Circle the best single letter choice for each of the following questions
before transferring your answers to your computer sheet.

1. Which of the following ideas is **not** included in modern evolutionary theory?

A. Natural selection drives ~~all~~ evolutionary change. *(so does mutation, migration, mate selection, genetic drift)*
B. The great variety of species alive today resulted from the diversification of ancestral species.
C. Natural selection preserves adaptive traits.
D. Genetic drift may eliminate both adaptive and non adaptive traits.
E. All organisms that have ever existed arose through evolutionary modifications of ancestral species.

2. An individual's biological fitness is measured by

A. its relative contribution to the gene pool of the next generation. (produce viable offspring)
B. its ability to compete with other individuals for key resources.
C. its resistance to disease and parasites.
D. its ability to survive relative to other individuals.
E. how early it can begin to reproduce.

3. A gene pool can best be described as

A. the total number of gene loci that occurs in each species. (all genes and alleles in the gene pool of a species)
B. that group of genes in a genome that are in ~~Hardy-Weinberg equilibrium~~.
C. that group of genes responsible for ~~polygenic traits~~.
D. the total collection of genes in an ~~individual organism~~.
E. those genes found ~~only in isolated populations.~~

4. Which of these evolutionary factors will **not** alter allele frequencies in a Hardy-Weinberg population?

A. random mating (= no mate selection)
B. migration
C. mutation

D. genetic drift
E. natural selection

5. The Hardy-Weinberg Equilibrium states that

A. there is a predictable, constant distribution of phenotypes in any population that is not evolving. $(p^2 + 2pq + q^2)$
B. populations can evolve only if the forces of natural selection act on them.
C. large populations (N>1,000) with great genetic variability are less likely to evolve than are smaller populations (N<100) with less genetic variability.
D. populations evolve only when environmental conditions change.
E. evolution does not occur naturally; rather, it is a result of human interference (e.g. animal breeding).

6. A population of mice is at Hardy-Weinberg equilibrium at a gene locus that controls fur color. The locus has two alleles, *M* and *m*. A genetic analysis of one population reveals that 60% of its gametes carry the *M* allele. What percentage of mice contain both the *M* and *m* alleles?

A. 48% (p=0.6, q=0.4, 2pq = 0.48)
B. 60%
C. 40%
D. 36%
E. 16%

7. A rare lethal recessive allele (r) occurs with a frequency of one in a thousand (.001). In a town of 14,000 people, approximately how many people would carry this rare allele?

A. 28 (p=0.999, q=0.001)
B. 140
C. 280
D. 465
E. 857

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8. Phenotypic characteristics that increase the fitness of individuals are called

A. adaptive traits.
B. polymorphisms.
C. heterozygote advantages.
D. founder effects.
E. mutations.

9. The smallest biological unit that can evolve is

A. a population. (phenotypes live or die)
B. a species.
C. an individual.
D. a gene in an individual.
E. a genome.

10. Which of the following **increases** genetic variability in a population?

A. mutation (all others reduce variability)
B. stabilizing selection
C. genetic drift
D. assortative mate selection
E. founder effect

11. Natural selection is **most** closely related to

A. differential survival/reproduction.
    (phenotypic selection)
B. random mating.
C. genetic drift.
D. gene flow.
E. diploidy.

12. If environmental conditions are frequently changing, then natural selection favours wide phenotype curves. In this situation, epistasis and pleiotropy _____ a population's ability to maintain itself in its habitat.

A. add to (wide range of polymorphic traits needed in changing environments)
B. have no influence on
C. have unpredictable effects on
D. subtract from
E. oppose each other in

13. Two distinctly different beak sizes occur in a single population of black-bellied seedcrackers, a species of finch that lives in Cameroon, West Africa. Small-billed individuals feed mainly on soft seeds, whereas large-billed individuals feed on hard seeds. This is an example of

A. diversifying selection. (= divergent selection, against middle phenotype)
B. mate selection.
C. adaptive radiation.
D. directional selection. (against one tail)
E. stabilizing selection. (against both tails)

14. In any given bird population, eggs which are either much smaller or much larger than the average egg size (as measured by weight or volume) tend to have a lower probability of hatching. This might suggest that egg size is

A. under stabilizing selection. (selection against both tails)
B. a balanced polymorphism.
C. not subject to natural selection.
D. under disruptive selection.
E. under directional selection.

