Final Exam Key

1. Wilson (1992) describes a dispute between loggers and environmentalists in Oregon and Washington over logging in some spotted owl habitat as follows. "Said the loggers: 'Are we really expected to sacrifice thousands of jobs for a handful of birds?' Said the environmentalists: 'Must we deprive future generations of a race of birds for a few more years of timber yield?'" What important point does this argument overlook entirely?
A. The owls were a keystone species that most other plants and animals in the forest relied on.
*B. The disputed habitat included thousands of other species, most of them too poorly studied for us to even know what we would lose if they were destroyed.
C. The owls prefer to nest near tree stumps, so logging could actually have improved the quality of their habitat.
D. The land that loggers wanted to harvest was almost all contained within twelve national forests, so they would never have been allowed to log there anyway.
E. The same species of owl was abundant in numerous other forests in the United States, so the loss of the disputed forest habitat would have had only a minor impact on the species.

2. Which of these is a function of an immature fruit?
*A. To protect the seeds from being eaten.
B. To attract dispersal agents.
C. To attract pollinators.
D. To provide nutrition for symbiotic microbes.
E. To attract granivores.

3. Which of these kinds of organisms would be the easiest to remove from an island on which it became invasive?
A. Grass
B. Vine
C. Snake
D. Eagle
*E. Goat

4. Which of these characteristics would you expect to observe in the seed of a tree with no animal dispersal agent?
A. Bright color of the seed itself
*B. Large supply of nutrients inside the seed
C. Sugar-rich fruit around the seed in a fruit of a very different color
D. Conspicuous aril of a different color than the mature fruit
E. Showy flowers

5. Which of these is true of the symbiosis between plants and arbuscular mycorrhizal fungi?
A. Plants give the fungi phosphorus in exchange for carbon.
B. Fungi give the plants nutrients in exchange for digesting some of the plant's roots.
C. Plants give the fungi carbon in exchange for digesting some of the fungi's hyphae.
D. Fungi give the plants carbon in exchange for phosphorus.
*E. Fungi give the plants phosphorus in exchange for carbon.

6. Which of the following traits would be undesirable in a plant according to the restoration strategy of the Palmerton Zinc Superfund Site?
*A. High heavy metal uptake
B. Large number of leaves
C. High turnover of roots
D. Large production of roots
E. High transpiration rates

7. Which of these best characterizes the relationship between tropical plants and the epiphytes growing on their leaves?
A. The epiphytes provide their host plants with carbon, but interfere with their ability to acquire nitrogen.
*B. The epiphytes provide their host plants with nitrogen, but interfere with their ability to acquire carbon.
C. The epiphytes provide their host plants with carbon and nitrogen.
D. The epiphytes parasitize their host plants by taking carbon and nitrogen from them.
E. The epiphytes have evolved to shade out their host plants and grow to replace them in canopy openings.

8. What is the first step in the formation of a "guanacaste island" in an abandoned pasture near a forest?
A. Several early-successional shrubs and trees arrive in the field and eventually produce an environment with enough shade to support guanacaste tree seedlings.
*B. A horse, cow or peccary defecates a guanacaste seed in an abandoned pasture.
C. A *Liomys* mouse opens a guanacaste fruit and eats some, but not all, of the seeds.
D. A *Liomys* mouse carries a guanacaste seeds back to its burrow, and then dies before it can eat the seeds.
E. Cattle farmers plant guanacaste trees in their pastures to supplement their income during years that are bad for cattle.

9. Which of these is a benefit that acacia ants provide to their acacia tree?
A. Removal of unnecessary material from the insides of the swollen acacia thorns
*B. Relief from plant-plant competition
C. Protection from all animals that touch the tree
D. Nutrients in the form of sugars
E. Nutrients contained in Beltian bodies

10. Pharmaceutical companies today do not develop novel antibiotics as quickly as they used to. Why not?
A. Antibiotics are more expensive to develop than other drugs.
*B. Antibiotic resistance evolves too quickly for companies to recoup the cost of developing the drugs.
C. Developing novel antibiotics is seen as less important than developing other drugs because most old antibiotics still work fine.
D. It is no longer legally possible to get a patent for a novel antibiotic.
E. We have already discovered all the antibiotics there are to discover.

11. How did Europeans' and Americans' taste for stovepipe top hats affect beaver populations?
A. Stovepipe hats are made from beaver tails, so the increase in popularity of the hats led to overhunting.
*B. Stovepipe hats are made from beaver fur, so the increase in popularity of the hats led to overhunting.
C. Stovepipe hats are made from a plant that beaver rely on for food, so the increase in popularity of the hats led to beaver starving.
D. Stovepipe hats are made from a plant that beaver cannot eat, so the increase in popularity of the hats did not affect beaver.
E. Stovepipe hats are made from the fur of wolves, which are beaver main predators, so the increase in popularity of the hats caused beaver populations to increase.

12. Why did the gold miners in the Parque Nacional Corcovado rainforests in southern Pacific Costa Rica think that it was morally acceptable for them to mine gold in the national park, destroying the rainforest and its rivers in the process?
*A. They perceived the parkland as having no owner because there was no social presence there.
B. They believed making money for the country to be more important than preserving biodiversity.
C. They believed the gold they were mining to be more beautiful than the forest.
D. They disapproved of the government's keeping people out of this land, and mined as a form of protest.
E. They believed it was wrong to destroy the forest, but felt like they had no other way to make a living.

13. What does it mean to say that an insect hides from a bat by acoustic camouflage?
A. The insect is colored in such a way as to blend in with its surroundings.
B. The insect's body shape is such that a bat's echolocation calls are deflected away from the bat, rendering the insect acoustically invisible.
C. The insect can fly quietly relative to the ambient noise in its habitat, so a foraging bat cannot hear it.
*D. As the insect rests on a rough surface, it is more difficult for the bat to distinguish it from the surface than were it on a smooth surface.
E. The insect produces sounds that confound the bat's echolocation.

