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## Speciation & Reproductive Isolation

### Study Guide — Speciation

High school / IB / pre-med level questions covering allopatric, sympatric, parapatric and peripatric speciation; gene flow, drift, selection, mutation; prezygotic vs postzygotic isolation; hybrid zones, reinforcement, ring species, and common concept traps about what counts as a species.

72 items — Study Guide with Answers

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1 Which statement best captures what must happen for speciation to be considered complete (using the biological species concept)?

- A Individuals develop different-looking body shapes
- B Two populations show any allele frequency differences
- C **Gene flow between populations is effectively prevented by reproductive isolation ✓**
- D Populations become geographically separated for at least 1 million years
- E A mutation occurs in one population

► **Explanation:** Under the biological species concept, speciation is complete when reproductive isolation prevents significant gene flow. Appearance differences or time alone are not sufficient, and mutation/evolution can occur without producing new species.



2 Two populations of the same bird species become separated by a new mountain range. Over time they diverge genetically. This is most directly an example of:

- A Sympatric speciation
- B **Allopatric speciation ✓**
- C Parapatric speciation
- D Artificial selection
- E Horizontal gene transfer

► **Explanation:** Allopatric speciation involves geographic separation that reduces gene flow, allowing divergence by selection/drift/mutation.



3 Which scenario best fits sympatric speciation?

- A A river splits one population into two isolated groups





- B A storm carries a few individuals to a distant island
- C A plant population produces a polyploid lineage that can reproduce with itself but not with the original diploids ✓
- D Two populations separated by a glacier diverge
- E Two populations meet and merge back into one gene pool

► **Explanation:** Sympatric speciation occurs without geographic separation. Polyploidy can create instant reproductive isolation in plants, producing a new species in the same area.

4 Two populations live in adjacent habitats along a long coastline. Individuals mostly mate with nearby neighbors, and a stable hybrid zone exists where the habitats meet. This pattern best describes:



- A Allopatric speciation
- B Parapatric speciation ✓
- C Sympatric speciation
- D Clonal reproduction
- E Artificial speciation by selective breeding

► **Explanation:** Parapatric speciation involves neighboring populations with limited gene flow across a boundary; hybrid zones and clines are common features.

5 A small group colonizes a new island and becomes isolated from the original mainland population. If speciation occurs, this is most often classified as:



- A Sympatric speciation
- B Peripatric speciation (a form of allopatric with a small founder population) ✓
- C Parapatric speciation





- D Hybrid speciation without isolation
- E No speciation because islands prevent evolution

► **Explanation:** Peripatric speciation is a form of allopatric speciation where a small peripheral/founder population becomes isolated. Drift and selection can act strongly because population size is small.

6 Which statement best describes gene flow's effect on speciation?



- A Gene flow always speeds up speciation by creating new mutations
- B Gene flow tends to reduce divergence between populations, often opposing speciation ✓**
- C Gene flow is the same thing as genetic drift
- D Gene flow only happens in asexual species
- E Gene flow prevents natural selection from acting

► **Explanation:** Gene flow mixes alleles between populations, making them more similar. This can slow or prevent speciation unless other forces (strong selection, barriers) overcome it.

7 Which is a prezygotic reproductive isolating mechanism?



- A Hybrid sterility (e.g., mule)
- B Hybrid breakdown in F2 generation
- C Different mating seasons (temporal isolation) ✓**
- D Embryo dies early after fertilization
- E Hybrid has reduced survival after birth

► **Explanation:** Prezygotic barriers prevent fertilization from occurring (before a zygote forms). Temporal isolation prevents mating because populations breed at different times.





8 Which is a postzygotic reproductive isolating mechanism?



- A Different courtship rituals
- B Different habitats within the same area
- C Incompatible reproductive structures preventing mating
- D Gametes cannot fuse (gametic isolation)
- E **Hybrids are viable but sterile ✓**

► **Explanation:** Postzygotic barriers act after fertilization. Sterile hybrids (reduced fertility) can survive but cannot produce fertile offspring, stopping gene flow.

9 Two closely related frog species live in the same pond. One breeds in early spring; the other breeds in midsummer. This is best described as:



- A Mechanical isolation
- B **Temporal isolation ✓**
- C Gametic isolation
- D Hybrid breakdown
- E Bottleneck effect

► **Explanation:** Temporal isolation is a prezygotic barrier where populations breed at different times, preventing mating even in the same location.