15. In a large natural population of trillium plants you find that there are far fewer individuals with the heterozygote genotype than predicted by Hardy-Weinberg equilibrium. This would **most likely** be due to

A. self-pollination. (assortative mating)
B. genetic drift.
C. bottleneck effect.
D. random mating.
E. founder effects.

16. All of the following can help maintain genetic variability in populations **except**

A. genetic drift. (chance loss, not gain)
B. gene flow.
C. heterozygous advantage.
D. frequency-dependent selection.
E. diploidy hides rare recessive alleles from selection in heterozygotes.

17. For speciation to occur

A. populations must evolve reproductive isolation so they can no longer interbreed in the wild. (RIMs, genetic isolation)
B. environmental variables must be changing in space and time.
C. populations must evolve <u>substantial</u> genetic differences. (may not be different enough)
D. populations must be separated for millions of years.
E. a geographic barrier forms to prevent gene flow between populations. (only the first stage)

18. The process of speciation

A. acts as a "lock" on the gene pool to prevent gene mixing with other species. (genetic isolation)
B. disrupts community stability by increasing competition. (reduces competition)
C. requires very long periods of time. It cannot happen instantly within one generation.
D. requires biological magnification to increase genetic divergence from other species.
E. is slow in primitive forms like sponges (Porifera) but faster in more recent forms like fish (Vertebrata).

19. The geographical ranges of the western spotted skunk (*Spilogale gracilis*) and the eastern spotted skunk (*Spilogale putorius*) overlap, but members of these species do not interbreed because *S. gracilis* mates in late summer and *S. putorius* mates in late winter. This is an example of

A. a pre-zygotic barrier that prevents interbreeding. (bad timing)
B. a post-zygotic barrier that prevents interbreeding.
C. mechanical isolation.
D. gametic isolation.
E. habitat isolation.

20. In the model of allopatric speciation, the geographical separation of two populations

A. inhibits gene flow between them. (Stage 2 leads to RIMs)
B. reduces the relative fitness of hybrid offspring.
C. allows gene flow between them.
D. occurs only after speciation is complete.
E. is sufficient for speciation to occur.

21. The Eastern Gray Squirrel has two colour morphs, gray and black. The frequency of the black morph in squirrel populations increases as one travels progressively farther north. This is most likely an example of

A. a cline.
B. polyploidy.
C. adaptive radiation.
D. heterozygote advantage.
E. genetic drift

22. An animal breeder, attempting to cross two different species of sheep for finer wool, found that the hybrid offspring rarely lived more than a few weeks. This outcome probably resulted from

A. postzygotic reproductive isolation.
B. prezygotic reproductive isolation.
C. genetic drift.
D. sympatric speciation.
E. polyploidy.

23. Allopatric speciation

A. works well in the formation of both plant and animal species.
B. has genetic divergence as the ~~first~~ stage of its process.
C. depends ~~heavily~~ on the process of genetic drift. (mostly natural selection, not chance)
D. favours post zygotic reproductive isolation mechanisms (RIMs) over prezygotic RIMs.
E. All of A, B, C and D are correct.

24. The fossil record

A. **provides no evidence about the physiology or behavior of ancient organisms.**
B. is equally good for all organisms that ever lived.
C. provides abundant data about rare species with limited local distributions.
D. supports the gradualist hypothesis, but not the punctuated equilibrium hypothesis.
E. provides direct evidence about life in the past.(not really but half marks anyway)

25. The absolute age of a geological rock layer is best determined by

A. **radiometric dating techniques.** (isotopes)
B. protein electrophorysis analysis.
C. the types of fossils found within it.
D. the mineral content of the rock.
E. the thickness of that rock layer.