14. What happened when the orange juice company Del Oro dumped truckloads of orange peels into Area Conservacion Guanacaste (ACG)?
A. The orange peels polluted the site and killed many of the plants that ACG was trying to grow.
B. ACG sued Del Oro for trespassing and dumping.
C. The Costa Rican government sued ACG staff, including Dr. Janzen as a technical advisor, for polluting a national park.
*D. The orange peels quickly generated fertile soil and asphixiated the grasses, which then sped the regeneration of the ACG's dry forest.
E. The orange peels provided a food source that helped endangered birds and monkeys survive an unusually dry year.

15. Recall that *Crescentia* (jicaro) is a tree with seeds ancestrally dispersed by horses with large, hard-walled fruits that turn from green to brown as they ripen. What is the unappetizing-looking black material inside the ripe fruits?
A. A mass of fungal and bacterial decomposers degrading the edible flesh of the green fruit.
B. A sticky, tar-like substance the plant uses to chemically defend its seeds.
*C. A sugar-rich substance much like molasses.
D. A protein-rich substance that supplements horses' protein-poor diet of grasses.
E. A "bag lunch" for the plant's seeds.

16. Temperate forests generally appear to recover from disturbances such as logging much faster than tropical forests. There are several reasons for this – which of the following is not one of them?
A. Tropical forest soils contain fewer nutrients than temperate forest soils.
B. Tropical forest soils are more acidic than temperate forest soils.
*C. Tropical forests contain more tree species than temperate forests.
D. Tropical tree seeds tend to germinate faster than temperate tree seeds.
E. Tropical forests experience more precipitation than temperate forests, which tends to wash free nutrients out of the soil.

17. Analysis of stable isotope ratios has many applications outside of studying ecosystems. Which of the following is not one of them?
A. Determining the geographic origin of illicit drugs
B. Detecting illegal steroid use in professional athletes
*C. Determining the age of objects by radioactive decay
D. Tracing the past movements of individual people
E. Finding the origin of counterfeit US money

18. Which of the following does not describe a current dilemma in the conservation of the Brazilian Amazon?
A. Many Brazilians fear that the international community wants to take over Amazonia.
B. Some land that governing bodies want to turn into preservation areas is already inhabited by people.
*C. Most governing bodies have difficulty procuring the money for conservation efforts despite widespread agreement about the best conservation strategies.
D. Some regulatory bodies have internal disagreements about conservation priorities and strategies and thus may behave inconsistently.
E. Many different stakeholders (federal, state, and local governments, industry, non-governmental organizations, indigenous people, etc) have highly conflicting priorities.

19. What is the first and most important thing needed for a restoration project?
A. An end to the disturbance that initially damaged the ecosystem.
B. Reduced frequency of fire in or near the site.
C. Removal of pollutants from the site.
*D. Permission from society to restore the site.
E. A reference site to provide target conditions for the restored site.

20. How was the "Paradise Reclaimed" movie we saw in class received in Costa Rica?
A. Negatively because it showed humans as bad for the environment.
*B. Negatively because it showed foreigners managing a national park.
C. Positive because it emphasized teaching.
D. Positive because it fostered pride in their national heritage.
E. Positive because they realized the social and economic benefits of Parque Nacional Santa Rosa being featured for conservation work.

21. During what two physiological processes do plants discriminate against ^{13}C compared to ^{12}C?
*A. Diffusion into the leaf and photosynthesis
B. Diffusion into the leaf and respiration
C. Photosynthesis and respiration
D. Photosynthesis and transpiration
E. Respiration and the synthesis of defense compounds

22. Imagine that you are on vacation and hiking through Costa Rica's Area Conservacion Guanacaste (ACG) and you see a beautiful, red flower with a long tubular shape on the side of the trail, and think, "That flower looks like it must be pollinated by hummingbirds!" You take a picture of it to send back to your TA suffering through the Philadelphia winter, but then you notice a bee crawling out of the flower with multiple parts of its body covered in pollen. What do you make of this?
A. The bee just pollinated the red flower.
B. The bee could not have pollinated the flower because it is clearly hummingbird-pollinated.
C. All of the pollen on the bee's body must have come from other plant species.
*D. The bee is either a pollinator or a visitor of this flower, or even both.
E. The plant has a generalist pollination strategy.

23. Why did "ivory tower" scientists object to DNA barcoding?
*A. It would democratize biodiversity, compromising their authoritative dominance of the subject.
B. It would create more work for them.
C. It takes longer than whole-genome sequencing.
D. It is faster, but more expensive, than whole-genome sequencing.
E. It does not work.

24. Why are so many male moths (and other insects) attracted to manmade lights?
A. This is a common misconception; nocturnal insects are similarly active and abundant even in the dark.
B. To a male moth, the shadows around many manmade lights resemble the fluttering of potential mates.
C. Moths' predators tend to avoid light, so moths seek out lights to avoid predation.
D. Female moths are also attracted to light, so males seek out lights to increase their chances of finding potential mates.
*E. Male moths evolved to orient themselves by moonlight or starlight to fly in straight lines when searching for potential mates, but when a light is nearby, this system results in the moth spiraling towards it.

25. Which of these is the cheapest and easiest way to discover antibiotics in the lab?
A. Chemically synthesize potential antibiotics and test their ability to kill common lab bacteria.
B. Sequence the genome of the bacterium you are trying to kill, and predict chemical structures that will kill it based on its DNA sequences.
C. Look for mutations that render bacteria resistant to antibiotics.
*D. Grow multiple microbes together on a petri dish and look for zones of inhibition.
E. Infect a lab mouse with a bacterium of interest and isolate chemicals from its blood.