**10** Two insect species court using different pheromones. Individuals rarely attempt to mate across species because they do not recognize each other as mates. This is:

- A** Behavioral isolation (prezygotic) ✓
- B** Hybrid inviability (postzygotic)
- C** Polyploidy (sympatric)
- D** Bottleneck effect (drift)
- E** Gene flow (migration)

► **Explanation:** Behavioral isolation is prezygotic: differences in courtship signals prevent mating attempts and reduce gene flow.



**11** Two snail species have opposite shell-coiling directions, making mating physically difficult. Which barrier is this?

- A** Mechanical isolation ✓
- B** Gametic isolation
- C** Hybrid breakdown
- D** Temporal isolation
- E** Adaptive radiation

► **Explanation:** Mechanical isolation is prezygotic: anatomical differences prevent successful mating or pollen transfer.



**12** Two sea urchin species release gametes into the water at the same time and place, but fertilization between species almost never occurs because sperm cannot bind to the egg surface proteins. This is:





- A Habitat isolation
- B Gametic isolation ✓**
- C Hybrid sterility
- D Temporal isolation
- E Founder effect

► **Explanation:** Gametic isolation is prezygotic: sperm and egg (or pollen and ovule) cannot fuse or interact properly, preventing fertilization even when mating/release overlaps.

**13** Which situation best illustrates habitat isolation (a prezygotic barrier)?



- A Hybrids die before reaching adulthood
- B Two populations live in the same region but breed in different microhabitats (e.g., one in shallow water, one in deep water) ✓**
- C Hybrids are sterile
- D A hurricane reduces population size drastically
- E Chromosome number doubles in a plant

► **Explanation:** Habitat isolation occurs when populations occupy different habitats in the same area and rarely encounter each other for mating, preventing zygote formation.

**14** Two bird populations look different and sing different songs. However, when brought together in captivity, they mate readily and produce fertile offspring. Under the biological species concept, they are best considered:



- A Definitely different species because they look different
- B Different species because they sing different songs
- C The same species because they can interbreed and produce fertile offspring ✓**





- D Different species because captivity always creates new species
- E Impossible to classify without counting chromosomes

► **Explanation:** The biological species concept focuses on reproductive compatibility and fertile offspring. Differences in appearance/song may be early divergence but do not necessarily mean full speciation.

15 Which statement best distinguishes genetic drift from natural selection?



- A Genetic drift is nonrandom and always adaptive
- B Natural selection is random changes in allele frequencies
- C **Genetic drift is random change in allele frequencies; natural selection is nonrandom change based on fitness differences ✓**
- D Natural selection occurs only in small populations; drift only in large populations
- E Drift requires mutation; selection does not

► **Explanation:** Drift is random sampling of alleles (strongest in small populations). Natural selection systematically favors alleles that increase reproductive success in a given environment.

16 A sudden disaster reduces a population from 10,000 to 200 individuals. The surviving allele frequencies differ from the original purely by chance. This is best described as:



- A Founder effect
- B **Bottleneck effect (genetic drift) ✓**
- C Reinforcement
- D Assortative mating
- E Gene flow





► **Explanation:** A bottleneck is drift caused by a drastic population size reduction. It can reduce genetic variation and change allele frequencies by chance.

17 Which statement about the founder effect is most accurate?



- A It is a type of natural selection that always improves adaptation
- B It is genetic drift when a small group starts a new population, potentially with unrepresentative allele frequencies ✓**
- C It is gene flow between populations
- D It occurs only in plants due to polyploidy
- E It prevents evolution from occurring

► **Explanation:** Founder effect is drift caused by colonization by a small number of individuals. The new population's gene pool may differ simply by chance from the source population.

18 A key reason drift can accelerate divergence (and potentially speciation) in small isolated populations is that small populations:



- A Have more directed mutations
- B Experience stronger sampling error, so allele frequencies can change rapidly by chance ✓**
- C Always have higher fitness than large populations
- D Cannot experience natural selection
- E Have no gene flow by definition, even when they migrate

► **Explanation:** In small populations, random sampling effects are stronger, causing larger random allele-frequency shifts. If gene flow is low, these differences can accumulate between populations.





