WRITTEN (30 points)

1. (10 pts.) Female guppies have been observed to prefer to mate with male guppies that risk their lives to inspect predatory fish that come near the mixed-sex guppy school. What is an explanation for the behavior of both the male and the female guppies, and why the males are swimming closer and closer to the predatory fish every generation?

Handicap principle: the female is looking for trait(s) that can't be faked -- the male has to be superior than other males, not just copying those with good genes. So, she looks for traits that are a handicap to the male's survival. He has to be very fit just be alive with his brave behavior. +5 pts.

Runaway selection: the female's choice is exaggerated after generations of preference for trait -- her sons will all have trait and her daughters all will select for trait. Soon the trait spreads throughout the population. ***In order to out compete males all with the similar trait, a male will have to be even braver and go even closer to predator.*** *The exaggeration of the trait will continue until it reaches a limit beyond which survival by the male is impossible. +5 pts.*

2. (10 pts.) Bluefin Tuna and Ruby-throated Hummingbirds have evolved adaptations to deal with the problems (the disadvantages) of being poikilothermic and homeothermic animals, respectively. Briefly, describe both the problems and their adaptations to overcome the problems.

A) Tuna: Poikilothermic problem = slow chemical reactions in cold water (MR directly proportional to temp.); Adaptation = muscles near heart shiver (contractions that do no work, just generate heat) to warm blood. Circulatory system then moves the heat around the body so tissues are warm enough to do fast reactions to catch fast moving prey. 5 pts. (2 pts. problem and 3 pts. adaptation). Note: all fish have adaptation of countercurrent arterioles and venules in gills.

B) Hummingbird: Homeotherm problem = warm Tb takes a lot of energy and therefore a lot of food (bird would starve at night); Adaptation = don't defend Tb for limited periods, i.e., let MR and Tb fall during night or any time energy reserves run low (torpor). 5 pts. (2 pts. problem and 3 pts. adaptation)

3. (10 pts.) Acorn Woodpeckers and 23 species termites live in the Coast Range and Sierra Nevada foothill regions of California. Acorn Woodpecker and all termite species live only in social groups. **A)** What are **TWO** evolutionary factors that **both** of these species **have in common** that favor living in societies? **B)** Compare and contrast Acorn Woodpecker and termite societies by providing **ONE** specific example of how they are SIMILAR and **TWO** specific examples of how they DIFFER in their social behavior adaptations (not genetics, anatomy, physiology, or evolution).

Both need to live in a group to because of FOOD (protist to digest cellulose and acorns). +2 pts
Both need to live in group to have any fitness benefit (if live alone or as pair, then no one has any kids) +2 pts.

1 SIMILARITY (+2 pts.)
1) sacrifice direct fitness for indirect fitness by helping raise relatives' kids
2) breeding repressed by breeders (queen and king termite or co-breeders)
3) help feed kids and breeders
4) mean genetic relatedness of siblings is 50%
5) male and female helpers/workers
6) all helpers/workers related to breeders
7) breeders of both sexes stay in group (king termite stays around after mating flight)
8) all individuals are diploid

2 DIFFERENCES (+2 pts. each)

Termites
1) workers suppressed by pheromones
2) workers never reproduce
3) soldier worker caste defends colony
4) food available all year around
5) nymphs can feed themselves after inoculated with protist

Acorn Woodpecker
1) helpers controlled by alphas' behavior
2) helpers can move up to alpha status
3) all members of group defend granary tree
4) food has to be stored as acorns only ripen in fall
5) babies feed by adults (cannot feed themselves)

MULTIPLE CHOICE (40 points, 2 points each)

__B__1. Which of the following invests the **most** energy in production of offspring from gamete to maturity?
A) male in polygyny system C) male in promiscuous system E) Both B and D invest equally.
B) female in polygyny system D) female in polyandry system

__A__2. What is the probable mating system in the beetle species described as follows? Females: 3.5cm long (head to thorax), 1cm long antennae, dull green back with 2 brown spots on each wing. Males: 5.25cm long, 2cm long branching antennae (look like they have fringe), iridescent green back with 4 yellow spots on each wing.
A) polygyny B) polyandry C) polygynandry D) monogamy E) cooperative

__D__3. Why is polygyny the most common mating system found in mammals?
A). Mammal sperm is cheap for males to produce. D) Both (A) and (B) are correct
B) Mammal females invest more in post-fertilization care. E) All of these are correct.
C) Mammal females are able to produce many unfertilized eggs.

__B__4. What is the average amount of alleles in common between wolf full siblings (brother and sister of same parents)?
A) 25% B) 50% C) 75% D) 100%

_CorD_5. Why is cheating so rarely observed in societies of all animals?
A) Cheaters are punished or forced out of the society by the breeders/leaders.
B) Kin selection favors non-cheating relatives gaining greater inclusive fitness.
C) Groups without cheaters out-compete and survive longer than those with cheaters.
D) All of these are correct.