26. Lee goes to New Zealand and discovers a fossil of a bird that appears to be adapted for fishing, and a fossil of a small fish that resembles modern fish currently preyed on by fishing birds. He concludes that his fossil bird species must have preyed on his fossil fish species, but when he brings these specimens back to his paleontologist friends they tell him he is wrong. Why?
*A. The organisms may not have lived at the same time.
B. Birds did not evolve the ability to eat fish until very recently.
C. Birds evolved too recently for any of them to be fossilized yet, so his fossil bird must be fake.
D. Fish are nutritionally unsuitable prey for birds.
E. Both the fish and the bird are extinct.

27. Why would it be a problem for the acacia plant (now called *Vachellia* because of a taxonomic name change in 2015) if its ants patrolled its flowers in the same way as they patrol the leaves and branches?
A. Acacia flowers are very fragile and the ants might damage them by climbing on them.
B. Acacia flowers are toxic to the ants and might harm the ant colony, thus harming the acacia.
*C. The acacia needs other animals to access its flowers in order to reproduce.
D. The scent of the ants may deter potential pollinators.
E. If the ants get too close to the flowers, would-be pollinators may attack the ants.

28. A single species of tortoises is separated into two populations by a sudden change in the path of a river. Assume that one of the populations remains identical to the ancestral state, and the other undergoes one of the following changes. Which of these changes will contribute least strongly to speciation between these two populations?
A. A change in the number of chromosomes.
B. A change in the time of year the tortoises prefer to reproduce.
*C. A change in diet.
D. A change in the time of day the tortoises prefer to reproduce.
E. A change in mating behavior.

29. What is a parataxonomist?
A. An armed park guard recruited from a local town.
B. A derogatory term for academic taxonomists who “parachute” into ecosystems only to collect samples.
C. A visiting scientist who collects samples and exports them to the Smithsonian institution and other museums
*D. A locally-based employee who collects samples and records their natural history online.
E. A PhD-level researcher who focuses on distinctions between higher taxonomic levels.

30. Acacias have nectaries both in their flowers and on their leaves (i.e. both floral and extrafloral nectaries). Which of the following is true of the nectars they produce?
A. They are nutritionally similar because the two kinds of nectaries have the same developmental origin.
B. They are nutritionally similar because they evolved to feed the same kind of animal.
C. They are nutritionally different because extrafloral nectaries are evolutionarily newer and thus less well optimized to the dietary needs of the animals they feed.
*D. They are nutritionally different because they have evolved to feed different kinds of animals.
E. They are nutritionally different because only one evolved to be eaten by an animal.

31. Recall that carbon has an atomic mass of 12.01 atomic mass units. What does this tell us about carbon isotopes in nature?
A. All naturally occurring carbon is ^{12}C, and the extra 0.01 atomic mass units includes the mass of its electrons.
B. Most naturally occurring carbon is ^{13}C, but rare heavier or lighter isotopes exist.
C. Most naturally occurring carbon is ^{12}C. Rare heavier isotopes exist, and all are stable.
D. Most naturally occurring carbon is ^{12}C. Rare heavier isotopes exist, and all are radioactive.
*E. Most naturally occurring carbon is ^{12}C. Rare heavier isotopes exist, which may be either stable or radioactive.

32. Why might a civil engineer want to know about slime molds?
A. Slime molds are potent decomposers of concrete.
B. Slime molds produce extremely sturdy physical structures.
*C. Slime molds can be used to model efficient transportation networks.
D. Slime molds' decomposition activity can dramatically affect soil stability.
E. Some slime molds produce bright, durable pigments that could improve road signs.

33. Which of these islands would you expect to change biologically the most, following invasion by a new species?
A. A large island close to the mainland
B. A large island an intermediate distance from the mainland
C. A large island far from the mainland
D. A small island close to the mainland
*E. A small island far from the mainland

34. Why do *Liomys salvini* mice seek out seeds in the dung of larger animals, especially horses?
A. The mice prefer to eat dead seeds than live seeds, and the digestive tract of a horse kills most seeds that pass through it.
*B. The mice orient themselves primarily by smell, which makes it easy to find piles of dung that are routinely rich in seeds.
C. This is false; the mice actually avoid all large mammal dung due to the risks of contracting pathogens from it.
D. This is false; the mice avoid horse dung piles because the strong smell of the dung compromises their ability to distinguish edible and inedible seeds by smell.
E. The mice prefer to eat the leaves of recently germinated seedlings, which are common in horse dung.

35. Which of these would you expect to be the worst strategy for a fungus consuming a fallen mature fruit?
*A. Thoroughly digest one small portion of the fruit at a time, leaving other portions untouched until it is ready to consume them.
B. Colonize the entire fruit quickly.
C. Infuse the fruit with chemicals toxic to other organisms.
D. Digest the chemical components most attractive to the fruit's dispersal agents first.
E. First digest the chemical components that are easiest to digest, and then move on to more difficult components.

36. While out hiking one afternoon, you find 11 individuals each of five very different looking caterpillars, all feeding on leaves of the same tree. You have them DNA barcoded, and find to your surprise that each one has the same barcode! What do you make of this?
A. These five different caterpillar species must be very closely related to each other.
B. These five different caterpillar species are probably the product of a recent adaptive radiation.
C. Something must have gone wrong with the barcoding procedure.
*D. These five caterpillar morphotypes are part of a single species with highly variable morphology.
E. Whether they are the same species or not, these caterpillars are probably poisonous.

37. Which of the following is a benefit of DNA barcoding?
A. It allows us to determine traits of fossil organisms from their DNA sequences.
B. It attaches a fluorescent barcode to DNA, allowing us to identify individual organisms with a laser scanner.
C. It allows us to use region-specific DNA barcodes to geolocate the origin of biological materials like illegal drugs.
D. It improves accuracy in mark-recapture studies by putting a barcode in target organisms' DNA rather than on tags or bands which can disrupt an organism's natural behavior.
*E. It reliably identifies species without the aid of professional taxonomists.

