**1.** *JK* Of the pairs of interacting species, which pair is most vulnerable to extinction in a natural setting:

A. Herbivore and grass
B. Mutualist and mutualist
C. Commensal and its host
D. Parasite and its host

2. *JK* Sea otter indirect effects on the kelp forests are an example of:

A. An ecological engineer
B. A predator release
C. A predator avoidance, like killer whales
D. A keystone species

3. *JK* An ecological climax represents:

A. A moment when the predator catches the prey
B. Final and stable stage of ecological succession
C. A population reaching and persisting at or near the carrying capacity
D. Long stasis (persistence) of the most favorable climatic conditions
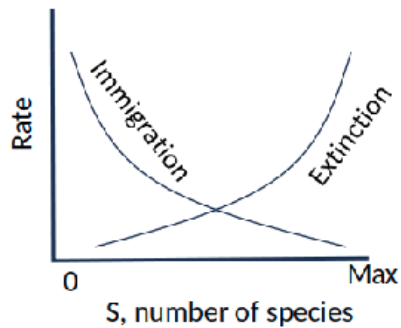
4. *JK* In the graph above, summarizing the basic tenets of the Theory of Island Biogeography, the predicted maximum species number will be:

A. Close to the value labelled 'Max'
B. Close to about one-third of the x-axis
C. Close to where the two processes intersect
D. Close to about two-thirds of the x-axis

5. *JK* When a population approaches its growth limits in terms of number of individuals, this growth is best represented by:

   A. Exponential growth model
   B. Existential growth model
   C. Logistic growth model
   D. Lethargic growth model

6. *JK* Carrying capacity is:

   A. Ability of the environment to sustain a fixed number of individuals of all species combined
   B. A property of organisms to carry stores of energy, like fats, to survive without food for a prolonged period
   C. A variable ceiling to a given population growth
   D. Amount of resources that is at a population's disposal to sustain itself

7. *JK* The most likely cause of irregularly clumped spatial distribution of individuals is:

   A. Stochastic combination of factors
   B. Sociality
   C. Competition
   **D.** Strong continuous gradient of resources
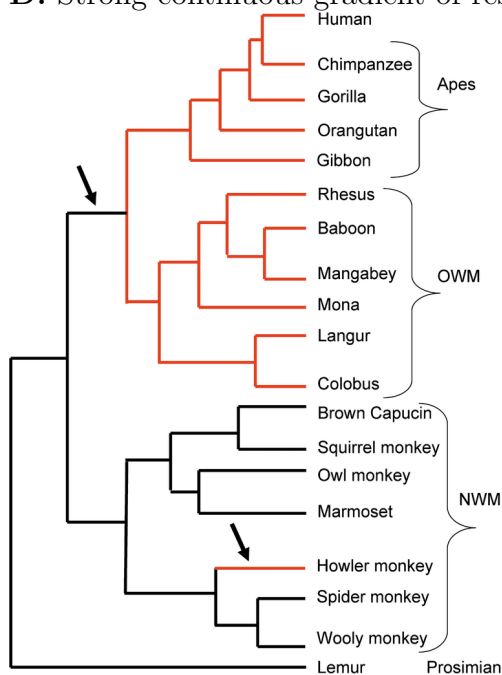
Use the figure above for the next three questions

8. *JD* Which of the groupings *shown on the tree* is *not* a clade according to the model shown in the tree?

    A. Apes
    B. Old-World monkeys (OWM)
    C. New-World monkeys (NWM)
    D. Prosimians
    E. None; these are all clades

9. *JD* According to the tree, the sister taxon for the New-World monkeys is:

    A. Prosimians
    B. Old-World monkeys
    C. Old-World monkeys plus apes
    D. Old-World monkeys plus apes and humans

10. *JD* Which of the taxa listed below is closest on this tree to langurs?