26. The formation of the Panama land bridge between North and South America about 3 million years ago resulted in which of the following?

   I   Increased gene flow between previously allopatric marine populations

   II Decreased gene flow between previously allopatric terrestrial populations

   III Increased gene flow between previously allopatric terrestrial populations (North and South America now joined)

   IV Decreased gene flow between previously sympatric marine populations (Atlantic and Pacific now split)

A. **III and IV only**
B. I and II only
C. II and III only
D. I only
E. III only (half marks)

27. The differential development of body parts is called

A. **heterochrony.** (def'n from lecture slide)
B. cladogenesis.
C. preadaptation.
D. paedomorphosis.
E. allometric synchrony.

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28. Adaptive radiation is the process by which

A. a single ancestral species evolves into a variety of different species.
(mammals after dinosaur extinctions)
B. different populations of the same species vary along a geographic gradient.
C. several species become adapted to the same environment and merge to become a single species.
D. harmful UV radiation causes adaptive change.
E. two species living under similar conditions evolve to become more and more similar.

29. Extinction rates are quite variable among plant and animal taxa. The highest rate of world-wide extinction was experienced

A. during the Permian period, 250 million years ago, when continental drift caused the loss of all but about 10% of all marine species. (90% loss of marine species)

B. during the Cretaceous period, 65 million years ago, when dinosaurs and many other groups succumbed to reduced sunlight and lower temperatures.

C. during the period when the earth underwent increased volcanic activity at the same time as increased asteroid bombardment.

D. only recently, in the past 200 years, since the industrial revolution and human technology has interfered with virtually every aspect of our planet.

E. during the ice age which lasted from about 100,000 years ago until about 10,000 years ago.

30. The model of exponential population growth predicts that the per capita growth rate (r)

A. does not change as a population gets larger. ($I = rN$, no matter what the N)
B. gets larger as a population gets larger.
C. gets smaller as a population gets larger.
D. is always at its maximum level ($rmax$).
E. fluctuates on a regular cycle.

31. A population of 1000 individuals experiences 562 births and 282 deaths in 1 year. What is the value of r for this population?

A. 0.280/individual/year ($r=(b-d)$)
B. 0.028/individual/year
C. 0.003/individual/year
D. 0.562/individual/year
E. 0.844/individual/year

32. A habitat has a carrying capacity (K) of 100,00 individuals. As a small population (N = 100) begins to fill up this habitat, at approximately what population size will this group begin to experience decreasing population growth rates?

A. 50,000 (max rate at K/2, after that rate drops from max to zero)
B. 25,000
C. 75,000
D. 100,000
E. 100,100

33. The growth curves of populations in limited habitats match logistic predictions

A. seldom for most natural populations.
B. very closely for most natural populations.
C. only if there are no competitors.
D. never very closely at all for any situation.
E. always for populations in controlled lab conditions.

34. When the age structure of a population shifts from a pyramid with a wide base (Mexico) to that of one with a narrower base (Sweden), what is happening in this population?

A. This population is becoming more stable and less likely to reach its K value. (lower doubling time)
B. This population is experiencing character displacement because of intraspecific competition.
C. Predation pressures are causing disruptive selection against certain age categories.
D. This population is rapidly approaching its K value and is in danger of local extinction.
E. The birth rate is growing faster than the death rate.

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35. Which example might reflect density-dependent regulation of

A. The size of a clam population declines as the number of predatory herring gulls explodes. (fluctuates with predator density)
B. Northeast storms blow over and kill all willow trees along a lake.
C. The lawn dies after a month-long drought.
D. Mosquitoes (all) disappear from an area after the first frost.
E. An exterminator uses a pesticide to eliminate (all) carpenter ants from a home.

36. A *K*-selected species is likely to exhibit a

A. Type I survivorship curve and a long generation time. (characteristic of equilibrial species)
B. Type II survivorship curve and a long generation time.
C. Type III survivorship curve and a short generation time.
D. Type II survivorship curve and a short generation time.
E. Type I survivorship curve and a short generation time.