38. Lee sought to test whether later-successional tree seedlings grew differently on soils inhabited by grasses compared to soils inhabited by birch trees. Why did he cut down the grasses and birch trees in half of his plots?
A. To protect his seedlings from plant diseases.
B. To control for potential differences in mycorrhizal fungal communities in the soil.
C. To deter deer from eating his experimental tree seedlings.
D. To make it easier to plant and measure his experimental tree seedlings.
*E. To control for potential differences in aboveground competition from grasses and birches.

39. Which of these fruits would a chocolate plant be most likely to allow to mature? Assume that a mature fruit can contain as many as 20 fully developed seeds.
*A. A fruit with all ovules fertilized by all different males.
B. A fruit with all ovules fertilized by a male closely related to the mother plant.
C. A fruit with at least 14 ovules all fertilized by the same male.
D. A fruit with 5 ovules collectively fertilized by 3 different males.
E. The plant would mature all of these; it cannot choose between them.

40. Which of these best describes the process of coevolution?
A. One species evolving the ability to eat individuals of another species
B. Two species evolving similar characteristics in response to similar environmental conditions, despite being unrelated to each other
C. Two species evolving in response to their environment
*D. Two species evolving in response to each other's evolutionary changes
E. Two species evolving tolerance to a similar set of abiotic stresses.

41. Which of the following factors would be least likely to affect a plant's uptake of heavy metals from soil?
*A. The species identity of neighboring plants
B. The soil's heavy metal concentration
C. The soil's community of mycorrhizal fungi
D. The soil's community of bacteria and other microbes
E. Interactions between the plant and soil-dwelling fungal and bacterial communities

42. Why is it commonly believed in Asia that bamboo flowering years cause famines?
A. The weather that triggers bamboos to flower is too dry for crop plants to prosper.
B. The weather that triggers bamboos to flower predisposes crops to succumb to fungal diseases.
C. The abundance of bamboo seeds makes it more difficult for animals to find more nutritious food, thus many animals starve or become malnourished in bamboo flowering years.
*D. Populations of seed predators such as rats and mice increase following bamboo massive seed production, and then spread into agricultural landscapes.
E. This is a superstitious belief rooted in local folklore that science has recently refuted.

43. Which of the following is not ecologically an island?
A. A rocky piece of land in the middle of an ocean.
B. A pond in the woods.
C. A wooded park in a city.
*D. A peninsula.
E. The top of a mountain.

44. How does logging affect the bushmeat trade in Africa?
A. The presence of loggers tends to deter bushmeat hunters because they fear the loggers will report them to local authorities.
B. Loggers tend to avoid bushmeat hunters because they fear that the hunters will mistake them for game animals and shoot them.
C. Bushmeat hunters are generally opposed to logging because it destroys the habitat of the animals they rely on for food.
D. Logging helps bushmeat hunters by making it easy for hunters to catch animals fleeing logged areas.
*E. Logging roads, and sometimes even logging trucks, give bushmeat hunters easy access to previously remote forest areas.

45. What is the apparent evolutionary purpose of false eyespots on, for example, a butterfly or caterpillar?
*A. To mimic the predators of the butterfly's own predators
B. To help the butterfly blend in with its surroundings
C. Aposematism
D. To startle the predator with a novel pattern it has never seen before (fear of the unknown)
E. Müllerian mimicry

46. How does ungulate (large wild herbivore) grazing most benefit cattle in the wet season?
A. Cattle are able to find favorable areas to forage by following wild ungulates.
*B. Wild ungulates specialize on plants with low nutritional quality, thus improving the growth of plants that cattle prefer.
C. Wild ungulates leave incompletely-consumed animal carcasses behind, creating a major food source for cattle.
D. Wild ungulates are better adapted than cattle to disperse the seeds of desirable forage plants, increasing their abundance.
E. Wild ungulates' waste products are highly effective fertilizer for plants, which helps improve the growth of desirable forage plants.

47. Why does Nile perch require technical innovation in Lake Victoria fishing villages?
*A. It is so much bigger than the native cichlids that it cannot be preserved in the same way.
B. Its meat is toxic and needs special chemical treatment before it can be eaten.
C. Its skin is so tough that stronger tools are needed to butcher the fish and extract the meat.
D. Its skin contains poisonous spines, so one needs strong protective gloves to handle it safely.
E. It is so much smaller than the native cichlids that fishermen need special, extra-fine nets in order to catch it.

48. Why is it in most plants' best interest to outcross? (i.e. to mate with a genetically different individual rather than self-pollinate)
A. To avoid trying to make offspring with incompatible DNA from members of other species.
B. To avoid trying to make offspring with incompatible DNA from members of the same species.
C. To reduce investment in showy flowers.
D. Because most plants are not capable of self-pollination.
*E. To avoid the accumulation of deleterious mutations that occurs through inbreeding.

49. If you eat a seed and it begins to germinate in your small intestine, what will happen to it?
A. It will die from residual stomach acid.
B. If it grows quickly enough, it may take root in your intestinal wall.
C. It will die by being digested.
D. If it grows slowly enough, it may survive to be defecated out into the world.
*E. It will die for lack of oxygen.

50. Why could we not have evolved without the meteorite that killed (most of) the dinosaurs?
*A. Large mammals would have faced too much predation pressure from larger dinosaurs to become established.
B. There were already dinosaurs filling humans' ecological niche, and they would have outcompeted us.
C. Chemicals released in the meteorite impact accelerated the mutation rates of early mammals, allowing them to evolve faster than they would have otherwise.
D. The meteorite impact permanently changed the earth's climate, making it more favorable for mammals to increase in size.
E. Early humans were already present before the impact, but the extinction of the dinosaurs allowed them to increase in population size.