    A. Squirrel monkeys
    B. Squirrel monkeys *or* howler monkeys (they're equally close)
    C. Gibbons
    D. Gibbons *or* humans (they're equally close)

11. *JD* Select the *strongest* correct answer: Scientists discover a new mammal with spines and defensive behaviors similar to hedgehogs. They conclude that this suite of behaviors

    A. is a homology
    B. is an analogy
    C. is a homology only if the relevant common ancestor also had it
    D. is an analogy only if the relevant common ancestor also had it

12. *JD* There were two "contraction" events in the hominin tree we discussed. These were most likely due to

    A. Changes in the physical environment
    B. Competition from other hominins
    C. Competition from non-hominin apes
    D. Genetic drift

13. *JK* The mark-recapture method requires that (choose the best answer):

    A. Individuals are first captured, then released

    B. Individuals are captured and marked, then released

    C. Individuals are captured several times after being released to find out how fast they learn from mistakes

    D. Individuals are captured and marked, then released and recaptured
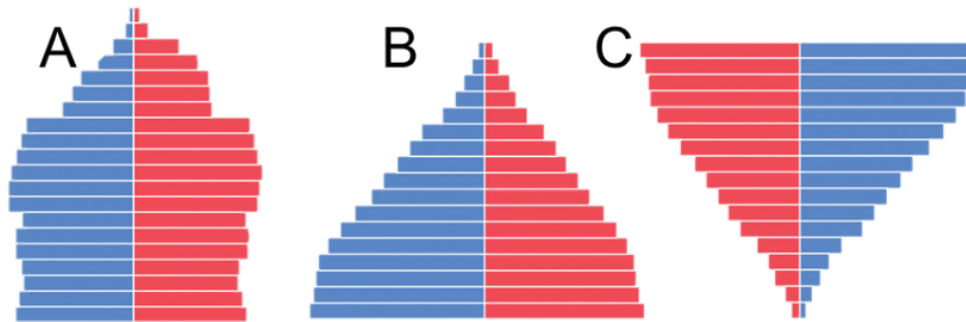
14. *JK* In the picture above, which population shows the fastest growth rate (recall population age structure by 5-year cohorts?

    A. A

    B. B

    C. C

    D. A and C are faster than B

15. *JK* Life table can identify for us whether:

    A. A species fits a survivorship curve of Type III

    B. An individual is a male or female

    C. A population has an age structure

    D. Individuals reached reproductive maturity

16. *JK* r and K-strategy:

    A. Are related in many different ways

    B. Usually correspond to unpredictable and predictable environments, respectively

    C. Usually correspond to predictable and unpredictable environments, respectively

    D. One applies only to populations living closer to carrying capacity

17. *JK* Species living in island habitats have:

    A. A metapopulation

    B. A greater probability of dispersal

    C. A greater probability of extinction

    D. Less resources on a per capita basis

18. *JK* Tigers have stripes and lions a uniform coloration because:

A. A need to recognize each other to avoid competition
B. Diversity of coloration confuses their prey
C. Of some poorly understood reason
D. They match their typical habitats best (forest vs. savanna)

19. *JK* Wherever they live together, one of mechanisms that allows prey and predator to persist is:

A. The rate of prey reproduction being faster than that of its predator
B. Prey being able to make faster turns than the predator
C. Prey being able to survive in habitat pockets inaccessible to the predator
D. Prey being able to fight off predator's attacks

20. *JK* If one competing species pushes another into somewhat different habitat, we observe a case of:

A. Habitat partitioning
B. Competitive cooperation
C. Competitive exclusion
D. Increased super-competition

21. *JD* Scientists should take a cladistic approach to tree reconstruction:

A. Always
B. Never
C. Whenever there is enough information to do so
D. When there is enough information to do so, but not enough to do a phenetic analysis

22. *JD* Which of the following is an accurate description of one form of *survivorship bias*?

A. Beneficial mutations are more likely than deleterious mutations to lead to convergent evolution
B. Deleterious mutations are more likely than beneficial mutations to lead to convergent evolution
C. Most mutations are beneficial, but long-term effects of deleterious mutations are more likely to be observed
D. Most mutations are deleterious, but long-term effects of beneficial mutations are more likely to be observed

23. *JD* A biologist observes a population of bacteria. When acidic chemicals are added, some of these bacteria carry on as normal, and some enter a persistent state with very low activity. Can the biologist say that if the level of acidic chemicals in the population's environment increases, adaptation through natural selection is expected?

