BIOL 4230 — Practice Final — Quantitative-heavy · Variation C

30 MC (3 pts each) + 4 short answer · ~50 min · weighted toward HW · breeder's eq · Hamilton

Cumulative practice final for BIOL 4230 (Evolution). Mark your answers to all multiple-choice questions on a separate sheet (this is **practice variation Final-C**). Time yourself ~50 minutes closed-note. The answer key and sample short-answer responses are on the last pages.

Multiple choice: 3 points each

1. HIV is treated with COMBINATION antiretroviral therapy (multiple drugs simultaneously) rather than a single drug. What is the evolutionary rationale?

A) Multiple drugs cure HIV completely.
B) Multiple drugs improve patient compliance.
C) Resistance to multiple drugs simultaneously
D) Multiple drugs work in different organs.

2. Total phenotypic variance V_P can be partitioned as:

A) $V_P = h^2 + V_E$
B) $V_P = V_A \cdot V_E$
C) $V_P = V_G + V_E$
D) $V_P = V_A + V_D + V_I + V_E$

3. Hamilton's rule for the evolution of altruism is:

A) $C > rB$
B) $B > C$
C) $B = C$
D) $rB > C$

4. An Evolutionarily Stable Strategy (ESS) is best defined as:

A) A strategy that produces the most offspring on average.
B) A strategy that, when adopted by most members of a population, cannot be invaded by any rare alternative strategy.
C) The strategy that maximizes population mean fitness.
D) A strategy that always wins in head-to-head competition.

5. DNA methylation acts at which level of gene regulation?

A) Transcriptional
B) Post-transcriptional
C) Pre-transcriptional
D) Post-translational

6. Caterpillars now emerge earlier in spring due to warming. The bird species that depends on those caterpillars for chick food now arrives at the breeding grounds AFTER the caterpillar peak. This is called:

A) Convergent evolution.
B) Inclusive fitness.
C) Phenological mismatch.
D) Coevolution.

7. Side-blotched lizards have three male morphs whose frequencies cycle over years (Orange beats Blue, Blue beats Yellow, Yellow beats Orange). What does this real-world example illustrate?

A) Negative frequency-dependent selection
B) Sexual conflict between males and females.
C) Genetic drift in a small lizard population.
D) A single ESS dominates and the other strategies disappear.

8. Biomarkers are:

A) Radioactive isotopes used for dating.
B) Chemical signatures (often lipid molecules) preserved in ancient rocks that indicate the past presence of specific organisms.
C) Genetic markers used in modern populations.
D) Magnetic minerals showing past magnetic field reversals.

9. How did Charles Lyell's work most directly influence Darwin's theory of natural selection?

A) Lyell established that Earth was very old
B) Lyell catalogued the fossils Darwin used in On the Origin of Species.
C) Lyell discovered the genetic basis of inheritance, providing a mechanism.
D) Lyell argued that natural selection had been operating on geological scales.

10. Reinforcement of speciation occurs when:

A) Geographic isolation alone completes speciation.
B) Two species that have come back into secondary contact evolve stronger prezygotic isolation
C) Species independently evolve similar traits in different regions.
D) Polyploidy doubles chromosome counts — that's polyploidy, a mode of sympatric

11. A population has p = 0.4 (allele A) and q = 0.6 (allele a). Hardy-Weinberg expects 32% heterozygotes (2pq = 0.48 → 48%, sorry let me recompute: 2 × 0.4 × 0.6 = 0.48 = 48%). The population is observed to have only 20% heterozygotes. Which mechanism best explains this deviation?

A) Inbreeding or population subdivision
B) Strong selection against the AA homozygote
C) Heterozygote advantage (overdominance)
D) Recent admixture between populations

12. Evolutionary medicine differs from conventional medicine primarily by:

A) Asking WHY (in evolutionary terms) bodies are vulnerable to disease
B) Using evolutionary concepts to oppose vaccination and antibiotics.
C) Focusing only on infectious disease — evolutionary medicine spans infectious disease,
D) Replacing modern medical practice with paleolithic remedies.

13. Modern non-African humans typically carry approximately what fraction of Neanderthal-derived DNA?

A) 20–30%
B) 50%
C) 1–4%
D) 0%

14. Narrow-sense heritability is most directly estimated from:

A) The slope of offspring trait values regressed on the mid-parent trait value.
B) Counting the number of genes contributing to the trait.
C) The variance of trait values in the population.
D) The ratio of within-family to between-family variance.

15. In Drosophila, male seminal fluid contains compounds that increase female short-term egg-laying but reduce female lifespan. From a sexual-conflict perspective:

A) This is mutualism — both sexes benefit equally.
B) Females have evolved zero counter-adaptations to these compounds.
C) The compounds randomly evolved with no selective basis.
D) Male and female evolutionary interests diverge: males benefit from immediate fertilization even at long-term cost to females.