51. Which of these mechanisms might a plant use to optimize its female reproductive function?
A. Chemically defending pollen grains against pollen predators.
B. Depositing pollen selectively on those insect visitors most likely to leave that pollen on other plants.
C. Producing increased floral rewards such as nectar during the time of year that the female parts of most other neighboring conspecifics are most receptive.
D. Producing most of its pollen at the time of year that its most effective pollinators are active.
*E. Selectively aborting low-quality seeds to maximize investment in higher-quality seeds.

52. You are replicating Dr. Janzen's experiment in which he mixed seeds of several plant species into horse and cow dung and set them out overnight to study seed predation by *Liomys salvini* mice. Like Dr. Janzen, you observe that the number of seed species taken by the mice changes over the course many days. Why might this be?
A. The mice prefer to eat a varied diet and get tired of eating a single kind of seed over and over.
B. The mice always take the most attractive seeds first, but depending on how hungry or satiated the different mice in your study site were when you began the experiment, each mouse may become satiated and stop coming to your pseudodefecations at different times.
C. The mouse's metabolism changes substantially from day to day as it matures, causing its dietary requirements to change radically from one day to the next.
D. As predators consume the mice over time, fewer of them are left to collect seeds from your pseudodefecations.
*E. The mice may try eating seeds of many species at first, and gradually learn which ones are edible and which are not.

53. Which of the following statements about the assembly of ecological communities is false?
A. Studying what happens when certain species are removed can tell us about which orders of colonization are possible and which are not.
B. The majority of propagules entering a community will fail to establish and reproduce.
C. The initial species present in a community can affect which species will subsequently become established in the community.
D. Ecological communities are assembled by repeated colonization and extinction by individual species.
*E. Ecological communities include many species that have coevolved extensively with each other.

54. Why is it important for conservation that we think of wildlands as "wildland gardens"?
A. The intensity of human disturbance worldwide means that already most species in "wild" areas were put there manually by humans.
B. Introducing diverse human crop species into wild ecosystems is a crucial step in feeding the world's growing human population.
C. If we do not harvest biomass products (wood, fruit, meat) from wild ecosystems, there is no other way for those ecosystems to be worth preserving in economic terms.
*D. If we do not recognize the value of the goods wild ecosystems provide us, and protect them accordingly, they will be destroyed for short-term profits.
E. Increasing the biodiversity of our gardens and farms by introducing wild species is a crucial step in feeding the world's growing human population.

55. Advertisements for allergy medications often depict yellow goldenrods, with honeybees pollinating them, as a source of the pollen that causes allergy symptoms (hayfever). What is wrong with these advertisements?
A. Honeybees can't see the color yellow.
B. Goldenrods flower for only one day at a time, which is not long enough to produce enough pollen to cause hayfever in humans.
*C. Hayfever is caused primarily by pollen from wind-pollinated species, and goldenrod is bee-pollinated.
D. Goldenrods have separate male and female plants.
E. Hayfever is caused not by pollen, but by the scent molecules flowers emit to attract pollinators, which goldenrods barely produce.

56. What does Dr. Janzen mean by describing the ACG as a "green freezer"?
A. He is exaggerating the extent to which trees can cool the ground below them by shading and transpiration.
B. He is describing the unusually slow decomposition rates observed in ACG soils, which are much like those found in permafrost soils.
C. He is describing the peculiar ability of the guanacaste tree to generate ice crystals as a defense against herbivores.
D. He is advocating introducing rare species from all over the world into ACG to preserve them.
*E. He is pointing out that preserving organisms in their natural habitat is more effective than preserving them in an actual freezer.

57. Which of the following is not true of plant defenses?
A. Plant defense strategies include physical and chemical mechanisms
B. Some plant defenses are effective against parasites or predators other than the ones they initially evolved to repel
C. Some plant defenses are not currently effective against the parasites they initially evolved to deter
D. Lignin and cellulose are chemical, not just physical defenses
*E. Some plant defenses are effective against all herbivores

58. Which of these is the most likely evolutionary reason for the long distances migrated by monarch butterflies?
A. Monarch butterflies migrate south for the winter so that they can benefit from serving as the model for more mimic butterflies in Mexico.
B. Monarch butterflies migrate south for the winter to escape northern predators.
*C. During the last glacial maximum, monarchs lived in Mexico and migrated short distances between temperate-tropical habitats during the wet season and to cool cloud forest habitats during the dry season. As the glaciers receded, monarchs slowly increased the length of this migration to follow their favorable wet-season habitat as it expanded northward.
D. During the last glacial maximum, monarchs found refugia (safe habitats) in the Northeast United States and in Mexico. Since the retreat of the glaciers, monarchs from both populations have begun migrating between these sites to re-establish gene flow between the populations.
E. During the last glacial maximum, Mexico and the Northeast United States were closer together because of plate tectonics, so monarchs could more easily migrate between these two areas. As the glaciers receded and the continents moved further apart, the monarchs' migration distance gradually increased to what it is today.

59. Which of these arguments was used in favor of dumping waste orange peels on grassland areas in ACG that Dr. Janzen was trying to turn back into tropical dry forest?
A. The decomposing orange peels were poisoning local soils.
B. The decomposing orange peels contained d-limonene, a chemical some have described as a dangerous carcinogen.
*C. The decomposing orange peels would smother and kill the grasses.
D. The company dumping the orange peels had benefitted from a conflict of interest among the government officials who had signed the contract allowing the dumping.
E. The company dumping the orange peels was polluting nearby waterways.