19 Mutation is best described as:

- A A directed change that happens because an organism needs it
- B A random change in DNA sequence that can introduce new alleles ✓**
- C The process of sorting chromosomes during meiosis
- D Always harmful and always removed immediately
- E The same as genetic drift

► **Explanation:** Mutations arise without regard to what is beneficial; they create new alleles. Whether they spread depends on selection, drift, and gene flow.



20 Which statement about natural selection and speciation is most accurate?

- A Natural selection always creates new species quickly
- B Natural selection can contribute to divergence, but reproductive isolation is needed for speciation ✓**
- C Natural selection cannot act unless populations are geographically separated
- D Natural selection is random, so it cannot cause consistent divergence
- E Natural selection prevents any hybrid zones from forming

► **Explanation:** Selection can drive populations to adapt differently, but speciation requires barriers that reduce gene flow (pre- or postzygotic).



21 Two populations diverge in isolation. When they come into secondary contact, hybrids have low fitness. Over time, individuals that avoid cross-mating leave more offspring. This process is called:

- A Reinforcement ✓**





- B Bottleneck effect
- C Founder effect
- D Gene flow
- E Convergent evolution

► **Explanation:** Reinforcement is selection that strengthens prezygotic isolation because producing low-fitness hybrids is costly.

22 Which outcome is most consistent with reinforcement after secondary contact?



- A Prezygotic barriers become stronger (more mate discrimination) ✓
- B Hybrids become more fertile immediately
- C The populations become genetically identical
- D Mutation rates drop to zero
- E The environment becomes uniform

► **Explanation:** Reinforcement increases prezygotic isolation—traits that reduce interbreeding are favored when hybrids are less fit.

23 A hybrid zone is best described as:



- A A region where a species reproduces asexually
- B A region where two diverging populations meet and produce hybrids ✓
- C A place where mutation cannot occur
- D A zone of complete geographic isolation
- E A region where natural selection stops





► **Explanation:** Hybrid zones form where populations/species contact and interbreed. Their stability depends on selection against hybrids, dispersal, and environmental gradients.

**24** Two populations are separated by a barrier for 500 years, then the barrier disappears. They interbreed freely with no reduction in fitness of offspring. The most accurate conclusion is:



- A Speciation has occurred because there was geographic separation
- B Speciation has not occurred under the biological species concept because reproductive isolation is absent ✓**
- C Speciation must have occurred but then reversed by mutation
- D They are different species if they look different
- E Speciation is impossible in 500 years

► **Explanation:** Geographic separation can start divergence, but speciation requires reproductive isolation. If they freely interbreed with fertile offspring, they remain the same species in the biological species concept.

**25** Which is the best example of a postzygotic barrier rather than a prezygotic barrier?



- A Different courtship songs
- B Different mating seasons
- C Sperm cannot fertilize egg
- D Hybrid embryos fail to develop properly ✓**
- E Different habitats reduce encounters

► **Explanation:** Postzygotic barriers occur after fertilization; hybrid inviability (embryo failure) is postzygotic.





26 A classic 'mule' scenario (horse × donkey) best illustrates which postzygotic barrier?



- A Hybrid inviability
- B Hybrid sterility (reduced hybrid fertility) ✓**
- C Habitat isolation
- D Gametic isolation
- E Temporal isolation

► **Explanation:** Mules are typically viable but sterile, a postzygotic barrier that prevents gene flow even if mating occurs.

27 Hybrids between two plant species are healthy and fertile, but when hybrids mate with each other, the F2 generation has low survival. This is best called:



- A Hybrid breakdown ✓**
- B Gametic isolation
- C Mechanical isolation
- D Bottleneck effect
- E Directional selection

► **Explanation:** Hybrid breakdown is a postzygotic barrier where first-generation hybrids are viable/fertile, but later generations show reduced fitness due to genetic incompatibilities.

28 Which statement about polyploidy is most accurate for speciation?





- A Polyploidy is common in animals and rarely affects plants
- B Polyploidy can cause immediate reproductive isolation in plants ✓**
- C Polyploidy always prevents reproduction entirely
- D Polyploidy is the same as gene flow
- E Polyploidy is a type of behavioral isolation

► **Explanation:** A sudden change in chromosome number (polyploidy) can make a lineage unable to produce fertile offspring with the original diploid population, creating instant isolation—especially common in plants.

