND ITEROPARITY. Cole (and Charnov and Schaffer) modeled the factors that influence the likelihood for an evolutionary switch between different types of reproductive strategies; a similar approach can model other types of adaptations.

Consider a population of wildtype individuals that reproduce over a number of consecutive years and a mutant that causes individuals to produce far fewer offspring (35% of the wildtype) which are more likely to survive to adulthood (i.e., their survival rate is higher than that of the wildtype). By producing fewer offspring the adults also have a 20% higher probability of surviving each year.

(a, 5 pts) What would this mutant’s juvenile survival rate ($C_m$) need to be to experience a fitness value equal to the normal wildtype individuals? Express $C_m$ in terms of $b_w$, $P_w$ and $C_w$ where these terms represent the values in the wildtype individuals.

Show all the steps in your derivation and make your final answer clear.

Wildtype growth rate: $N' = (b_wC_w + P_w)N$
Mutant growth rate: $N' = (b_mC_m + P_m)N$
They will have equal fitness when: $(b_mC_m + P_m)N = (b_wC_w + P_w)N$
Which is: $b_mC_m + P_m = b_wC_w + P_w$
From above: $b_m = 0.35b_w$ and $P_m = (1.2)P_w$
This gives: $(0.35)b_wC_m + (1.2)P_w = b_wC_w + P_w$
$(0.35)b_wC_m = b_wC_w - (0.2)P_w$
$C_m = (1/0.35)C_w - (0.2/0.35)(P_w/b_w)$

$C_m = (1/0.35)C_w - (0.2/0.35)(P_w/b_w)$

or

$C_m = (2.857) C_w - (0.571) P_w/b_w$

-2 pts for a single algebra error, otherwise correct

(b, 5 pts) Consider a situation in which the wildtype population is stable (i.e., no population growth), each adult has an average of 5 offspring per generation, and adults have a 60% chance of surviving each year. What must the mutants’ juvenile survival rate therefore be? (answer to nearest 0.001)

Wildtype birth rate: $b_w = 5$
Wildtype adult survival $P_w = 0.60$

For a stable population, This is when is $N' = N = (5C_w + 0.6)N$
$1 = (5C_m + 0.6)$
$0.4 = 5C_w$
$0.4 / 5 = C_w$
$0.08 = C_w$

From above: $C_m = (1 / 0.35) (0.08) - (0.2 / 0.35)(0.60 / 5)$
$C_m = 0.22857 - 0.06857$

$C_m = 0.160$

-2 pts for a single algebra error, otherwise correct
FOR THE REMAINING QUESTIONS USE YOUR SCANTRON FORM,

► MULTIPLE CHOICE: (3 pts each).

(1) Which of the following steps in the process of reinforcement is incorrect?
(A) Inbreeding depression.   (D) Sexual separation.
(B) Outbreeding depression.  (E) Ecological separation.
(C) Gametic isolation.

(2) Which of the following best describes the evolutionary explanation for senescence?
(A) Alleles with benefits to individuals during intermediate ages and detriments during youth or old age are favored and a history of fixation of these alleles results in the evolution of senescence.
(B) Alleles with benefits to individuals during older ages and detriments during their youth are favored and a history of fixation of these alleles results in the evolution of senescence.
(C) Alleles with benefits to individuals during youth and detriments during older ages are favored and a history of fixation of these alleles results in the evolution of senescence.
(D) Alleles with benefits to individuals during times of high reproductive value and detriments during periods of low reproductive value are favored and a history of fixation of these alleles results in the evolution of senescence.
(E) Alleles with benefits to individuals during times of low reproductive value and detriments during periods of high reproductive value are favored and a history of fixation of these alleles results in the evolution of senescence.