60. Which of the following pairs of treatments would not have been applied to any plots in Lee's experiment to investigate whether initial seed and compost restoration treatments could affect subsequent plant community succession?
A. C_4 grass seeds / mushroom compost
B. C_4 and annual C_3 grass seeds / straw mulch
C. C_4 and perennial C_3 grass seeds / duck manure
*D. Straw mulch / duck manure
E. C_4 grass seeds / sewage sludge

61. Puerto Rico is an island with respect to the mainland of Costa Rica. Why does Puerto Rico have so many fewer beetle species than Costa Rica, per habitat or per unit area?
A. Beetles cannot fly and thus have no way to disperse from Costa Rica to Puerto Rico.
*B. Puerto Rico contains fewer potential host plant species.
C. The ocean currents between Costa Rica and Puerto Rico are not conducive to insects rafting from Costa Rica to Puerto Rico.
D. There are too many birds on Puerto Rico for a colonizing beetle species to establish a reproductive population before getting eaten.
E. Puerto Rico should eventually gain as many beetle species as Costa Rica, but it is geologically too young for that to have happened yet.

62. What is meant by trophic downgrading?
A. The process in the ocean where organisms in deeper water rely primarily on material from shallower water for food.
B. The tendency of herbivores to congregate at low elevation (e.g. in valleys) relative to the carnivores that eat them, which live at higher elevation.
C. The loss of primary producers from an ecosystem.
*D. The loss of higher predators from an ecosystem.
E. The loss of decomposers from an ecosystem.

63. Why might small animals evolve to be larger on an island than on the mainland?
A. Because they lack competitors on many islands, small animals can consume more resources and grow bigger.
B. Because many islands lack predators, more small animals grow to reach their full adult size before they die.
*C. Harsh seasonality on many islands favors animals that are able to store greater food reserves.
D. Greater diversity of food plants on islands than on the mainland means that small animals can have healthier, more balanced diets on islands.
E. This is most often due to founder effects, in which the first individuals of a species to survive the long trip to an island are more likely to be relatively large.

64. Which of the following is not a major concern with organisms we introduce into new habitats for biocontrol?
A. The introduced organism may eat one or more prey species other than the one it was intended to control.
B. The introduced organism may parasitize one or more host species other than the one it was intended to control.
C. The introduced organism may become invasive itself.
*D. The introduced organism may become reproductively isolated from its source population and speciate over time.
E. The introduced organism may be poisonous to local predators that do not recognize it as such, thereby sickening or killing them when they try to eat it.

65. Why do marijuana growers cultivate their plants only in high light and fertile soils? (Note: the active ingredient of marijuana is tetrahydrocannabinol, or THC).
A. Marijuana plants will not grow under other conditions.
B. These conditions cause the plant to make more leaves, which are harvested for their high THC concentrations.
C. These conditions cause the plant to make a longer stem, which is harvested for its high THC concentration.
*D. These conditions allow the plant to make more female reproductive parts, which are harvested for their high THC concentrations.
E. Fertile soils tend to contain higher microbial diversity than poorer soils, which increases the diversity of chemicals in the soil, making it more likely that the plant will take up and concentrate THC.

66. Which of the following statements about Area Conservacion Guanacaste (ACG) parataxonomists is false?
*A. Most of them studied biology in college.
B. They are able to perform intensive biodiversity inventory including DNA barcoding samples.
C. They help integrate ACG into the surrounding community.
D. They are less expensive than graduate students or postdocs.
E. They live near or in ACG.

67. You set up fences to exclude elephants from an area of savanna in Africa. What do you expect will happen in this fenced-in area?
*A. Increased abundance of woody plant species
B. Decreased abundance of woody plant species
C. Increased frequency of fire
D. Decreased frequency of fire
E. Increased gecko population sizes

68. You want to make a leather pouch from a squirrel skin. You poach a squirrel from the Biopond in the dead of night, boil oak bark in a pot of water and add your squirrel skin to the pot. After soaking for 48 hours in hot water, you refrigerate the skin and then eventually stretch it out in the sun to dry. What does the oak bark do to the squirrel skin to make this possible?
A. The oak bark only contributes the brown color of leather; boiling in water alone would be sufficient to sterilize and preserve the squirrel skin.
B. Tannins from the oak bark react with tannins the squirrel sequestered in its skin, giving it the characteristic brown color of leather.
C. The oak bark releases sugars when boiled, which caramelize over the squirrel skin, preserving it and turning it brown.
*D. The oak bark releases tannins when boiled, which oxidize with the protein in the squirrel skin, protecting it from microbial enzymes.
E. Lignin and cellulose from the oak bark are chemically transferred to the squirrel skin and render it difficult to decay.

69. What function does a sweet potato serve for the vine that produces it?
A. It stores energy and nutrients to help the plant's seeds become established.
B. It attracts animals that will disperse the plant's seeds.
C. It stores nutrients for a single bout of reproduction.
*D. It stores nutrients for a period of very fast growth.
E. It helps anchor the plant more firmly into the ground.

70. The current leading understanding of the extinction of the dinosaurs was an impact from a large meteorite that hit at what is today the tip of Yucatan about 65 million years ago. What was the leading alternative hypothesis? (Hint: it may also have contributed to the extinction)
A. The abrupt evolution of extremely effective pathogens
B. An impact from a comet
*C. Massive volcanic activity
D. An abnormal spike in solar radiation
E. Climate change due to glaciers melting

71. Which tropical Central American ecosystem did European settlers most prefer to settle in?
A. Desert because it was already open for crops.
B. Tropical rainforest because of its high biodiversity.
C. Tropical rainforest because of its abundant moisture and major rivers for transportation.
D. Tropical dry forest because the deciduous trees reminded the settlers of home.
*E. Tropical dry forest because it was the best habitat for an agricultural and ranching society.

72. Which of these dynamics would you expect to observe on an island where species diversity was governed by extinction-based saturation?
A. The number of species on the island will increase until a threshold is reached, in which case all will go extinct.
B. As the number of species on the island increases, their population sizes also increase until no new individuals can colonize the island.
*C. The number of species on the island may increase above a certain threshold from time to time, but species will eventually go extinct until the island is back below the threshold (also known as carrying capacity for species).
D. The number of species on the island may increase until all niches are filled, at which point no more species will be able to successfully become established on the island.
E. The number of species on the island will increase until the island includes all of the species from the mainland that are able to disperse to the island.

