BIOL 4230 — Practice Final — Cumulative · Variation B

30 MC (3 pts each) + 4 short answer · ~50 min · cumulative L01–L20

Cumulative practice final for BIOL 4230 (Evolution). Mark your answers to all multiple-choice questions on a separate sheet (this is **practice variation Final-B**). 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. Tall and short individuals in a wildflower population produce different numbers of seeds, but height in this species is determined entirely by soil nutrients (no genetic component). Across many generations, will the population evolve to be taller?

A) Yes — but only if selection pressure is strong enough.
B) No — but only because the population is not large enough.
C) No — selection requires heritable variation, and there is none.
D) Yes — natural selection is acting on height, so the population will evolve.

2. Florida panthers (a remnant subpopulation of cougars) suffered severe inbreeding depression. Conservation managers introduced cougars from Texas. The Florida population's fitness improved significantly. This intervention is called:

A) Convergent evolution.
B) Sympatric speciation.
C) Captive breeding.
D) Genetic rescue.

3. Lamarck's most famous proposed mechanism of evolution was:

A) Reproductive isolation between populations.
B) Genetic drift in small populations.
C) Inheritance of characteristics acquired during an individual's lifetime.
D) Natural selection of heritable variation.

4. A non-toxic hoverfly evolves yellow-and-black bands resembling a stinging wasp. Predators avoid both. As the hoverfly population grows so that hoverflies become MORE COMMON than wasps, what is most likely to happen?

A) Predator avoidance becomes stronger because the warning signal is more frequent.
B) Predator avoidance breaks down because most yellow-and-black insects are actually palatable.
C) Both species converge further on each other's appearance (Müllerian mimicry).
D) The hoverfly population stabilizes due to the ESS payoff structure.

5. Which statement best describes the pre-Darwinian Great Chain of Being?

A) A fixed hierarchical ladder placing humans at the top and lower forms at the bottom
B) A theological argument that God created species in series over time.
C) A geological framework explaining extinction events.
D) An early evolutionary tree showing common ancestry of organisms.

6. Why might captive-bred animals released into the wild have lower fitness than their wild counterparts?

A) Captive breeding produces genetically inferior offspring.
B) Captive environments impose unique selection pressures (relaxed predation
C) Captive breeding always works perfectly.
D) Wild and captive animals are different species.

7. After the 1977 drought on Daphne Major, the medium ground finch population shifted toward deeper beaks. The Grants concluded this was natural selection because:

A) The drought directly caused beaks to grow.
B) All small-beaked birds happened to die randomly.
C) Birds physically modified their beaks to deal with hard seeds.
D) Beak depth was heritable

8. Why don't cheetahs have BOTH the speed of a sprinter AND the heat tolerance of a slow-walking lion?

A) Cheetahs are still actively evolving toward both.
B) Mutations for both traits never occurred.
C) Trade-offs: high-speed sprinting generates body heat that exceeds heat dissipation capacity
D) Lion alleles cannot be transferred to cheetahs.

9. In a population of 200 diploid individuals, the genotype counts are 50 AA, 100 Aa, and 50 aa. What is the frequency of allele A?

A) 0.75
B) 0.50
C) 0.40
D) 0.25

10. Species in which females mate with multiple males within a single breeding cycle tend to evolve relatively LARGE TESTES compared to species with strictly monogamous mating. The most likely explanation is:

A) Sperm competition — males who produce more sperm have higher chances of fertilizing ova when ejaculate from rival males is also present.
B) Larger testes are required for hormone signaling.
C) Larger testes evolved randomly via drift — the pattern is too strong and consistent across
D) Larger testes in polyandrous species support larger overall body size.

11. Two related fly species court at different times of day, so they rarely encounter each other. This is best classified as:

A) Prezygotic isolation — temporal.
B) Prezygotic isolation — mechanical.
C) Postzygotic isolation — hybrid sterility.
D) Postzygotic isolation — hybrid breakdown.