(3) Bergman’s rule states that species in colder climates often have stockier bodies and shorter limbs than ones that live in warmer climates. Which of the following best explains the presence of this pattern?
(A) Individuals with shorter limbs do better in cold regions therefore their offspring are born with even shorter limbs to provide them with this advantage.
(B) Individuals vary in the lengths of their limbs and in colder climates having shorter limbs aids with heat retention; therefore these individuals tend to have more offspring and over a number of generations the population slowly evolves shorter limbs.
(C) Organisms want to survive and not go extinct therefore they will evolve shorter limbs in colder regions because this is advantageous.
(D) Mutations to shorten limbs happen more often in cold regions because shorter limbs aid with heat retention; therefore these species have more mutations and evolve shorter limbs.
(E) Species vary in the lengths of their limbs and in colder climates having shorter limbs aids with heat retention; therefore these species tend to have more individuals and over a number of generations the only species remaining are the ones with short limbs.

(4) When some members of a group completely give up reproduction to assist others, this is called which of the following?
(A) Autofecundity.   (C) Eusociality.   (E) Senescence
(B) Dimorphism.     (D) Haplodiploidy.

(5) The term used to describe the approach in which we design multiple hypotheses instead of just one when we test ideas is which of the following?
(A) Deduction.   (C) Induction.   (E) Strong inference.
(B) Factorial analysis. (D) Logical competition.
Consider the citation and abstract for a recently published paper below. You will use the information to answer 4 questions.


**Abstract:** Behavioral ecologists and evolutionary biologists have long studied how predators respond to prey items novel in color and pattern. Because a predatory response is influenced by both the predator’s ability to detect the prey and a post-detection behavioral response, variation among prey types in conspicuousness may confound inference about post-prey-detection predator behavior. That is, a relatively high attack rate on a given prey type may result primarily from enhanced conspicuousness and not predators’ direct preference for that prey. Few studies, however, account for such variation in conspicuousness. In a field experiment, we measured predation rates on clay replicas of two ___(1)___ forms of the poison dart frog *Dendrobates pumilio*, one novel and one familiar, and two ___(2)___ controls. To ask whether predators prefer or avoid a novel ___(1)___ prey form independently of conspicuousness differences among replicas, we first modeled the visual system of a typical avian predator. Then, we used this model to estimate replica contrast against a leaf litter background to test whether variation in contrast alone could explain variation in predator attack rate. We found that absolute predation rates did not differ among color forms. Predation rates relative to conspicuousness did, however, deviate significantly from expectation, suggesting that predators do make post-detection decisions to avoid or attack a given prey type. The direction of this deviation from expectation, though, depended on assumptions we made about how avian predators discriminate objects from the visual background. Our results show that it is important to account for prey conspicuousness when investigating predator behavior and also that existing models of predator visual systems need to be refined.

(6) Which of the following words best fits in the blanks marked with the (1)?
(A) Aposematic.  
(B) Batesian.  
(C) Cryptic  
(D) Heterozygous  
(E) Mullerian

(7) Which of the following words best fits in the blank marked with the (2)?
(A) Aposematic.  
(B) Batesian.  
(C) Cryptic  
(D) Homozygous  
(E) Mullerian

(8) A similar study was described in the lectures. What organism was the focus of the study described in the lectures?
(A) Giraffes.  
(B) Horses.  
(C) Penguins.  
(D) Rotifers.  
(E) Snakes.

(9) How did that study account for the conspicuousness issue that these authors addressed with their careful color choices?
(A) Alternating the days that the models were placed outside.  
(B) Clearing the area around the models of debris.  
(C) Making the models all the exact same size.  
(D) Placing the models against a white background.  
(E) Using actual organism tissue and fur instead of plastic.
(10) When doing evolutionary psychology studies it is especially difficult to do which of the following?
(A) Come up with a plausible scenario that explains the fitness advantage of the behavior.
(B) Design studies to test conscious behaviors.
(C) Design studies to test unconscious behaviors.
(D) Measure the fitness advantage of the behavior.
(E) Separate culturally influenced behaviors from evolved behaviors.