73. When Dr. Janzen and his student explored African hunting communities, they found that many of the houses, especially those near the local river, looked fragile, simple, and "primitive" in construction. Why was this?
A. The local people were too poor to afford sturdier houses.
B. The local people had strict rules about how houses could be built.
*C. The local people needed their houses to be cheap and expendable to cope with periodic flooding from the river.
D. This design, though fragile, is actually very resistant to flood damage.
E. The local people had a cultural belief that to build a house otherwise was boastful and rude.

74. What is the relationship between arctic permafrost and climate change?
A. The arctic is getting warmer faster than the rest of the earth. Warming causes permafrost to melt, but the melting ice consumes so much thermal energy from the air that it slows down the rate of arctic warming in a negative feedback mechanism.
*B. The arctic is getting warmer faster than the rest of the earth. Warming causes permafrost to melt, which frees up previously frozen soil organic matter to be decomposed, releasing more CO_2 into the atmosphere, which accelerates warming in a positive feedback mechanism.
C. The arctic is getting warmer at about the same rate as the rest of the earth, which gradually melts permafrost. The primary effect of this is to change the physical characteristics of the soil, thereby causing additional stress to soil-dwelling animals.
D. The arctic is getting warmer, but at a slower rate than the rest of the earth, buffered by the large amount of energy required to melt permafrost.
E. Although the overall global climate is getting warmer, the arctic is locally getting cooler, generating more permafrost, which cools the arctic still more, thus making it even more difficult for organisms to live there.

75. When do the trees in tropical dry forests lose (drop, dehisce) their leaves, and why?
A. In the rainy season, to avoid fungal and bacterial diseases
B. In the rainy season, to avoid herbivory
C. In the dry season, to avoid herbivory
*D. In the dry season, to avoid desiccation
E. In the dry season, to decrease the risk of fire

76. Which of the following species is semelparous?
*A. Salmon
B. Squirrel
C. Red oak
D. Humpback whale
E. Acacia

77. Which of the following actions would be the least effective at counteracting global climate change?
*A. Harvest forest biomass for biofuels.
B. Reduce fossil fuel extraction.
C. Reduce fossil fuel consumption.
D. Allow forests to regenerate on developed areas.
E. Reduce human population size.

78. Which of these is a benefit that mature trees may experience from having a rotten, hollow core?
A. Improved structural support
B. Animals may live in the core and protect the tree from herbivores
*C. Animals may live in the core and fertilize the tree with their fecal and urine waste
D. The tree may digest unneeded core material and use it for production, defense, or reproduction
E. A rotten core is never increases a tree's genetic fitness

79. Which of the following did not happen after Nile perch were introduced into Lake Victoria?
A. Cichlid fish ate Nile perch larvae.
B. Mature Nile perch ate cichlid fish.
C. Local fishing villages shifted from an artisanal bartering economy to a cash economy.
D. Forests were cut down around the lake.
*E. Populations of algae in the lake decreased.

80. Which of these is the most valuable "crop" for Costa Rica?
*A. Tourists
B. Coffee
C. Bananas
D. Timber to build with more natural materials
E. Knowledge to avoid climate change

81. Which of the following views of cichlid fish diversity is the rarest among Lake Victoria fishing villages?
A. Extinction of cichlid species is an unfortunate loss of dietary variety.
B. Extinction of cichlid species is not a big deal as long as Nile perch are supporting the villages.
*C. Extinction of cichlid species is a tragic loss of biological diversity.
D. Extinction of cichlid species presents a problem to some fishermen because they need more expensive gear to fish for Nile perch.
E. Extinction of cichlid species is unfortunate because they are delicious.

82. Recall that avocados fall from their parent trees when they are still hard, before they are ready to eat. Why?
A. The maturing fruit must experience a sudden impact from the fall, in order to ripen completely.
B. The fruit is not yet evolutionarily optimized to fall when it is ripe.
*C. To remain intact after falling to the forest floor where it can be eaten.
D. This behavior is suboptimal for seed dispersal, but it kills many nearby plants, reducing competition.
E. The impact with the ground is necessary to open the fruit's wall to give animal dispersal agents access to the fruit.

83. What does Dr. Janzen mean by "interviewing a shareholder" of a park like ACG?
A. Talking to donors about their visions and desires for the park.
B. Briefing government officials on progress in the park.
*C. Studying a forest organism to learn about its biology.
D. Asking students what they like most about the park.
E. Telling students about the ecology of the forest.

84. Which of these was not part of the African Timber and Plywood Company's strategy for sustainable forestry?
A. Map out all trees in the ~1 km^2 plots to decide which ones to harvest.
B. Cut down only a precisely chosen few trees in any given plot at any given time.
C. Leave plots alone the year after harvesting.
*D. Plant seeds of desirable timber species in recently harvested areas.
E. Cut down fast-growing tree species two years after a harvest.

85. What is wrong with the following argument? "There are sugars in human breast milk that infants can't digest; beneficial gut microbes can digest them, therefore these sugars evolved to feed gut microbes."
A. The microbes living in human guts actually can't digest these sugars either.
B. Eukaryotes, including humans, can digest any kind of sugar.
*C. Breast milk could have evolved to contain these sugars for some other reason.
D. These sugars must be an evolutionary anachronism from an ancestor whose offspring were capable of digesting them.
E. Mammals evolved so much more recently than these microbes that any evolutionary connection between them is impossible.

