

## BIOL 4230 — Practice Final — Cumulative · Variation A

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-A**). 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. If alleles at a locus act additively, the phenotype of an Aa heterozygote is most likely:
  - A) Identical to AA homozygote.
  - B) Wholly different from either homozygote.
  - C) Identical to aa homozygote.
  - D) Intermediate between AA and aa.
2. On a reaction-norm graph (phenotype on y-axis, environment on x-axis), what does a horizontal line for a given genotype indicate?
  - A) There is genotype-by-environment interaction.
  - B) The trait is environmentally determined and not genetic.
  - C) The genotype is plastic — a horizontal line means NO change
  - D) The genotype is not plastic
3. On Ram Mountain, bighorn sheep were heavily trophy-hunted for large-horned males. Over decades, average horn size in the population DECREASED. The most likely cause is:
  - A) Selective hunting of large-horned individuals removed those phenotypes from the breeding pool
  - B) Sheep with large horns voluntarily hid them.
  - C) Random drift in a large population.
  - D) Climate change shrank horns.
4. An island has unpredictable resource availability — sometimes abundant, often scarce. Selection on this island would most likely favor:
  - A) Producing many small offspring as a bet-hedging strategy.
  - B) Eliminating reproduction entirely.
  - C) Producing few, large, well-provisioned offspring (K-strategy).
  - D) Producing exactly one offspring per lifetime.
5. Most cancers occur in older individuals. From an evolutionary perspective, why has selection failed to eliminate cancer susceptibility?
  - A) Cancer is contagious in some species.
  - B) Cancer was unknown in ancestral populations.
  - C) All organisms have an upper age limit.
  - D) Selection's strength declines with age

6. Acetylation of histone tails generally:
- A) Triggers degradation of the protein the gene encodes.
  - B) Causes alternative splicing of the resulting mRNA.
  - C) Tightens chromatin and represses transcription.
  - D) Loosens chromatin and promotes transcription.
7. In which scenario does NATURAL SELECTION OCCUR but NO EVOLUTION result?
- A) A population shows heritable variation in beak depth, and large-beaked birds reproduce more during a drought.
  - B) Two populations are separated by a mountain range and experience different selective pressures.
  - C) A herd of cattle has variation in milk yield due entirely to feed differences ( $h^2 = 0$ )
  - D) Bacteria exposed to antibiotics develop resistance through mutation.
8. Which of the following is a HYPOTHESIS rather than a scientific theory?
- A) The cell theory — cell theory is
  - B) The germ theory of disease.
  - C) Antibiotic-resistant strains will increase in frequency in hospitals where antibiotics are heavily used.
  - D) Evolution by natural selection.
9. Hospitals that heavily use a particular antibiotic see rising rates of resistance to that antibiotic. Which evolutionary mechanism is most directly responsible?
- A) Natural selection on rare resistant mutants that arise independently of the antibiotic.
  - B) Lamarckian inheritance — bacteria acquire resistance from exposure and pass it to offspring.
  - C) Mutation rate increases when antibiotics are present, generating resistance on demand.
  - D) Genetic drift — random change in a small bacterial population.
10. Earth is approximately how old, based on radiometric dating?
- A) 100 million years
  - B) 4.568 billion years
  - C) 13.8 billion years
  - D) 4.568 million years
11. PROTEIN PROMISCUITY refers to:
- A) Proteins frequently interacting with foreign DNA.
  - B) Proteins binding multiple partners with equal strength.
  - C) Proteins that move freely between cellular compartments.
  - D) Proteins having weak side-activities beyond their primary function
12. Salmon reproduce once in a single massive spawning event and die shortly afterward (semelparity). What life-history logic best explains this strategy?
- A) Multiple breeding events are forbidden by Pacific Ocean conditions.
  - B) Salmon are too dumb to live longer than one breeding season.
  - C) Adult salmon survival is so low after migration that maximum effort in a single reproductive bout outperforms hedging across multiple bouts.
  - D) Salmon are unable to reproduce more than once due to a genetic defect.