12. Life-history trade-offs exist because:

A) Resources are finite; energy spent on one trait cannot also be spent on another.
B) Selection has not yet eliminated trade-offs — given enough time, all could be optimized simultaneously.
C) Trade-offs are a textbook simplification that doesn't apply in nature.
D) Organisms have unlimited resources but choose to allocate them strategically.

13. After the UK's Clean Air Act reduced pollution, peppered moth populations shifted back toward the light morph. This best illustrates:

A) Selection direction can reverse when the environment changes.
B) Mutations had to occur to produce the light morph.
C) Genetic drift is more powerful than selection.
D) Selection direction is fixed once a trait evolves.

14. Radiometric dating works by measuring:

A) The total amount of radioactivity in a rock.
B) The depth at which a rock is buried.
C) The color of mineral inclusions in the rock.
D) The ratio of a parent isotope to its daughter (decay product)

15. Two full siblings share a coefficient of relatedness r equal to:

A) 0.5
B) 0.125
C) 0.25
D) 1.0

16. Horses and donkeys mate and produce viable offspring (mules), but mules are sterile. This is best classified as:

A) Prezygotic isolation — behavioral.
B) Postzygotic isolation — hybrid sterility.
C) Postzygotic isolation — hybrid inviability.
D) Prezygotic isolation — gametic.

17. Why does aggressive chemotherapy that initially shrinks a tumor often lead to relapse with drug-resistant cancer?

A) Chemotherapy is a strong selective pressure
B) Chemotherapy causes new cancer mutations.
C) The drug stops working after a few weeks regardless.
D) Cancers learn from chemotherapy.

18. Which of the following is NOT one of the 'Big Five' mass extinctions?

A) End-Cretaceous / K-Pg (~66 MYA).
B) End-Pleistocene (~11 KYA megafauna extinction).
C) End-Permian (~252 MYA).
D) End-Triassic (~201 MYA).

19. A trait has a large selection differential S but heritability $h^2 = 0$. What is the predicted response to selection R?

A) Equal to S, since selection is strong.
B) Negative — the population evolves the opposite way.
C) Half of S, on average.
D) R = 0, regardless of S.

20. In a Hawk-Dove game, why doesn't a population evolve to be entirely Hawks (always-aggressive)?

A) When Hawks are common, Hawk-Hawk fights inflict heavy costs
B) All-Hawk populations are never possible due to genetic constraints.
C) Doves are intrinsically more fit in all environments.
D) Group selection penalizes aggressive populations.

21. The traditional group 'Reptilia' (turtles, lizards, snakes, crocodiles) excludes birds. Birds, however, are descended from theropod dinosaurs, nested within Reptilia by descent. What kind of group is traditional 'Reptilia'?

A) Diphyletic — has exactly two ancestral origins.
B) Polyphyletic — members lack an immediate common ancestor.
C) Paraphyletic — includes a common ancestor and SOME but not all of its descendants.
D) Monophyletic — it's a clade — a clade includes ALL descendants

22. Fisherian runaway sexual selection refers to:

A) Mutation pressure generating new ornament traits.
B) A positive-feedback process where female preference for a male trait and the trait itself co-amplify over generations
C) Predators learning to avoid mating displays of unpalatable species.
D) Loss of all sexual ornaments due to high predation.

23. Influenza virus rapidly evolves resistance to antiviral drugs. Which statement best captures the role of mutation in this process?

A) Antiviral exposure causes the virus to mutate toward resistance.
B) The drug induces directed mutations only in the genes that confer resistance.
C) Mutations conferring resistance arise by chance independently of drug presence
D) Resistance is acquired during the host's lifetime and passed to offspring viruses through epigenetic inheritance.

24. The same Hox genes pattern the anterior-posterior axis of fruit flies, mice, and humans. What is the strongest evolutionary inference from this fact?