**29** A diploid plant ( $2n$ ) produces an autopolyploid offspring ( $4n$ ). Which mating is most likely to produce fertile offspring?



- A  $4n \times 2n$
- B  $4n \times 4n$  ✓**
- C  $2n \times 2n$  always yields  $4n$
- D  $4n \times 1n$
- E  $4n$  cannot reproduce at all

► **Explanation:** Polyploids often have reduced fertility when mating with the original ploidy due to mismatched chromosome pairing in meiosis. Same-ploidy mating ( $4n \times 4n$ ) allows proper pairing and fertility.

**30** Allopolyploid speciation differs from autopolyploid speciation because allopolyploidy typically involves:



- A Chromosome doubling within one species only
- B Hybridization between two species followed by chromosome doubling, restoring fertility ✓**





- C Only mutations in mitochondrial DNA
- D Behavioral isolation due to mate choice
- E Geographic isolation by a mountain range

► **Explanation:** Allopolyploidy begins with a hybrid between species (often sterile due to mismatched chromosomes). Chromosome doubling can restore pairing and fertility, creating a new reproductively isolated lineage.

**31** Which is the best reason reproductive isolation is central to defining species (biological species concept)?



- A It ensures all species look different
- B It determines whether populations share a gene pool over generations ✓
- C It guarantees mutations stop happening
- D It prevents any environmental change
- E It means individuals cannot move

► **Explanation:** Species (under this concept) are defined by shared gene pools. Reproductive isolation prevents gene flow, allowing populations to evolve independently.

**32** Which species concept is most difficult to apply to fossils?



- A Morphological species concept
- B Biological species concept ✓
- C Phylogenetic species concept
- D Ecological species concept
- E All are equally easy to apply





► **Explanation:** The biological species concept relies on observing interbreeding and reproductive isolation, which cannot be tested directly in fossils (and is also tricky for asexual organisms).

33 A key limitation of the morphological species concept is that it:



- A Cannot be used for fossils at all
- B Cannot recognize cryptic species that look similar but are reproductively isolated
- C Requires DNA sequencing for every specimen
- D Depends on testing mating compatibility
- E Works only for bacteria

► **Explanation:** Morphological classification can miss cryptic species (distinct gene pools that look similar) and can be confused by variation within a species (sex, age, environment).

34 Which statement best matches the phylogenetic species concept (high school level summary)?



- A Species are groups that can interbreed and produce fertile offspring
- B Species are defined by a unique role in an ecosystem
- C Species are the smallest monophyletic groups on a phylogenetic tree (shared ancestry + distinct traits)
- D Species are defined only by geographic boundaries
- E Species are defined by chromosome number only

► **Explanation:** The phylogenetic concept emphasizes evolutionary history: a species is a distinct lineage (often a monophyletic group) diagnosable by unique traits/genes.





35 Which scenario is **MOST** likely to produce rapid speciation by adaptive radiation?



- A A stable environment with no new niches for millions of years
- B A population colonizes a new area with many empty ecological niches and little competition ✓**
- C High gene flow between all populations worldwide
- D A complete absence of mutation
- E All individuals are genetically identical and remain so

► **Explanation:** Adaptive radiation often occurs when organisms enter environments with many available niches (e.g., islands, post-extinction), leading to rapid diversification by natural selection.

36 A ring species is best described as a situation where:



- A Two species always live on islands shaped like rings
- B Populations spread around a geographic barrier, neighboring populations interbreed, but end populations cannot ✓**
- C All populations are completely isolated from all others
- D Speciation happens instantly by polyploidy only
- E Gene flow is equal between all populations

► **Explanation:** Ring species illustrate gradual divergence with gene flow between neighbors, yet reproductive isolation between terminal populations—showing speciation can be a continuum.

37 Which observation would most strongly support that two populations are currently experiencing allopatric speciation rather than sympatric speciation?



