Chapter 6: Evolution - NCERT Exercise Answer Key

Medium Detailed Answers for Board and NEET Preparation

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1. Explain antibiotic resistance ... selection theory.

Answer: Antibiotic resistance in bacteria perfectly demonstrates Darwin's theory of natural selection through the following mechanism:

Initial Population Variation: In any bacterial population, there exists natural genetic variation. Some bacteria may have mutations that make them slightly resistant to antibiotics due to:

- Modified target proteins
- Enzyme production that breaks down antibiotics
- Altered cell membrane permeability

Selection Pressure: When antibiotics are introduced, they act as a strong selection pressure. Non-resistant bacteria are killed, while resistant variants survive.

Survival and Reproduction: Resistant bacteria have higher fitness in the antibiotic environment. They survive, reproduce rapidly, and pass resistance genes to offspring.

Population Change: Over time, the population shifts from mostly sensitive bacteria to predominantly resistant strains. This happens within days or weeks due to bacteria's rapid reproduction rate.

Modern Examples:

- MRSA (Methicillin-resistant Staphylococcus aureus)
- Drug-resistant tuberculosis

- Multiple antibiotic-resistant bacteria in hospitals

This demonstrates natural selection's core principle: organisms with favorable heritable traits survive better and reproduce more in their environment.

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2. Find out from ... about evolution.

Answer: Recent Fossil Discoveries:

Significant Finds:

- *Homo naledi* (South Africa, 2013): New human ancestor with mixed primitive and modern features
- *Denisovan* fossils (Asia): DNA evidence of interbreeding with early humans
- Feathered dinosaur fossils (China): Evidence linking dinosaurs to bird evolution
- *Tiktaalik* (Arctic Canada): Transitional form between fish and early tetrapods

Current Controversies:

Human Evolution Debates:

- Multiple human species coexistence
- Out-of-Africa vs Multiregional evolution models
- Role of interbreeding between human species

Mechanism Disputes:

- Gradualism vs Punctuated equilibrium
- Relative importance of natural selection vs genetic drift
- Epigenetic inheritance role in evolution

Ongoing Research:

- Ancient DNA extraction improving understanding
- Molecular clocks refining evolutionary timelines
- Climate change impact on evolutionary rates

Students should regularly check scientific journals and reputable science news sources for latest discoveries and debates in evolutionary biology.

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3. Attempt giving a ... term species.

Answer: Definition of Species:

Biological Species Concept (Most Widely Accepted): A species is a group of actually or potentially interbreeding populations that are reproductively isolated from other such groups. Members can produce fertile offspring.

Key Components:

- **Reproductive compatibility:** Can interbreed successfully
- **Fertile offspring:** Progeny must be capable of reproduction
- **Reproductive isolation:** Cannot produce fertile offspring with other species

Examples:

- Dogs and wolves: Same species (fertile offspring)
- Horse and donkey: Different species (sterile mule offspring)

Alternative Concepts:

Morphological Species: Based on structural similarities **Ecological Species:** Based on ecological niche occupation **Genetic Species:** Based on DNA similarity levels

Challenges to Definition:

- Asexually reproducing organisms
- Geographically separated populations
- Ring species
- Chronospecies (time-separated populations)

The biological species concept remains most practical despite limitations, emphasizing reproductive compatibility as the defining characteristic.

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4. Try to trace ... preference, etc.)

Answer: Components of Human Evolution:

1. Brain Size Evolution:

- *Australopithecus*: 400-500cc
- *Homo habilis*: 650-800cc
- *Homo erectus*: 900cc
- *Homo neanderthalensis*: 1400cc
- *Homo sapiens*: 1350-1450cc

2. Brain Function Development:

- Language centers (Broca's and Wernicke's areas)
- Abstract thinking capabilities
- Tool-making cognitive abilities

- Social cooperation skills
- Self-awareness and consciousness

3. Skeletal Structure Changes:

- **Bipedalism:** Upright walking adaptation
- **Pelvic modifications:** Wider pelvis for upright posture
- **Spinal curvature:** S-shaped spine for balance
- **Skull changes:** Flatter face, reduced brow ridges
- **Hand dexterity:** Opposable thumb refinement

4. Dietary Preferences Evolution:

- Early hominids: Primarily vegetarian (fruits, leaves)
- *Homo habilis*: Scavenging, some meat consumption
- *Homo erectus*: Active hunting, meat-rich diet
- *Homo sapiens*: Cooking, diverse omnivorous diet
- Agricultural revolution: Grain-based diets

Integration: These components evolved together, with brain growth supporting tool use, which enabled dietary changes, which further supported brain development in a positive feedback loop.