    A. Yes, it is expected

    B. No, it is not expected

    C. The biologist still needs to test whether the observed behaviour is heritable

    D. The biologist still needs to test whether the observed behaviour affects reproductive success

    E. The biologist still needs to do *both* tests described above

24. *JD* Hippos and cows share a pulley-shaped ankle bone that whales lack. If it is confirmed that the relevant common ancestor had this trait, then a parsimony-based analysis of the relationship between these three species should consider that this trait _____ a synapomorphy and provides _____ evidence of similarity between hippos and cows.

    A. is; some

    B. is not; some

    C. is; no

    D. is not; no

25. *JD* Scientists studying the phylogeny of hominins sometimes include chimpanzees in their analyses. This is probably because:

    A. They want to confirm whether chimpanzees are hominins or not

    B. Chimpanzees are ancestral compared to hominins

    C. Chimpanzees are derived compared to hominins

    D. Chimpanzees are serving as an outgroup for the hominins

26. *JD* Adaptive loops can occur when adaptations in one area _____ in another area, and vice versa.

    A. Are selected to promote future adaptations

    B. Cancel the effects of earlier adaptations

    C. Cause earlier adaptations to be reversed

    D. Create favorable conditions for further adaptations

27. *JD* Early primates had a suite of traits that were likely involved in adaptive loops leading to larger brain size. Which of of the following is *not* one of those traits?

    A. Front-facing eyes

    B. Grasping hands

    C. Metabolic capacity to vary their diet

    D. Tail loss

28. *JD* Which of the following is correct?

    A. Humans are harder for us to understand than many other organisms because of observer bias

    B. Modern humans are harder to understand than many other organisms because of the effects of our complex brains

    C. Modern humans are harder to understand than many other organisms because of the effects of our complex culture

    D. The basic principles of evolutionary biology are relevant to modern humans

    E. All of the above

29. *JD* The large brain size of dolphins is probably evidence that _____ is an important driver of brain size

    A. Organism size

    B. Sociality

    C. Adaptive foraging

    D. Living in the water

30. *JD* Chimpanzees probably have larger genitals than gorillas because

    A. of genetic drift

    B. there is more overall competition for females among chimpanzees than gorillas
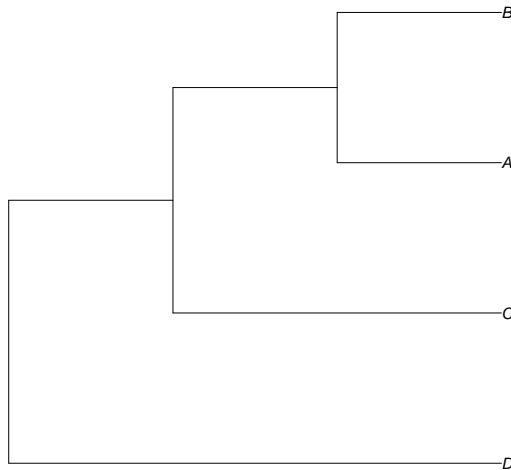
    C. gorillas compete for females primarily through other means

    D. chimpanzees have more variation in male reproductive succss than gorillas

Short-answer questions

Answer questions *in pen*. Be *brief*: bullet points are acceptable, try to keep the answer in the space provided.

31. *JD* Assume the following are all derived characters in the relevant context. Bonobos have robust teeth, earlobes, curved spines and brachiation (a style of swinging through trees). Gibbons have brachiation. Gorillas have robust teeth, earlobes and curved spines, orangutans have robust teeth and brachiation.

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                               ┌─────────────── B
                    ┌──────────┤
                    │          └─────────── A
          ┌─────────┤
          │         │
          │         └───────────────── C
──────────┤
          │
          └─────────────────────────── D
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a) (2 points) A scientist draws the tree above, based on the information above. Which species should correspond to which labels?

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b) (1 point) Which trait does not match the tree above? Assuming the tree above is correct, what is your explanation for how this probably happened?

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32. *JK* Name two density independent factors that limit human population? (0.5 each, 1 mark total)

33. *JK* Please name *and* give an example for five of the species interaction types discussed in class (with effects such as -/-, +/0, +/- and +/+). (5 marks)

34. *JK* Explain why we cannot call leaf cutting ants herbivores? (1 marks)