- A They occupy different microhabitats in the same forest





- B They have a physical barrier between them that prevents interbreeding ✓**
- C They have different courtship calls
- D They have different chromosome numbers due to polyploidy
- E They mate at different times in the same lake

► **Explanation:** Allopatric speciation begins with geographic separation (physical barrier) reducing gene flow. The other options are reproductive barriers that can occur without geographic separation (sympatric).

**38 Two fish types live in the same lake. Type 1 eats near the surface; type 2 eats near the bottom. Over time they develop different body shapes and preferentially mate with their own type. This is best interpreted as:**



- A Sympatric divergence leading toward speciation driven by ecological differences and assortative mating ✓**
- B Allopatric speciation because the lake separates them
- C Bottleneck effect only
- D Gene flow increasing divergence
- E No evolution because both live in the same lake

► **Explanation:** Different resource use within the same area can lead to disruptive/ecological selection, and assortative mating reduces gene flow—classic ingredients for sympatric speciation.

**39 Which statement about reproductive isolation is correct?**



- A Reproductive isolation requires that populations never meet geographically
- B Reproductive isolation can be prezygotic, postzygotic, or both ✓**
- C Reproductive isolation only refers to sterile hybrids





- D Reproductive isolation prevents mutation from occurring
- E Reproductive isolation is the same as genetic drift

► **Explanation:** Isolation mechanisms can prevent mating/fertilization (prezygotic) or reduce hybrid fitness/fertility after fertilization (postzygotic).

40 Which is the most direct way a physical barrier (like a canyon) promotes allopatric speciation?



- A It forces mutations to happen faster
- B It reduces gene flow, letting drift and selection act independently in each population** ✓
- C It guarantees that both sides have identical environments
- D It creates new chromosomes instantly
- E It causes immediate hybrid sterility

► **Explanation:** The key effect of geographic barriers is preventing interbreeding, so populations evolve independently by selection, drift, and mutation.

41 Two populations of insects are in the same region. One shifts to a new host plant and mates only on that plant. Over time, gene flow decreases. The initial isolating mechanism is best classified as:



- A Hybrid inviability
- B Habitat isolation (prezygotic)** ✓
- C Hybrid sterility
- D Polyploidy
- E Bottleneck effect





► **Explanation:** If mating occurs in different habitats (host plants), individuals rarely meet/mate across groups—this is habitat isolation and can start sympatric divergence.

42 Which statement about 'geographic isolation' vs 'reproductive isolation' is most accurate?



- A Geographic isolation is a type of postzygotic barrier
- B Geographic isolation is not required for speciation, but reproductive isolation is central to maintaining separate gene pools ✓**
- C Reproductive isolation is only a result, never a cause, of speciation
- D Reproductive isolation always happens before geographic isolation
- E Geographic isolation means two populations must be different species

► **Explanation:** Speciation can occur without geographic separation (sympatric). But for stable species separation, reproductive isolation must reduce gene flow.

43 A student says: 'If two populations are geographically separated, they are different species.' Which is the best evaluation?



- A Correct—geographic separation automatically defines species
- B Incorrect—geographic separation can start divergence, but species status depends on reproductive isolation and gene flow ✓**
- C Correct only for plants
- D Correct only if mutation rate is high
- E Incorrect—because geographic separation prevents evolution

► **Explanation:** Geographic separation can produce populations that are still capable of interbreeding if reunited. Speciation is about long-term gene pool separation, not just distance.





44 Which of the following best represents a **NON**random evolutionary mechanism that can drive divergence between populations?



- A Genetic drift
- B Founder effect
- C **Natural selection** ✓
- D Bottleneck effect
- E Random sampling of alleles in small populations

► **Explanation:** Natural selection is nonrandom because it consistently favors traits that increase reproductive success in a given environment. Drift-related processes are random.

45 Which mechanism introduces **NEW** alleles into a population's gene pool?



- A Genetic drift
- B Natural selection
- C **Mutation** ✓
- D Nonrandom mating
- E Reproductive isolation

► **Explanation:** Mutation creates new alleles. Other mechanisms change frequencies of existing alleles or how they are combined, but do not create new sequence variants directly.

46 Two populations diverge in different environments. When they meet again, they can mate, but hybrids are less fit than either parent in both environments. Over time, what outcome is most likely if selection is strong against hybrids?