(11) Which of the following does NOT accurately describe a portion of the logical argument for sexual asymmetry leading to differences between males and females?
(A) As energy investment increases, so does the risk of mating with a poor reproductive partner.
(B) Differences in optimal behaviors can lead to differences in morphology.
(C) Females are not as limited as males in their total number of reproductive events.
(D) Females generally contribute more energy than males to each reproduction event.
(E) Males generally experience higher levels of intrasexual competition than females.

(12) Which of the following species definitions is the best one to use to understand the phenomenon of cryptic species in which two groups that appear identical in all physical ways nevertheless shows signs of being distinct genetically?
(A) Biological
(B) Essentialist
(C) Nomalist
(D) Phenetic
(E) Typological

(13) Which of the following best describes the concept of the independent contrasts method as used in comparative studies?
(A) Evolution is most likely to have occurred when there are large and distinct differences between species on the tree.
(B) The more evolutionary transitions required according to the phylogeny, the stronger the evidence for the change in pairs of traits being adaptive.
(C) The more species that differ in their traits across the phylogeny, the stronger the evidence for the traits being adaptive.
(D) The tree or trees with fewer paired evolutionary events are preferred over the trees that invoke more events.
(E) When the outgroup has the largest value of the trait, the rate of evolution is the slowest.

(14) Which of the following is NOT accurate?
(A) Female hyenas have masculinized external genitalia.
(B) Insects are limited in size by developmental constraints.
(C) Mammalian inner ear bones evolved from ancestral jaw bones.
(D) Many hymenopteran species demonstrate haplodiploidy.
(E) Giraffe males use their necks for combat and dominance.

(15) What was the major insight demonstrated by the analysis of the prisoner's dilemma game?
(A) Actions that are beneficial for individuals can lead to systems detrimental for all in the group.
(B) Hawks prey on doves because they fly more quickly.
(C) Playing aggressively always results in better long term success.
(D) Playing conservatively always results in better long term success.
(E) When trapped, escape behaviors are more useful than combative ones.
The following 3 questions are based upon the videos you watched in preparation for this exam.

(16) Which of the following best describes the visual and production style of these videos?
(A) Dark and noire style animation using black and white only.  
(B) Flash video with a muted sepia tone color palette.  
(C) Groups of children in costumes acting the roles of the animals.  
(D) Low budget physical props and sets using a single actor.  
(E) Narrated nature documentary footage.

(17) Which of the following describes the limpet reproductive scenario?
(A) Because limpets are sessile and connected to the substrate they all coordinate their broadcast spawning on the same bright moonlit nights each summer.  
(B) Individuals settle atop an initial sessile female and create a stack of individuals. The ones above the female turn male and stay that way until the female dies, at which point the lowest male becomes the new female.  
(C) Individuals settle atop an initial sessile male and create a stack of individuals. The ones above the male turn female and stay that way until the male dies, at which point the lowest female becomes the new male.  
(D) Sessile females attract planktonic males with pheromones and when they arrive the females capture them and extract their sperm for the fertilization of their eggs. As each captured male dies, a new one is lured to its reproductive doom.  
(E) Sessile males attract planktonic females with pheromones and when they arrive the males capture them and extract their eggs for fertilization with their sperm. As each captured female dies, a new one is lured to its reproductive doom.

(18) Which of the following was highlighted as an interesting aspect of the salmon reproductive scenario?
(A) Individual salmon always spawn at the exact same point of their natal river.  
(B) Male salmon only turn bright red when there are enough females to trigger the change.  
(C) Newly hatched young feed on decomposers living on the corpses of their dead parents.  
(D) Salmon hatching is timed to when the currents in the river are optimal for easy swimming back out to sea.  
(E) To better hide their offspring, salmon dig their nests in shaded parts of the river instead of areas exposed to bright sunlight.

(19) Which type of speciation did the fictional Rinkidinks undergo in the book we read in class?
(A) Allopatric.  
(B) Autopatric.  
(C) Parapatric.  
(D) Peripatric.  
(E) Sympatric.