__A__6. How does a new queen in a honeybee hive achieve her "royal" and fecund (fertile) status?
A) She ate royal jelly as larva. C) She killed her mother in order to take over hive.
B) She secretes a pheromone. D) She found a drone to mate with.

__E__7. The survival of which of the following would gain you an inclusive fitness benefit?
A) son B) mother C) son-in-law D) nephew E) Both (A) and (D) F) All of these

__E__8. In meerkat groups which of the following would defend the groups' nursery den?
A) breeders B) baby sitters C) lookouts D) foragers E) all members of group

__C__9. What type of behavior is often associated with a lower-ranking wolf interacting with a higher-ranking wolf?
A) Lower wolf usually mimics sexual behavior.
B) Higher wolf usually ignores lower wolf.
C) Lower wolf usually mimics puppy behavior.
D) Higher wolf usually uses its tail to hide its anal glands.

__T__10. (True/False) In ant and termite societies the workers will perform the same job all their lives.

__B__11. Why do unrelated clown anemonefish helpers form cooperative groups with a breeding pair?
A) The helpers receive inclusive fitness benefit.
B) The largest helpers will inherit the sea anemone nest.
C) The helpers hope to have EPF with one of the breeders.
D) Both (A) and (C) are correct.
E) All of these are correct.

__C__12. To which of the following are fire ant workers **most** closely related?
A) their mother B) their father C) their sisters D) their sister's daughters

__B__13. What is the ultimate causation of extra-pair fertilizations (EPFs) from the **female's** perspective?
A) Female attempts to breed with best male even if he is pair-bonded with another female.
B) Female attempts to increase genetic diversity in her offspring by mating with more than one male.
C) Female attempts to breed with as many males as possible to increase the number of her offspring.
D) Female attempts to decrease her cost of altruism by increasing her relatedness to other members of population.

__E__14. Which of the following members of a fire ant colony are physiologically capable of reproducing?
A) adult winged drone B) adult winged female C) nursery worker D) soldier/guard workers E) Both (A) and (B)

__B__15. In which of the following would altruism most likely occur?
A) between unrelated members of a society
B) between parents and offspring
C) when benefit and cost of behavior are both high
D) when benefit and cost of behavior are both low

__C__16. How is the social hierarchy for command and control of group's behavior maintained in meerkats?
A) Same sex siblings battle other sibling partnerships to fill alpha vacancy in unrelated group of meerkats.
B) Oldest son inherits his father's alpha status; all daughters and younger sons must leave their natal (birth) group.
C) Ritualized aggression displays and physical confrontations happen between alpha breeders and all helpers.

__C__17. What is the primary mode of communication for integrated behavior in all insect societies?
A) auditory B) visual C) olfactory D) tactile E) gustatory

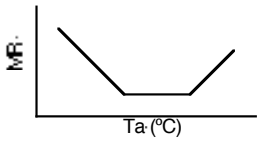
__E__18. Which of the following is **NOT** an example of an abiotic factor in an ecosystem?
A) elevation B) soil nitrogen C) annual precipitation D) human road E) decaying leaves

__D__19. What level of ecology studies the metabolism of the fire ants on the AC campus?
A) ecosystem B) population C) community D) individual E) biospheric

__C__20. Which of the following is the energy (E) used to maintain the vital life sustaining functions of an individual organism?
A) productive E B) excretory E C) existence E D) metabolic E E) digestible E

__B__21. What is the greatest physiological problem faced by terrestrial plants?
A) access to sunlight (phototaxis) B) water balance C) carbon dioxide uptake D) nutrient uptake E) fighting gravity

__A__22. Which of the following animals would have a graph of metabolic rate as a function of ambient temperature similar to that found to the right?
A) homeotherm B) poikilotherm C) ectotherm D) hibernating rodent



__B__23. Which of the following is **NOT** a density dependent factor in population ecology?
A) predation B) natural disaster frequency C) inbreeding D) intraspecific competition E) parasitism

__A__24. Which of the following is/are (a) consequence(s) to living in a population with a low population density?
A) Predation is less likely to occur.
B) Disease transmission is more likely to occur.
C) Competition for scarce resources is high.
D) Both (A) and (B) are correct.
E) Both (A) and (C) are correct.

__T__25. (True/False) In a uniform population dispersion pattern the size of each individual's territory has no connection to the distribution of resources in the habitat but instead depends on the number of individuals in the population.

ESSAY (20 points)

1. European Vipers (*Vipera berus*) emerge from hibernation beginning in March in England. In April mating occurs. Large congregations of 10-100 vipers are seen. The larger female slowly moves through the congregation with multiple males wrapping their bodies around her. A male vibrates his muscles while wrapped around a female. The males also intertwine with other males, pushing each other away from the female. The female gives birth to approximately 12 live young in August. The vipers return to hibernation in October, searching out vacant mammal burrows. Large burrows may contain 50-80 hibernating vipers. Vipers eat lizards, mice and shrews after killing them with a poisonous bite. European Vipers are one of the most widely found snake species—there are populations living in Spain to above the Arctic Circle in Norway and even northern Asia (it is the northernmost reptile presently on Earth). **A)** Explain the courtship/mating behavior of the European Viper. **B)** What type of mating system would you expect to find in this species? **C)** What mate choice perspectives, evolutionary factors and selective pressures have favored vipers using this mating system? **D)** How are the vipers able to live in so great a range of habitats in Europe?