- A Reinforcement strengthens prezygotic isolation ✓**
- B Gene flow increases and populations become identical
- C Mutation stops
- D Hybrid fitness increases automatically with time
- E Drift disappears because selection is present

► **Explanation:** If hybrids have low fitness, selection favors mechanisms that avoid producing them (reinforcement), strengthening prezygotic isolation.

**47** Two populations meet after long isolation. They interbreed extensively and produce viable, fertile offspring, causing the populations to merge. This outcome is sometimes described as:



- A Fusion (collapse of divergence due to gene flow) ✓**
- B Reinforcement
- C Hybrid breakdown
- D Bottleneck effect
- E Sympatric polyploid speciation

► **Explanation:** If reproductive isolation is weak and hybrids are fit, gene flow can erase differences, leading to fusion into one population/species.

**48** Which isolating mechanism most directly prevents fertilization even when mating occurs?



- A Behavioral isolation
- B Gametic isolation ✓**
- C Habitat isolation





- D Temporal isolation
- E Adaptive radiation

► **Explanation:** Gametic isolation acts at fertilization: sperm/egg (or pollen/ovule) are incompatible, blocking zygote formation even if individuals mate or gametes meet.

49 Which statement correctly compares prezygotic and postzygotic barriers from an energy/fitness perspective?



- A Postzygotic barriers usually waste fewer resources because they prevent mating
- B Prezygotic barriers can be favored because they prevent the cost of producing low-fitness hybrids ✓**
- C Prezygotic barriers only evolve after polyploidy
- D Postzygotic barriers always increase hybrid fitness
- E Neither barrier affects fitness; they are neutral by definition

► **Explanation:** Producing hybrids that are inviable/sterile is costly. Selection can favor prezygotic barriers that reduce wasted mating and investment.

50 A cline is best described as:



- A A sudden jump in chromosome number
- B A gradual change in allele frequency or trait value across geographic space ✓**
- C A complete lack of genetic variation
- D A mating ritual that prevents interbreeding
- E A mutation that always produces sterility





► **Explanation:** Clines often occur in parapatric contexts: populations in different environments show gradual trait/allele shifts across space, sometimes with hybrid zones.

**51** Which condition makes genetic drift most powerful as a force of evolutionary change?



- A Large population size with high gene flow
- B Small population size ✓**
- C Very strong selection favoring one allele
- D No reproduction
- E High mutation rate always guarantees drift dominates

► **Explanation:** Drift is random sampling error; it has larger effects when sample size (population size) is small.

**52** Which statement about assortative mating is most accurate?



- A Assortative mating always increases gene flow between groups
- B Assortative mating (like-with-like mating) can reduce gene flow between groups and promote sympatric divergence ✓**
- C Assortative mating is identical to random mating
- D Assortative mating can only occur in allopatric speciation
- E Assortative mating prevents mutation

► **Explanation:** If individuals preferentially mate with similar types, it reduces mixing between types, strengthening reproductive isolation—especially important in sympatric settings.





53 Which example best fits behavioral isolation rather than habitat isolation?



- A Two insects mate only on different host plants
- B Two birds use different songs, and females respond only to their own song type ✓**
- C Two fish live at different depths in a lake
- D Two plants flower in different soils
- E Two populations are separated by a mountain

► **Explanation:** Behavioral isolation is about mate recognition/courtship differences. Habitat isolation is about using different habitats, reducing encounters.

54 Which of the following is NOT typically considered a reproductive isolating mechanism by itself?



- A Hybrid sterility
- B Temporal isolation
- C Gene flow ✓**
- D Mechanical isolation
- E Gametic isolation

► **Explanation:** Gene flow is the movement of alleles between populations and typically reduces reproductive isolation. The other options are barriers that limit successful reproduction across groups.

55 A student says: 'If hybrids exist, then the parents must be the same species.' Which is the best correction?



- A True—hybrids can only occur within a species





- B False—different species can hybridize; what matters is whether gene flow is substantial and whether hybrids are fertile and common ✓**
- C True—hybrids always have higher fitness**
- D False—hybrids cannot exist in nature**
- E True—hybrids always mean sympatric speciation is happening**

► **Explanation:** Hybridization can occur between different species, especially recently diverged ones. Species boundaries can be 'leaky'; the key is whether gene flow is enough to keep them as one gene pool.