13. Inbreeding depression in a small population arises because:
- A) Inbreeding increases homozygosity
  - B) Inbreeding only affects sexually selected traits.
  - C) Inbreeding causes new mutations.
  - D) Inbreeding directly reduces population size.
14. Two islands have identical species counts (50 species each). Island A has high immigration and high extinction; Island B has low immigration and low extinction. Which statement is true?
- A) Standing diversity differs; turnover rate is the same.
  - B) Standing diversity is the same
  - C) Neither matters because there are 50 species on each.
  - D) Both standing diversity and turnover differ.
15. Whales have small, internal pelvic bones that don't articulate with the spine. What does this best illustrate?
- A) Pelvic bones formed by chance during whale development.
  - B) Whales recently developed a pelvis through convergent evolution with mammals.
  - C) Whales evolved from terrestrial ancestors that had functional pelvic skeletons
  - D) These bones support the whale's swimming musculature in a major way.
16. Two populations of squirrels are separated when a mountain range rises between them. Over time, they diverge and become reproductively incompatible. This is:
- A) Allopatric speciation
  - B) Sympatric speciation.
  - C) Peripatric speciation only.
  - D) Parapatric speciation.
17. Which of the following best defines biological evolution?
- A) An individual organism becoming better adapted over its lifetime.
  - B) Change in the heritable traits of a population across generations.
  - C) Progressive improvement of organisms toward greater complexity.
  - D) Random variation among individuals within a single generation.
18. Why is 'evolution happens' a poor scientific hypothesis even though evolution is well supported?
- A) It is an example of inheritance of acquired characteristics.
  - B) It is religious rather than scientific.
  - C) It is too broad — it does not specify what observations would prove it wrong.
  - D) It is not supported by any evidence.
19. The Red Queen hypothesis proposes that sexual reproduction is favored because:
- A) Predators preferentially attack asexual species.
  - B) Sex makes reproduction faster than asexual processes.
  - C) Sexual reproduction reduces parental investment in each offspring.
  - D) Hosts must constantly evolve to keep up with rapidly evolving parasites

20. Closely related plant lineages on South America and Africa share an ancestor that lived ~120 MYA. The most likely explanation is:
- A) Convergent evolution producing similar plants.
  - B) Long-distance bird-mediated seed transport at the species' age.
  - C) Recent dispersal across the Atlantic Ocean.
  - D) Vicariance — the lineage was once continuous on Gondwana before South America and Africa separated.
21. 'Lucy' is a famous specimen of which species?
- A) Australopithecus afarensis
  - B) Sahelanthropus tchadensis
  - C) Homo neanderthalensis
  - D) Homo erectus
22. The Devonian period (~416–359 MYA) is most associated with which biological event?
- A) The first dinosaurs.
  - B) Diversification of fishes and the origin of land vertebrates (early tetrapods).
  - C) The Cambrian explosion.
  - D) The first land plants.
23. Which of the following is NOT one of the five assumptions of Hardy-Weinberg equilibrium?
- A) Random mating
  - B) Infinite population size
  - C) Equal allele frequencies
  - D) No mutation
24. On a phylogenetic tree, two taxa are 'more closely related' to each other than to a third when:
- A) Their lineages have evolved at similar rates.
  - B) Their branches end closer together horizontally on the page.
  - C) They share a more recent common ancestor (a more shallow node) than either does with the third.
  - D) They share more morphological similarities overall.
25. Worker honey bees forgo reproduction and help raise their queen's offspring. From an inclusive-fitness perspective, this makes sense because:
- A) Workers are sterile and incapable of reproduction.
  - B) Workers gain inclusive fitness by helping raise sisters (in haplodiploid systems)
  - C) Group selection at the colony level overrides individual fitness.
  - D) Workers are forced into helping by the queen and have no choice.
26. Why did the dark (melanic) form of *Biston betularia* rise to dominance in industrial regions of England?
- A) Polluted air directly killed light-colored moths through respiratory toxicity.
  - B) Bird predators were more likely to spot light moths against soot-darkened tree trunks
  - C) Pollution induced melanism in moths during their lifetime.
  - D) Moths actively chose darker resting sites in polluted areas.

27. INCLUSIVE FITNESS is best defined as:
- A) Average fitness of an individual's species.
  - B) The total number of allele copies an individual passes on
  - C) The fitness of the entire population.
  - D) The number of offspring an individual produces.
28. Which of the following best illustrates coevolution (rather than mere coexistence or convergence)?
- A) Two species of cactus in the same desert evolving similar water-storage tissue.
  - B) Two unrelated frogs in different continents evolving the same toxic compound.
  - C) Different bird species nesting in the same forest without interacting.
  - D) A predator and its prey both evolving faster running speeds in response to one another.
29. Which of the following groups is the Biological Species Concept LEAST well suited to?
- A) Sexual birds.
  - B) Sexual mammals.
  - C) Asexual bacteria.
  - D) Sexual amphibians.
30. Male elk grow large antlers used in physical combat with rival males during the breeding season. This is primarily an example of:
- A) Sexual conflict — sexual conflict is between
  - B) Intrasexual selection (same-sex competition).
  - C) Intersexual selection (mate choice).
  - D) Sexual cooperation — combat is competitive, not