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5. Find out through ... self-consciousness.

Answer: Evidence for Self-Consciousness in Animals:

Mirror Self-Recognition Test Results:

- **Great Apes:** Chimpanzees, bonobos, orangutans, gorillas pass mirror test

- **Dolphins:** Recognize themselves in mirrors, investigate marks on their bodies
- **Elephants:** Show self-recognition and self-awareness behaviors
- **Some Birds:** Magpies demonstrate mirror self-recognition

Other Indicators of Self-Consciousness:

Metacognition (Thinking about Thinking):

- Dolphins show awareness of their own knowledge states
- Some primates demonstrate uncertainty monitoring
- Certain birds show planning for future needs

Empathy and Theory of Mind:

- Elephants console distressed family members
- Chimpanzees show perspective-taking abilities
- Some corvids (crows, jays) demonstrate understanding of others' mental states

Cultural Transmission:

- Whales and dolphins have distinct cultural practices
- Chimpanzee tool use varies by community
- Some birds learn and modify songs across generations

Current Scientific Consensus: While humans show the most complex self-consciousness, mounting evidence suggests various degrees of self-awareness exist across multiple animal species, challenging the notion of human uniqueness in this domain.

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6. List 10 modern-day ... Name both.

Answer: Modern Animals and Their Ancient Fossil Counterparts:

1. **Elephant** → *Mammuthus* (Woolly Mammoth)
2. **Horse** → *Hyracotherium* (Eohippus/Dawn Horse)
3. **Whale** → *Ambulocetus* (Walking Whale)
4. **Bird** → *Archaeopteryx* (First Bird)
5. **Crocodile** → *Sarcosuchus* (SuperCroc)
6. **Shark** → *Helicoprion* (Spiral-toothed Shark)
7. **Bear** → *Arctodus* (Giant Short-faced Bear)
8. **Deer** → *Megaloceros* (Irish Elk)
9. **Turtle** → *Archelon* (Giant Sea Turtle)
10. **Human** → *Australopithecus* (Lucy)

Additional Examples:

- **Cat** → *Smilodon* (Saber-toothed Tiger)
- **Rhinoceros** → *Paraceratherium* (Giant Hornless Rhino)
- **Camel** → *Titanotylopus* (Giant Camel)

Significance: These fossil-modern pairs demonstrate evolutionary continuity while showing how species adapted to changing environments over millions of years. Some show size changes (gigantism in past), others show structural modifications for different ecological niches.

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7. Practise drawing various ... and plants.

Answer: Drawing Practice Guidelines for Evolution Study:

Recommended Subjects for Drawing:

Animals to Practice:

- Darwin's finches (different beak shapes)
- Homologous structures (whale, bat, human forelimbs)
- Analogous structures (butterfly vs bird wings)
- Human evolutionary stages (skulls, postures)
- Fossil specimens (Archaeopteryx, Australopithecus)

Plants to Practice:

- Adaptive radiation examples (Hawaiian honeycreepers)
- Homologous plant parts (thorns, tendrils)
- Fossil plant forms (seed ferns, early flowering plants)
- Convergent evolution examples (desert plants)

Drawing Benefits:

- **Visual Memory:** Enhances retention of structural details
- **Comparative Analysis:** Helps identify similarities and differences
- **Exam Preparation:** Useful for diagram-based questions
- **Understanding:** Improves comprehension of evolutionary relationships

Tips:

- Focus on key distinguishing features
- Label important parts and functions
- Practice comparative diagrams

- Include evolutionary significance notes
- Use scientific illustration techniques

Regular drawing practice strengthens observational skills crucial for understanding evolutionary biology and succeeding in biological sciences.

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8. Describe one example ... adaptive radiation.

Answer: Darwin's Finches - Classic Example of Adaptive Radiation:

Background: Darwin observed 14 different finch species on the Galapagos Islands, all derived from a single ancestral species that arrived from mainland South America.