A) Hox genes evolved independently in flies, mice, and humans through convergence.
B) Insects and mammals are equally complex — hox conservation is about toolkit, not complexity.
C) Hox genes were present in the common ancestor of bilaterian animals and have been conserved over hundreds of millions of years.
D) Hox genes are randomly distributed across animal genomes.

25. The Cambrian explosion (~541 MYA) refers to:

A) The first appearance of plants.
B) A nuclear-scale extinction event in the Cambrian.
C) A volcanic eruption that ended the Cambrian.
D) The rapid (~20 MYR) appearance of most modern animal phyla in the fossil record.

26. Why did mammals undergo a major adaptive radiation after the K-Pg extinction?

A) Mammals appeared for the first time after the K-Pg.
B) Mammals were not affected by the asteroid impact.
C) Mammals had higher mutation rates after the extinction.
D) Mammals had been small and ecologically restricted

27. An r-selected species would typically display which combination of traits?

A) One offspring per lifetime, no maturity stage, immortality.
B) Few offspring, late maturity, parental care, long lifespan.
C) Many offspring, early maturity, little parental care, short lifespan.
D) Sterile workers and a single reproductive queen.

28. A breeder selects heifers with the highest milk yield (mean = 25 kg/day) from a herd with mean 20 kg/day, and breeds them. Heritability of milk yield is $h^2 = 0.4$. What is the predicted mean milk yield of the next generation?

A) 25 kg/day
B) 23 kg/day
C) 20 kg/day (no change)
D) 22 kg/day

29. Bipedal locomotion in the hominin lineage began approximately:

A) 6–7 million years ago
B) 200,000 years ago
C) 100 million years ago
D) 1 million years ago

30. Why is mutation considered the 'ultimate source' of genetic variation?

A) Mutation generates more variation than any other process.
B) Mutation is the only process that creates new alleles
C) Mutation is always beneficial in the long term.
D) Mutation is the only process that can change allele frequencies.

BIOL 4230 — Practice Final — Cumulative · Variation B — Short Answer Section Name _____

1. Gene expression is regulated at four broadly different levels. Name each level and give one example of a regulatory mechanism that acts at that level.

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2. Altruistic behavior — paying a cost to benefit another — should be selected against, yet it is widespread. (a) State Hamilton's rule. (b) Define each variable. (c) Explain why a worker bee helping its queen sister is favored even though the worker doesn't reproduce directly. (d) Explain why apparent altruism toward NON-kin requires a different mechanism.

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3. A population of snails has the following genotype counts at a shell-color locus: 90 RR, 20 Rr, 90 rr (total 200). (a) Calculate p (frequency of R) and q. (b) Compute the expected number of heterozygotes under Hardy-Weinberg. (c) Propose ONE mechanism that could explain the deviation between expected and observed heterozygote counts.

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4. Pathogens evolve under medical pressure. (a) Explain why heavy antibiotic use selects for resistance using random-mutation logic. (b) Why does combination therapy slow this process? (c) How does mode of transmission shape virulence evolution? (d) Give one example of a directly-transmitted pathogen and one of a vector-borne or waterborne pathogen, predicting expected virulence trends.

Answer Key for Practice Final — Cumulative · Variation B

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

Short Answer — Sample Answers

1. Gene expression is regulated at four broadly different levels. Name each level and give one example of a regulatory mechanism that acts at that level.

PRE-TRANSCRIPTIONAL: DNA methylation at CpG sites silences gene access by altering chromatin packing. Histone modifications (e.g., histone acetylation opening chromatin, H3K9 methylation closing it) act at this level. TRANSCRIPTIONAL: transcription factors bind promoters and enhancers to recruit or block RNA polymerase II, controlling the rate of mRNA synthesis. POST-TRANSCRIPTIONAL: alternative splicing generates multiple mRNA isoforms from one gene; microRNAs bind complementary mRNAs to suppress translation or trigger degradation. POST-TRANSLATIONAL: protein phosphorylation activates or inactivates enzymes; ubiquitination tags proteins for degradation by the proteasome.