1. Evolution of complex adaptations like the vertebrate eye seems to require many coordinated changes. Explain (a) how STEPWISE GRADUAL EVOLUTION can build such structures; (b) the role of REGULATORY mutations; (c) the role of GENE DUPLICATION; (d) why complex adaptations are typically IMPERFECT.
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2. Describe what evidence the Grants needed to demonstrate that beak-depth evolution in *Geospiza fortis* after the 1977 drought was caused by natural selection. Name three specific kinds of evidence.
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3. Briefly explain what Dobzhansky's 1973 quote — 'Nothing in biology makes sense except in the light of evolution' — is claiming, and give one concrete example of a biological phenomenon that requires evolutionary thinking to explain.
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4. The Biological Species Concept (BSC) defines species by reproductive isolation. Give one strength and two specific limitations of the BSC, and name an alternative species concept that handles each limitation.
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## Answer Key for Practice Final — Cumulative · Variation A

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

### Short Answer — Sample Answers

**1. Evolution of complex adaptations like the vertebrate eye seems to require many coordinated changes. Explain (a) how STEPWISE GRADUAL EVOLUTION can build such structures; (b) the role of REGULATORY mutations; (c) the role of GENE DUPLICATION; (d) why complex adaptations are typically IMPERFECT.**

(a) Complex adaptations build by STEPWISE accumulation of small mutational changes, each conferring some fitness advantage. The vertebrate eye evolved through a sequence — light-sensitive patch → cupped patch → pinhole eye → lensed eye — and each intermediate stage exists in living organisms today and is functional in its own context. (b) Many morphological changes come from CIS-REGULATORY mutations that alter WHEN and WHERE genes are expressed, without changing the proteins themselves. This rewires existing toolkits (e.g., Hox expression boundaries) to produce novel body plans. (c) GENE DUPLICATION creates redundant copies; relaxed selection on one copy lets it accumulate mutations and evolve new functions (neofunctionalization) or subdivide ancestral roles (subfunctionalization). (d) Complex adaptations are IMPERFECT because selection works only on what's available — historical legacy, developmental constraints, and trade-offs limit what can evolve. The vertebrate retina has its photoreceptors backward (light passes through neurons before reaching them) — a quirk of history, not optimal design.

**2. Describe what evidence the Grants needed to demonstrate that beak-depth evolution in *Geospiza fortis* after the 1977 drought was caused by natural selection. Name three specific kinds of evidence.**

First, the Grants needed to show that beak-depth VARIATION existed in the pre-drought population. Second, they needed to show that variation was HERITABLE — using parent-offspring regressions to demonstrate that offspring beak depths predictably tracked their parents'. Third, they needed to show DIFFERENTIAL SURVIVAL: birds with deeper beaks survived the drought at higher rates because they could crack large seeds; and they needed to show that the next generation had measurably deeper beaks on average — the actual evolutionary RESPONSE to selection.

**3. Briefly explain what Dobzhansky's 1973 quote — 'Nothing in biology makes sense except in the light of evolution' — is claiming, and give one concrete example of a biological phenomenon that requires evolutionary thinking to explain.**

Dobzhansky meant that evolution is the unifying theory of biology — the framework that ties together molecular, cellular, organismal, and ecological observations into a coherent whole. Without evolution, the patterns biologists observe are just disconnected facts. Example: antibiotic resistance in bacterial populations only makes sense as natural selection acting on heritable mutations conferring resistance — the mutation is random, but the selection is non-random, and the rapid spread reflects differential reproduction.

**4. The Biological Species Concept (BSC) defines species by reproductive isolation. Give one strength and two specific limitations of the BSC, and name an alternative species concept that handles each limitation.**

The strength of the BSC (Mayr) is that it grounds species in a clear, testable evolutionary mechanism — gene flow — and is operational for most sexually-reproducing animals. Limitations: (1) The BSC fails for ASEXUAL organisms like bacteria and parthenogenetic lizards, where there's no interbreeding to test reproductive isolation against — these are typically classified using morphological or phylogenetic species concepts. (2) The BSC fails for FOSSILS, since you can't test interbreeding between extinct populations — paleontologists use the morphological species concept or phylogenetic species concept. Additional weakness (bonus): the BSC can be ambiguous when populations occasionally hybridize but maintain mostly distinct lineages.