Radiation Pattern: Original Ancestor: Seed-eating ground finch **Adaptive Diversification:**

- **Large Ground Finch:** Large beak for cracking big, hard seeds
- **Small Ground Finch:** Small beak for small seeds
- **Warbler Finch:** Thin, pointed beak for catching insects
- **Woodpecker Finch:** Uses cactus spines as tools to extract insects
- **Vegetarian Finch:** Curved beak for eating buds and fruits
- **Cactus Finch:** Long beak for nectar and cactus parts

Mechanism:

1. **Founder Population:** Single species colonized islands
2. **Geographic Isolation:** Different islands provided isolated environments
3. **Resource Partitioning:** Different food sources available
4. **Natural Selection:** Beak shapes optimized for specific food types
5. **Reproductive Isolation:** Eventually became separate species

Significance:

- Demonstrates how one ancestral species can diversify into multiple species
- Shows adaptation to different ecological niches
- Illustrates the power of natural selection in shaping morphology
- Provides evidence for common descent with modification

This example perfectly illustrates adaptive radiation principles in evolutionary biology.

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9. Can we call ... adaptive radiation?

Answer: Human Evolution as Adaptive Radiation - Analysis:

Arguments FOR: Geographic Radiation: Early humans spread from Africa across continents, adapting to diverse environments:

- Arctic populations (Inuit): Adaptations to cold
- High-altitude populations (Tibetans): Oxygen efficiency adaptations
- Desert populations: Heat and water conservation adaptations
- Tropical populations: UV protection, disease resistance

Phenotypic Diversification:

- Skin color variations
- Body size and proportions
- Metabolic adaptations
- Facial features and hair types

Arguments AGAINST: Single Species Status: All modern humans belong to *Homo sapiens* - can interbreed and produce fertile offspring

Recent Timeline: Human geographic spread occurred relatively recently (~100,000 years) compared to classic adaptive radiation examples

Limited Speciation: Unlike Darwin's finches, human populations haven't formed separate species despite geographic isolation

Conclusion: Human evolution shows **incipient adaptive radiation** or **subspecific adaptive radiation** rather than full adaptive radiation. While humans have adapted to diverse environments and show phenotypic variation, they remain a single species. True adaptive radiation typically involves formation of multiple distinct species from a common ancestor.

Human evolution better exemplifies **population-level adaptation** with **gene flow** maintaining species unity while allowing local adaptations.

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10. Using various resources ... say horse.

Answer: Evolutionary Stages of Horse:

Timeline and Major Stages:

1. Eohippus/Hyracotherium (55 mya):

- **Size:** Dog-sized (30 cm tall)
- **Toes:** 4 toes on front feet, 3 on back
- **Teeth:** Low-crowned, for soft leaves
- **Habitat:** Forest browser

2. Mesohippus (40 mya):

- **Size:** Larger (60 cm tall)
- **Toes:** 3 functional toes on all feet
- **Teeth:** Slightly higher crowned
- **Habitat:** Woodland areas

3. Merychippus (15 mya):

- **Size:** Pony-sized (1 meter tall)
- **Toes:** 3 toes, middle toe enlarged
- **Teeth:** High-crowned, grinding surfaces
- **Habitat:** Grassland grazer

4. Pliohippus (5 mya):

- **Size:** Modern horse size
- **Toes:** Single toe (hoof), side toes reduced
- **Teeth:** Very high-crowned
- **Habitat:** Open grasslands

5. Equus (Modern Horse - 4 mya to present):

- **Size:** Various breeds, 1.4-1.8 meters tall
- **Toes:** Single hoof, vestigial side toes
- **Teeth:** Continuously growing, high-crowned
- **Habitat:** Grasslands worldwide

Evolutionary Trends:

- **Size increase:** Small forest animal to large grassland runner

- **Toe reduction:** Multiple toes to single hoof for running
- **Tooth modification:** Soft-leaf teeth to grass-grinding teeth
- **Leg elongation:** Better running ability
- **Brain enlargation:** Improved coordination and awareness

Environmental Correlation: Changes correspond to climate shift from forests to grasslands, demonstrating adaptation to changing habitats.