Evolutionary Biology (LS2201)

End semester examination

Instructor: Anindita Bhadra

Full marks: 50

Time: 2.5 hours

Please read the questions carefully before answering. Please provide brief, to the point answers. <u>Marks will be deducted for unnecessarily long answers</u>.

<u>QUESTIONS 1-3: ANSWER ANY 2 (5X2 = 10)</u>

1. The given graphs represent a model for a certain kind of trade-off that determines life history traits.
   a) Name the model.
   b) Draw the graph that depicts parental fitness that would be achieved through this clutch, according to this model.
   c) Give an example of this trade-off observed in nature.   (1+3+1)
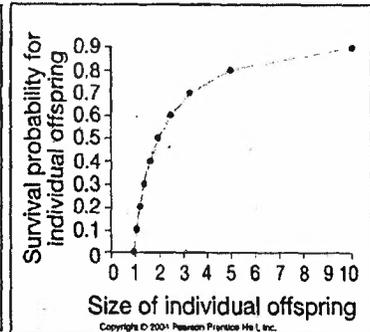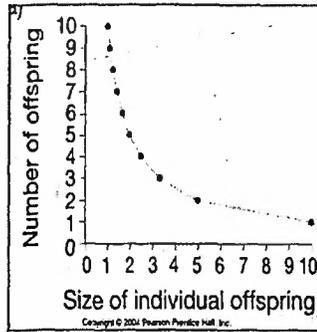
2. *"Well, in our country," said Alice, still panting a little, "you'd generally get to somewhere else — if you run very fast for a long time, as we've been doing."*
   "A slow sort of country!" said the Queen. "Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!"
   The conversation above is an excerpt from "Through the Looking Glass" by Lewis Carroll. The idea has been used to outline a phenomenon in evolutionary biology.
   (a)   What is this phenomenon and what is the hypothesis called?
   (b)   Name two contexts in which this phenomenon is seen in the biological world.
   (c)   Give one specific example where this concept is evident.   (2+2+1)

3. Parent-offspring conflict theory (Trivers, 1974) predicts that mothers should not nurse their young indefinitely, but after a period of nursing, mothers should be interested in weaning their young, so that they can invest in future offspring. The offspring should resist weaning for some time, and then they should "agree" to wean, as they should also be interested in the future offspring of their mothers. Explain this theory in the context of kin selection.   (5)

4. Albinism is a rare genetically inherited trait that is only expressed in the phenotype of homozygous recessive individuals (aa). Assume the average human frequency of albinism to be 1 in 20,000. In a certain ethnic community, the coefficient of inbreeding is 0.18. If albinism does not affect the probability of mating, and mating is random, what would be the frequency of albinos in the population? **(4)**

5. Assume that A is completely dominant over a, with aa individuals displaying a disease while all others are normal. An individual of genotype is Aa is called a carrier as they appear normal, but can have offspring with the disease.
   (a) Under Hardy-Weinberg, if freq(a) = 0.001 what fraction of all copies of a are in carriers?
   (b) What fraction of all aa individuals had both parents as carriers? **(2+2)**

6. In a large, randomly mating population of philodendron plants, HH and Hh individuals have heart-shaped leaves (H is dominant). These lose water from their pointed tips and resist mold, so these individuals have high survival and reproduction. hh individuals have round leaves that are subject to mold, and survive 60% as well as do individuals with heart-shaped leaves. The H and h alleles are in H-W equilibrium.
   (a) In one population of reproducing adults, there are 10% hh individuals and 15% Hh individuals. What is the frequency of h in the gametes produced by these adults?
   (b) In a different population, the frequency of the H allele in gametes at the start of a generation is 0.7. What is the frequency of the Hh genotype in the reproducing adults that develop from these gametes?
   (c) How many recessive homozygotes will be present in a population of 3000 plants? **(1+2+1)**

7. Graphically represent the life cycle of:
   (a) A semelparous plant that lives to 99 years.
   (b) An iteroparous animal that lives for 5 years and has two breeding seasons in a year. **(2+2)**