**56 Which statement best explains why polyploidy often causes speciation more easily in plants than in animals?**



- A Plants never undergo meiosis**
- B Many plants can self-fertilize or reproduce with close relatives, helping a new polyploid lineage establish ✓**
- C Animals lack chromosomes**
- D Plants have no DNA repair systems**
- E Polyploidy cannot affect reproduction**

► **Explanation:** A new polyploid individual may struggle to find a same-ploidy mate. Plants often can self-fertilize or reproduce vegetatively, allowing polyploid lineages to persist and become isolated.

**57 Two populations become geographically separated. In one population, a new predator appears, favoring faster individuals. In the other, no predator appears. Which force is directly causing adaptive divergence?**



- A Genetic drift**
- B Natural selection ✓**





- C Gene flow
- D Random mating
- E Bottleneck effect

► **Explanation:** Different environments create different selective pressures. Natural selection can drive adaptive divergence if gene flow is reduced.

**58** Which scenario most clearly represents artificial selection potentially contributing to 'artificial speciation' over long periods?



- A A drought causes random survival
- B Humans repeatedly breed only the smallest dogs with each other for many generations, reducing gene flow with other dog populations ✓
- C Mutations stop occurring due to human presence
- D Two populations migrate and interbreed
- E A volcano causes a bottleneck

► **Explanation:** Artificial selection is human-directed. If humans maintain strong breeding isolation and divergent selection, populations can become highly differentiated and potentially reproductively isolated.

**59** Two populations differ in one trait due to genetic drift. Which statement is most accurate about drift-driven divergence and speciation?



- A Drift cannot contribute to speciation because it is random
- B Drift can contribute to divergence, and if it leads to reproductive barriers (directly or indirectly), it can contribute to speciation ✓
- C Drift always creates adaptive traits
- D Drift guarantees speciation in all populations
- E Drift is the same as mutation





► **Explanation:** Although drift is random, it can still drive populations apart. If genetic differences accumulate and reduce successful interbreeding, speciation can result.

**60** Which is the most direct indicator that two populations remain part of the same gene pool?



- A They live on different continents
- B They look different
- C There is substantial ongoing gene flow between them through interbreeding ✓**
- D One has slightly higher mutation rate
- E One has a larger population size

► **Explanation:** A shared gene pool means alleles are exchanged across groups through interbreeding. Geographic distance and appearance can be misleading without evidence about gene flow.

**61** If two populations experience strong gene flow, which outcome is most likely unless selection is extremely strong or mating is highly assortative?



- A They rapidly become reproductively isolated
- B They tend to remain genetically similar, slowing speciation ✓**
- C They cannot mutate
- D They immediately become polyploid
- E They experience bottleneck every generation

► **Explanation:** Gene flow homogenizes allele frequencies. Speciation is harder when interbreeding is frequent, unless selection and mate choice maintain divergence.





62 Which statement correctly describes the relationship between speciation and reproductive isolation barriers?



- A A single barrier is always sufficient to produce instant speciation in animals
- B Multiple barriers often accumulate gradually; speciation can be a process rather than an instant event ✓**
- C Speciation only occurs when hybrids are completely impossible
- D Only prezygotic barriers matter; postzygotic barriers are irrelevant
- E Only postzygotic barriers exist in nature

► **Explanation:** Speciation often involves gradual accumulation of isolating mechanisms. Even partial isolation can evolve and strengthen over time (especially via reinforcement).

63 A population of insects is split into two isolated groups. In group 1, allele A becomes common; in group 2, allele a becomes common. No difference in survival or reproduction is linked to these alleles. The best explanation is:



- A Directional selection
- B Genetic drift acting independently in each isolated group ✓**
- C Gene flow
- D Reinforcement
- E Artificial selection

► **Explanation:** If allele changes are not linked to fitness differences and populations are isolated, random drift can cause divergence in allele frequencies.

64 A student claims: 'Selection creates mutations that organisms need.' Which statement is correct?





- A Correct—mutations occur because organisms need them
- B Incorrect—mutations arise randomly; selection changes which mutations become common by affecting reproductive success ✓**
- C Correct—selection directly edits DNA sequence in response to environment
- D Incorrect—selection cannot affect allele frequencies
- E Correct only in bacteria, not in eukaryotes

► **Explanation:** Mutation supplies variation randomly (with respect to fitness). Natural selection is nonrandom sorting: it increases frequency of beneficial variants and decreases harmful ones.