86. Which of these adaptations might best help a nectivorous insect species persist in a landscape with elevated plant extinction rates?
*A. The ability to live off of the nectar of multiple plant species.
B. Improved color vision to better distinguish desirable flowers from undesirable ones.
C. Improved sense of smell to better find desirable flowers.
D. A highly coevolved, specialist relationship with a single plant species.
E. Faster flying speed to better evade predators.

87. You notice several sunflowers in your backyard, and wonder if a generalist pollination strategy accounts for their reproductive success. You observe one flowering head for an afternoon, and sure enough, you notice many different kinds of insects visiting the flower (technically an inflorescence of many flowers for the botanists). What do you conclude?
A. You didn't even need to see the insects; you could deduce the sunflower's generalist pollination strategy just from observing the sunflower color and form..
*B. You can't conclude anything because you don't know whether these insect visitors are actually pollinating the sunflower.
C. You must observe the flower at night to look for nocturnal pollinators before making conclusions.
D. The sunflower uses a specialist pollination strategy because only a few of the visitors are actually pollinating it.
E. The sunflower uses a generalist pollination strategy because it is pollinated by many different kinds of insects.

88. Susan Smith showed that hand-reared motmots, tropical birds that coexist with coral snakes, avoid dowels painted with red and yellow rings, but not dowels painted with red and yellow stripes, or blue and green rings, even if they have never seen a snake. What does this suggest?
A. Motmots innately avoid the distinctive ringed pattern of coral snakes, no matter what color are the rings.
B. Motmots learn to avoid the distinctive ringed pattern of coral snakes, no matter what color the rings are.
*C. Motmots innately avoid only the red and yellow ringed pattern of coral snakes.
D. Motmots innately avoid anything with the colors red and yellow close together.
E. Motmots innately avoid anything shaped like a snake.

89. Which of these is not evidence suggesting that Polynesians, not Europeans, first brought chickens to Peru?
A. The first European explorers (Conquistadores) to reach Peru observed that the local Incans already had chickens.
B. Radiocarbon dating of chicken bones found in Peruvian archaeological sites indicates that chickens predate the European explorers in the region.
*C. The diet of modern Peruvian chickens consists primarily of plants native to South America, suggesting a Polynesian origin.
D. DNA sequences from Peruvian and Chilean chicken bones indicate that these chickens are relatively closely related to Polynesian chickens.
E. DNA sequences from ancient Peruvian and Chilean chicken bones indicate that these chickens are relatively distantly related to European chickens.

90. Sufficiently small marine islands are generally populated with a small group of species whose composition changes substantially from year to year. Why is this?
*A. The island's small size means that storms periodically wipe out all organisms living there.
B. The island's short distance to the mainland increases competition among its occupants.
C. The island's small size increases the number of available niches.
D. The large distance between the island and the mainland decreases colonization rates.
E. The large distance between the island and the mainland increases variability in the island's species composition because of the stochasticity (randomness) of colonization events.

91. Which of these is most analogous to the function of the fleshy, nutritious part of a ripe fruit like a fig, apple or the juice of the ancestor of the orange?
A. A physical defense against seed predation.
B. A chemical defense against herbivory.
C. A lure to attract pollinators.
D. A bribe to induce animals not to crush and kill the seeds.
*E. A reward to animals that accidentally disperse the seeds.

92. Where would you expect the seeds of the Costa Rican bat-dispersed *Andira* tree to be safest from seed predators?
A. On the ground under the mother tree
B. In the flower of the mother tree
*C. In an open field between the mother tree and the bats' roosting site
D. In the fruit while it is still on the tree
E. On the ground under the bats' roosting site

93. Which kind of organism was the first to arrive at Karakatau island after its eruption?
A. Plants, via wind-dispersed seeds from Antarctica.
B. Ants, by rafting from Europe.
C. Birds, by flying from South America.
*D. Spiders, by ballooning from many places.
E. Frogs, by swimming from North America.

94. In which of the following plants would you be most likely to find a chlorophyllous developing embryo (green seed)?
A. A tropical understory shrub
B. A temperate understory herb
*C. A vine with relatively translucent fruit
D. A tree with relatively opaque fruit

95. How did Nile perch first get into Lake Victoria?
A. They migrated from a natural population in a nearby river.
*B. People who thought they would be good for the surrounding human community introduced them into the lake illegally and in secret.
C. Small populations of Nile perch had been present in Lake Victoria for millennia, and they only reached noticeable levels in the 1950s due to climate change.
D. They were introduced by an enemy of the local people to devastate their cichlid fishery.
E. They were introduced downriver of a dam, by people exploiting a legal loophole, and then swam through the dam's turbines when they were closed for cleaning.

96. Why do *Passiflora* vines benefit from having leaves of many different shapes?
A. The leaves deter herbivores by mimicking the silhouettes of the herbivores' predators.
B. The leaves attract pollinators by mimicking the shapes of flowers.
C. The distinctive leaf shapes attract animals that will disperse the tree's seeds.
*D. The leaves deter herbivores by mimicking other, less suitable plants for oviposition
E. The different leaf shapes fit closely together to maximize the plant's ability to use available light.

97. Which of the following traits of non-mutualistic *Pseudomyrmex* ant species has been modified in acacia-dwelling ants?
A. They prefer to live in hollow woody plant tissues such as hollow stems
B. They are fast and agile runners, and see well
C. The larvae can survive several weeks without food
D. The worker ants do not have distinct morphological castes
*E. They eat insects

98. What philosophy does Dr. Janzen advocate to replace the "I have $X, what can I do?" mentality of restoration?
A. Given that I have $X, how much more money can I expect to raise, and what I can I do with that amount?
B. I have $X but can restore effectively for less than that; what do I do with the remainder?
*C. What does the site need and how can I raise the money to pay for it?
D. I have $X but ideally need more; how can I cut corners to get the best outcome for my $X?
E. I know how to do Y restoration treatment; how can I use that technology to help this ecosystem?