2. Altruistic behavior — paying a cost to benefit another — should be selected against, yet it is widespread. (a) State Hamilton's rule. (b) Define each variable. (c) Explain why a worker bee helping its queen sister is favored even though the worker doesn't reproduce directly. (d) Explain why apparent altruism toward NON-kin requires a different mechanism.

(a) Hamilton's rule: $rB > C$. (b) r is the COEFFICIENT OF RELATEDNESS — the probability that two individuals share a given allele by recent common descent (e.g., siblings $r = 0.5$, half-siblings $r = 0.25$, first cousins $r = 0.125$). B is the BENEFIT to the recipient in additional offspring produced; C is the COST to the actor in offspring foregone. (c) Worker bees forgo direct reproduction to help raise their queen's offspring (their sisters). In haplodiploid hymenopterans, sisters share $r = 0.75$ — higher than mother-offspring $r = 0.5$. Helping a sister propagates more copies of shared alleles than helping own offspring would. The worker's INCLUSIVE FITNESS through her sisters exceeds what direct reproduction would give. (d) For apparent altruism toward unrelated individuals, $r \approx 0$ and Hamilton's rule cannot be satisfied. These cases require different mechanisms: DIRECT RECIPROCITY (tit-for-tat), INDIRECT RECIPROCITY (reputation effects), MUTUALISTIC BYPRODUCTS (cooperation that's also self-beneficial), or PARTNER CHOICE.

3. A population of snails has the following genotype counts at a shell-color locus: 90 RR, 20 Rr, 90 rr (total 200). (a) Calculate p (frequency of R) and q. (b) Compute the expected number of heterozygotes under Hardy-Weinberg. (c) Propose ONE mechanism that could explain the deviation between expected and observed heterozygote counts.

(a) Total alleles = 400. R copies = 2·90 + 1·20 = 200, so p = 0.5; q = 0.5. (b) Expected Rr under HWE = 2pq·N = 2·0.5·0.5·200 = 100 individuals. Observed = 20, so there are 80 fewer heterozygotes than expected — a substantial heterozygote deficit. (c) The most likely mechanism is INBREEDING or assortative mating by shell color (RR snails preferentially mating with RR, rr with rr). Either would push genotype frequencies toward homozygosity without changing allele frequencies. Alternatively, the Wahlund effect — if the 200 snails are actually two subpopulations pooled together, each of which has different allele frequencies, the combined sample would appear heterozygote-deficient.

4. Pathogens evolve under medical pressure. (a) Explain why heavy antibiotic use selects for resistance using random-mutation logic. (b) Why does combination therapy slow this process? (c) How does mode of transmission shape virulence evolution? (d) Give one example of a directly-transmitted pathogen and one of a vector-borne or waterborne pathogen, predicting expected virulence trends.

(a) Antibiotic resistance evolves because resistance MUTATIONS OCCUR RANDOMLY at low frequency in large bacterial populations (independent of antibiotic exposure). When antibiotics are applied, susceptible bacteria die while rare resistant variants survive and multiply, raising the frequency of resistance — random mutation plus non-random selection. (b) COMBINATION THERAPY uses multiple drugs simultaneously. To survive, a bacterium must carry resistance to ALL drugs at once. The joint probability is the PRODUCT of individual probabilities — for three drugs at 10^{-9} each, joint resistance is 10^{-27}, vanishingly rare. (c) MODE OF TRANSMISSION shapes optimal virulence: directly-transmitted pathogens need a mobile, healthy host to spread, so very high virulence is selected against; vector-borne or waterborne pathogens transmit even from incapacitated hosts, so virulence can stay high. (d) EXAMPLES: the common cold (rhinovirus, directly respiratory) — predicted to evolve toward MODERATE virulence; cholera (waterborne) — predicted to evolve toward HIGH virulence. Improvements in clean water supply (Ewald) should select for less-virulent cholera strains.