The male vipers use tactile communication to stimulate the female (perhaps vibration also helps to warm her up after low body temperature from hibernation). Each male is in competition with the other males, hence the pushing away of other males and coiling around female to prevent other males from copulating with her. The male that vibrates the best and keeps the other males away the best should have the best genes for the female's expensive eggs. The female invest a great deal in post-fertilization care – she does not lay eggs, she gives birth. But the cost is apparent in that she only has 12 offspring at the END of summer. A case could be made for polyandry, promiscuity or monogamy. The female's size (bigger than male) points toward polyandry. But, it all depends on how many males mate with each female, and whether or not a male gets a second chance at an additional female. If the competition between males is strenuous, then he may be resource depleted after he finally gets a chance to fertilize a female. Since diversity of fathers is an insurance policy for females, she may mate with more than one male (she doesn't put all her expensive eggs in one father's basket – what's the best today may not be in the future). Unlike "normal" polyandry, the males would do none of the child rearing (if she mates with multiple males but he only gets one shot at fatherhood). Sperm are cheap, but the contest for female is not. Live young put more of a cost onto the female, but infant survival should dramatically increase (they come out at a great developmental state). Live young also means that the eggs do not have to be incubated in cold ground (as is found in egg-laying snakes). These two factors help to explain the vipers wide range, but the two biggest are: 1) non-specialized diet that can be obtained without huge investment beyond manufacture of poison and 2) HIBERNATION in groups – they escape the bitter cold of European winters by lowering metabolic rate during winter. The groups provide some security while "out cold". Intruder would have problem attacking and eating all the vipers in burrow.

2. The Hamadryas Baboon (*Papio hamadryas*) lives in the rocky, semiarid hills and mountains of Egypt, Ethiopia, Somalia and the Arabian Peninsula. The males are twice the size of females (males = 20kg/45 lb..; females = 11kg/24 lb..) and are silver-white colored. By the time they are ten years of age, the males have grown a cape of thick hair on neck and shoulders. The females are reddish-brown and have no cape. The females are sexually mature at 4 yr., males at 5-6 yrs. The average life span is 35 yr. The baboons spend the night on steep cliffs. They venture away from the cliffs to hunt for food during the day. They eat grass, roots, seeds, reptiles, insects, and small mammals. Each male baboon protects, mates with, and controls the movements of up to nine females (his harem). The harem may also contain a 6-9 yr. male that does not mate with the females. Two or more harems come together to form clans that feed in the same area. At night 2-4 clans form a band that will sleep near each other on the cliffs. Baboons rarely leave their natal band. Instead sexually mature females from one clan are recruited or kidnaped by 10 yr. or older males from other clans. Fights within clans are rare. Fights over females between males in different clans are more common. All the males in the band will join together to fight off another band from entering the band's territory. **A)** What type of mating system has evolved in the Hamadryas Baboon? **B)** Explain the social structure in the baboons (harems, clans, and bands): Why did it evolve? Who is probably related to whom? How is incest avoided? **C)** Explain the fighting behavior of the males and why a young male can be associated with a harem.

There is very obvious sexual dimorphism in baboons: males are twice as big as females and have cape when sexually mature. This goes along with the formation of harems of nine females by one male. This is polygyny. In polygyny the males compete for the females (if one male has nine females, then eight males have no females). This competition is reflected in that males kidnap females (forcibly remove her from her clan to join his harem). The females mate with the strongest males who have won the competition. This works out for her as she gets a high quality father for her expensive offspring (remember all that female mammals invest in young). The male tries to have as big a harem as he can defend (sperm are cheap, but the defense of females from other males is not). The baboons live in a habitat that favors foraging in groups (the clans). They eat a varied diet, but it is hard to find any food the semiarid habitat. The clans cooperate in finding the food and keeping a lookout for predators (see meerkats). For the harems in clans to work together there should be inclusive fitness benefits to cooperation. With the high competition between males it is unlikely that a male would cooperate with an unrelated male. So, it is likely that the males within a clan are all close relatives. This is supported also in that fights between males in the same clan are rare (no reason to decrease indirect fitness benefit through hurting brother, father or son). Predation at night must be a huge risk for baboons, so the clans come together to sleep in the safest place (cliffs). Also the competition for these safe sleeping cliffs must be high for all the males within a band being needed to defend the band's territory from other bands. The amount of relatedness within a band must be much less than within a clan because fights occur between males of different clans. Also, all offspring stay within their natal band (potential inbreeding problem). The females move (recruited or kidnapped) between clans, but not bands, to prevent incest. The young non-breeding male in the harem is related to the male. He tolerates his son (most likely) as helper until his son as achieved social and well as sexual maturity (has the necessary secondary sexual characteristics and the skill to use them to start his own harem). The son learns his dad's skills and helps dad defend harem.