16. Biologically, the FEMALE in a sexually reproducing species is defined as:

A) The sex that bears live offspring.
B) The sex that has two X chromosomes.
C) The sex that displays mate choice.
D) The sex that produces the larger, costlier gamete.

17. Vampire bats regurgitate blood to feed roost-mates who failed to feed that night. Recipients later return the favor when they have surplus and the original donor goes hungry. This best illustrates:

A) Naïve group selection.
B) Inclusive fitness through close kinship only.
C) DIRECT reciprocity
D) Sexual conflict.

18. Which of the following is NOT considered part of the genome?

A) Pseudogenes.
B) Free amino acids in the cytoplasm.
C) Mobile genetic elements.
D) Protein-coding genes.

19. After a gene duplication event, one copy retains the ancestral function while the other accumulates mutations and eventually evolves a novel role. This is:

A) Pseudogenization
B) Gene conversion
C) Neofunctionalization
D) Subfunctionalization

20. Medawar's mutation accumulation theory of aging proposes that:

A) Each species has a fixed number of cell divisions.
B) Mutations are more common in older individuals.
C) Late-acting deleterious mutations escape selection and accumulate in the gene pool
D) Aging is caused by accumulation of toxins.

21. A population is started with 60% AA, 0% Aa, and 40% aa individuals. After one generation of random mating with all five HWE assumptions met, what are the genotype frequencies?

A) 30% AA, 50% Aa, 20% aa
B) 36% AA, 48% Aa, 16% aa
C) 60% AA, 0% Aa, 40% aa (no change)
D) 100% Aa (all heterozygous)

22. Female peahens prefer males with larger, more iridescent tails. Male peacock tails reduce survival (visible to predators, costly to grow). The persistence of the tail despite its survival cost is best explained by:

A) Intersexual selection (mate choice) outweighing the survival cost.
B) Group selection for showy populations — group selection isn't needed
C) Intrasexual selection — males physically fight with their tails.
D) Sexual conflict — females can't tell males with tails apart from males without.

23. The genetic basis of dark coloration in industrial peppered moths was identified as a transposon insertion in the cortex gene. What does this finding imply about the source of the melanic variant?

A) All cortex-gene insertions cause dark coloration in any species.
B) The transposon insertion was a pre-existing mutation present at low frequency before the Industrial Revolution
C) Pollution caused the transposon insertion through DNA damage.
D) The dark morph evolved entirely after pollution began.

24. Which formula correctly defines narrow-sense heritability h^2?

A) $h^2 = V\_E / V\_P$
B) $h^2 = V\_G / V\_P$
C) $h^2 = R \cdot S$
D) $h^2 = V\_A / V\_P$

25. In Seychelles warblers, female offspring more often remain on natal high-quality territories as helpers, while males disperse. What does this pattern reveal?

A) Genetic differences between males and females in flight ability.
B) Females cannot survive away from natal territories.
C) Random dispersal independent of habitat quality.
D) Sex-biased dispersal driven by territory quality

26. The selection differential S is best defined as:

A) The fitness advantage of the heterozygote over both homozygotes.
B) The proportion of phenotypic variance that is genetic.
C) The slope of offspring values regressed on parent values.
D) The difference between the mean trait value of breeders and the mean of the original population.

27. Mainland opossums (heavy predation) and island opossums (no predators) have evolved different life histories. Which prediction is most consistent with theory and observed data?

A) Mainland opossums mature earlier and produce larger litters
B) Mainland opossums mature later and produce smaller litters.
C) Mainland opossums age more slowly because predation 'tests' them.
D) Both populations have identical life histories because they are the same species.

28. On a plot of reaction norms for two genotypes, the lines have different slopes and cross each other. This indicates:

A) Genotype-by-environment interaction (V_G×E).
B) No genotype-by-environment interaction.
C) Both genotypes are canalized.
D) The trait has zero heritability.

29. The vertebrate eye and the cephalopod eye are both camera-type eyes with lens, retina, and pupil. They are best described as:

A) An example of horizontal gene transfer.
B) Convergent (analogous) structures
C) Vestigial structures — both eyes are functional,
D) Homologous structures inherited from a common eyed ancestor.

30. The Wallace Line is:

A) A line on a phylogenetic tree separating chordates from arthropods.
B) A faunal boundary in the Indonesian archipelago that separates Asian and Australasian biotas
C) A genetic marker used to date the human-chimpanzee split.
D) The boundary of Wallace's voyage on the HMS Beagle.