8. In a certain bird, the males acquire a bright red patch on their neck in the breeding season.
   (a) What do you think is the reason for this?
   (b) Design an experiment to test the hypothesis that the males with bigger red patches are more attractive to females.
   (c) Provide hypothetical data that would help you to prove that it is the size of the patch, rather than the intensity of the colour that the females use to make their choice. **(1+3+4)**

9. On an island, there are two varieties of a certain species of beetles – green and black. There is a species of bird that loves to eat these beetles.
   (a) Design an experiment to test whether the predator has a preference for one of the two varieties.
   (b) Provide a hypothetical data set that will help you to test the hypothesis that the green variety evades predation by the bird due to camouflage.   (4+4)

QUESTIONS 10-12: ANSWER ALL (20)

10. Choose the correct answer in each of the following questions.   (1X4=4)

i) Which of the following is NOT a component of the Theory of Evolution by Natural Selection?

   (a) competition for food and space   (b) variation among species
   (c) inheritance of acquired characteristics (d) survival and reproduction

ii) The various dog breeds we have today were developed through:

   (a) natural selection   (b) artificial selection
   (c) sexual selection   (d) acquired selection

iii) To call a behaviour altruistic, an evolutionary biologist will have to demonstrate that

   (a) the behaviour increases the individual fitness of the donor and decreases the individual fitness of the recipient
   (b) the donor does not bear any cost when performing the behaviour and the recipient's individual fitness increases
   (c) the behaviour increases the individual fitness of both the donor and the recipient
   (d) the behaviour decreases the individual fitness of the donor and increases the individual fitness of the recipient.

iv) Males of different species of the fruit fly Drosophila that live in the same parts of the Hawaiian Islands have different elaborate courtship rituals. These rituals involve fighting other males and making stylized movements that attract females. What type of reproductive isolation does this represent?

   (a) geographic   (b) mechanical   (c) behavioural   (d) gametic

11. Match the definition listed below with the category of behavior that is the best match for it.
    (a) Behavior that is costly to the actor, and beneficial to the recipient.
    (b) Behavior that is beneficial to the actor, and costly to the recipient.

(c) Behavior that is costly to both actor and recipient.
(d) Behavior that is beneficial to both actor and recipient.

    A. Selfish behaviour   B. Co-operative behaviour
    C. Altruistic behaviour   D. Spiteful behaviour
    E. Mutualistic behaviour   F. Competitive behaviour   **(4)**

12. The given figure represents a famous experiment.
    (a) Which experiment is this?
    (b) Which organism was used for this experiment?
    (c) What did this experiment demonstrate?
    (d) Give an example of this phenomenon observed in a natural environment.
                          (1+1+2+2)

maltose food   starch food

Many generations pass
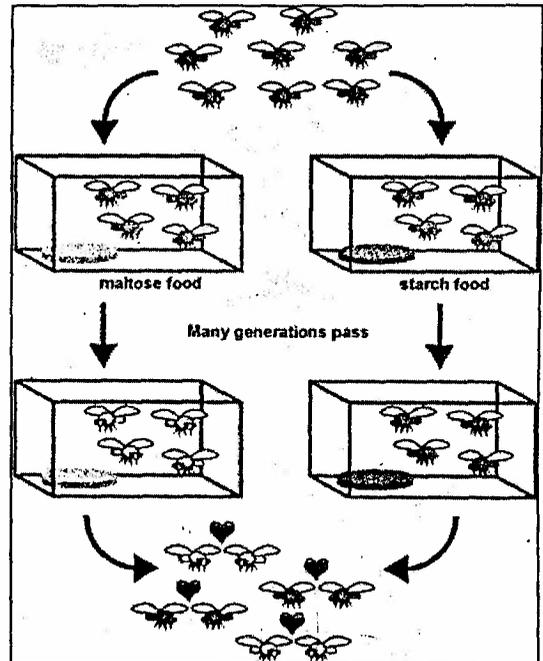
13. Calculate the relatedness between:
    (a) A male butterfly and its son.
    (b) Lucy (the fossil) and her daughter's grandson.
    (c) Two workers in a colony of monogamous wasps.
    (d) Fraternal twins in humans.
    (e) Two honeybee workers who have different fathers.
    (f) Two pups in a litter whose fathers are brothers of their mother.   **(1X6=6)**