**65** Which factor most directly converts 'divergence' into 'two species' under the biological species concept?



- A A different color pattern
- B A different diet
- C A barrier that prevents substantial gene flow (reproductive isolation) ✓**
- D A higher mutation rate
- E A larger population size

► **Explanation:** Differences in traits may indicate divergence, but species separation (biological concept) requires that the gene pools remain separated by reproductive isolation.

**66** Which statement about parapatric speciation is most accurate?



- A It requires complete geographic separation with no contact zone
- B It occurs only in plants and never in animals
- C It involves neighboring populations with limited gene flow across a boundary, often with a hybrid zone ✓**





- D It requires polyploidy
- E It can only happen if hybrids are always fitter than parents

► **Explanation:** Parapatric speciation occurs across continuous ranges where selection differs by environment and gene flow is limited by distance or habitat boundaries. Hybrid zones are common.

**67** Which pattern would most strongly suggest ongoing gene flow between two diverging populations?



- A They have completely different DNA at all loci
- B They have identical allele frequencies across their entire genomes
- C **They share many alleles and show intermediate individuals in a contact zone ✓**
- D They are separated by an ocean and never meet
- E Their chromosomes are different numbers

► **Explanation:** Shared alleles plus intermediate forms in a contact zone often indicate hybridization and gene flow between populations.

**68** Two populations share the same habitat and time of breeding, but individuals of population A are too small to mate successfully with population B due to size mismatch of reproductive structures. This is best classified as:



- A **Mechanical isolation ✓**
- B Temporal isolation
- C Gametic isolation
- D Hybrid breakdown
- E Bottleneck effect





► **Explanation:** Mechanical isolation is a prezygotic barrier caused by anatomical mismatch that prevents successful mating or transfer of gametes.

**69** Which scenario most clearly demonstrates that speciation can occur without geographic isolation?



- A A canyon forms, separating populations
- B A few individuals are blown to another island
- C A new polyploid plant lineage arises and becomes reproductively isolated in the same field ✓**
- D A glacier separates a population into two refuges
- E A drought reduces population size drastically

► **Explanation:** Polyploidy can cause instant reproductive isolation in plants without physical separation, making it a classic sympatric speciation mechanism.

**70** Why is a stable hybrid zone (persisting for many generations) possible at all?



- A Because mutation stops in hybrid zones
- B Because selection always favors hybrids
- C Because a balance can occur between dispersal/gene flow into the zone and selection against hybrids ✓**
- D Because reproductive isolation is complete in hybrid zones
- E Because hybrid zones only exist in labs

► **Explanation:** Hybrid zones can be stable if new hybrids continue to be produced by migration into the zone, while selection removes many hybrids—creating a dynamic balance.





**71** Which best explains why sympatric speciation is often considered harder to achieve than allopatric speciation?

- A** Because mutation cannot happen in the same geographic area
- B** Because ongoing gene flow within the same area tends to mix alleles, so strong selection and assortative mating are usually needed to maintain divergence ✓
- C** Because natural selection stops working in sympatry
- D** Because allopatric speciation requires no reproductive isolation
- E** Because sympatric speciation requires a physical barrier

► **Explanation:** In sympatry, individuals can interbreed easily, so gene flow counteracts divergence. Sympatric speciation generally requires mechanisms that reduce gene flow (assortative mating, ecological specialization, polyploidy).



**72** A teacher says: 'Speciation always takes a very long time, so it cannot happen quickly.' Which is the best correction at this level?

- A** Correct—speciation can never happen in fewer than 10 million years
- B** Incorrect—some mechanisms (like polyploidy in plants) can create rapid reproductive isolation, and strong selection in isolated populations can speed divergence ✓
- C** Correct—only genetic drift can cause speciation and it is always slow
- D** Incorrect—speciation is always instantaneous
- E** Correct—because mutation does not occur often enough

► **Explanation:** Speciation can be gradual, but it can also be rapid in some cases (especially polyploidy in plants). The key is how fast reproductive isolation evolves, not an absolute time rule.