BIOL 4230 — Practice Final — Quantitative-heavy · Variation C — Short Answer Section

Name _____

1. Briefly describe the hominin evolutionary sequence from the chimpanzee split to modern humans. Include: (a) approximate time of the chimp-hominin split, (b) the FIRST major hominin innovation, (c) the genus that first left Africa, and (d) the approximate age of anatomically modern Homo sapiens.

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2. Why does selection fail to eliminate aging? Briefly explain TWO theories that account for the persistence of senescence.

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3. Sexual reproduction has substantial costs. Name and briefly explain THREE benefits that have been proposed to outweigh those costs and explain why sex is widespread.

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4. Explain the significance of the K-T (K-Pg) boundary. Include: (a) approximate date, (b) the main proposed cause, (c) the evidence supporting that cause, and (d) one major biological consequence.

Answer Key for Practice Final — Quantitative-heavy · Variation C

1. C	11. A	21. B
2. D	12. A	22. A
3. D	13. C	23. B
4. B	14. A	24. D
5. C	15. D	25. D
6. C	16. D	26. D
7. A	17. C	27. A
8. B	18. B	28. A
9. A	19. C	29. B
10. B	20. C	30. B

Short Answer — Sample Answers

1. Briefly describe the hominin evolutionary sequence from the chimpanzee split to modern humans. Include: (a) approximate time of the chimp-hominin split, (b) the FIRST major hominin innovation, (c) the genus that first left Africa, and (d) the approximate age of anatomically modern Homo sapiens.

(a) The hominin lineage diverged from chimpanzees approximately 6–7 MYA in Africa. (b) BIPEDALISM was the first major hominin trait — present in the earliest probable hominins (Sahelanthropus tchadensis from Chad, ~7 MYA; Ardipithecus, ~4.4 MYA). Brain enlargement came LATER in hominin evolution. (c) Homo erectus was the FIRST hominin to leave Africa, ~1.9 MYA, reaching as far as East Asia (Java, China) and Europe. (d) Anatomically modern Homo sapiens emerged in Africa ~300 KYA, with the major out-of-Africa dispersal ~70 KYA. After this dispersal, modern humans interbred with Neanderthals and Denisovans, contributing the ~1–4% archaic-human DNA found in modern non-African populations.

2. Why does selection fail to eliminate aging? Briefly explain TWO theories that account for the persistence of senescence.

Two theories: (1) MUTATION ACCUMULATION (Medawar): selection becomes weaker at older ages because organisms have already reproduced; deleterious mutations whose effects manifest only late escape selection's filter and accumulate in the gene pool, producing senescence. (2) ANTAGONISTIC PLEIOTROPY (Williams): single genes can have beneficial effects early in life and harmful effects late. Selection favors them on net because the early benefit (boost to reproduction) outweighs the late cost (decline in old age). The cost of aging is the price of early-life adaptation. (A third theory, DISPOSABLE SOMA, frames aging as the result of an organism allocating finite resources between somatic maintenance and reproduction — investing in reproduction at the cost of long-term cell repair.)

3. Sexual reproduction has substantial costs. Name and briefly explain THREE benefits that have been proposed to outweigh those costs and explain why sex is widespread.

Three classical benefits of sex: (1) GENETIC DIVERSITY through recombination — sex shuffles alleles into novel combinations each generation, producing genetic variation on which selection can act. This is especially valuable when environments are fluctuating. (2) MULLER'S RATCHET avoidance — in asexual lineages, deleterious mutations accumulate irreversibly because there's no way to recreate the mutation-free class once it's lost. Sexual recombination can recreate clean genotypes, purging mutational load. (3) RED QUEEN dynamics — parasites coevolve rapidly with their hosts. Sexual recombination generates novel allele combinations that help hosts evade parasites that have adapted to last generation's common host genotypes. Despite the twofold cost of sex, these benefits collectively explain the widespread persistence of sexual reproduction.

4. Explain the significance of the K-T (K-Pg) boundary. Include: (a) approximate date, (b) the main proposed cause, (c) the evidence supporting that cause, and (d) one major biological consequence.

The K-T (K-Pg) boundary marks the end-Cretaceous mass extinction ~66 million years ago. The main proposed cause is an ASTEROID IMPACT at the Chicxulub site on the Yucatán Peninsula. Evidence includes a globally distributed thin sediment layer enriched in IRIDIUM (rare in Earth's crust but common in meteorites), shocked-quartz grains, and the buried Chicxulub crater itself. The biological consequence: non-avian dinosaurs, ammonites, and many marine groups went extinct; the niches they occupied became available, leading to the rapid adaptive radiation of mammals (and birds, the surviving avian dinosaurs) over the following tens of millions of years.