37. Differences in bill size of finch species living on the same island in the Galápagos may be caused by

A. character displacement. (competition reduced by phenotypic shifts)
B. interference competition. (may have been the original reason but could have been exploitative as well – half marks)
C. mimicry.
D. predation.
E. cryptic coloration.

38. The table below shows how many individuals were recorded for each of five species in five separate communities. Which community has the highest species diversity? (richness and abundance)

Community	S1	S2	S3	S4	S5
A.	**20**	**20**	**20**	**20**	**20**
B.	2	4	6	8	80
C.	25	25	25	25	0
D.	80	10	10	0	0
E.	90	10	0	0	0

39. Two closely related species are undergoing severe competition. You would expect to see the greatest amount of physical (morphological) difference in areas where they

A. occur sympatrically. (together therefore competitors)
B. occur allopatrically. (not together therefore no competition)
C. are separated by a geographic barrier.
D. experience reduced gene flow.
E. occur together along a cline.

40. A group of species sharing the same habitat is called a/an

A. community. (species only)
B. population.
C. ecosystem. (biotic plus abiotic)
D. ecological niche.
E. genus.

41. Russell defines Coevolution as "the evolution of genetically based, reciprocal adaptations in two or more species that interact closely in the same ecological setting". In which of the following species interactions would you expect the **least** amount of coevolution to occur?

A. commensalism (+/0)
B. competition (-/-)
C. parasitism (+/-)
D. predation (+/-)
E. mutualism (+/+)

42. Which of the following is an example of *Batesian Mimicry*?

A. A non-poisonous species of toad begins to resemble a poisonous species in areas where they are sympatric.

B. A species of moth has large eye-spots on its wings that, when the wings are open, resemble the face of an owl and may frighten away a predator. (protective)

C. The coat color of a fawn (a newborn deer) allows it to successfully blend in with the colors of the forest floor, protecting it from predators. (cryptic)

D. Two species of brightly colored, poisonous toads begin to resemble each other in areas where they are sympatric. (Mullerian)

E. A poisonous species of toad develops bright color patterns as a deterrent to predation. (aposematic)

43. During a walk in the woods with Richard, you notice two similar, brightly-coloured tree frogs and comment on their beauty. Richard explains that these two frogs are actually two different species and that one of them secretes toxin from its skin but the other does not. Richard warns you not to touch either of them because it's hard to tell which is which. You impress Richard by commenting "Hey, this is a perfect example of _____ ."

A. Batesian mimicry
B. cryptic colouration
C. character convergence
D. Müllerian mimicry
E. ecological equivalence

44. The ultimate source of energy in most ecosystems is

A. the sun. (energy comes in as sunlight and leaves as heat)
B. green plants.
C. any food item an organism may eat.
D. small organic monomers such as amino acids, carbohydrates and nucleotides.
E. large organic polymers such as proteins, lipids, sugars and nucleic acids.

45. The amount of energy available at the highest trophic level in an ecosystem is determined by

A. only the net primary productivity of the ecosystem.
B. only the gross primary productivity of the ecosystem.
C. the gross primary productivity and the standing crop biomass.
D. the net primary productivity and the ecological efficiencies of herbivores. (why just herbivores?)
E. the net primary productivity and the ecological efficiencies at all lower trophic levels.

46. A study of a meadow community revealed the following food chain:

green plants (-10%) →grasshoppers
grasshoppers (-10%) → frogs
$1° P → 1° C → 2° C$
$800,000 → 80,000 → 8,000$

The amount of energy in green plants in this community is 800,000 joules. How much of this energy would appear in the secondary consumers?

A. 8,000 joules
B. 80 joules
C. 800 joules
D. 80,000 joules
E. 400,000 joules

47. If you compared several ecosystems in terms of their contribution to total global net primary productivity the **largest** contributor would be

A. open ocean. (total - not average per m^2)
B. temperate deciduous forests.
C. tropical reefs and algal beds.
D. lakes, streams and marches.
E. tropical rain forests.

48. Which one of the following statements regarding *Succession* is **correct**?

A. A climax forest may be achieved through either primary or secondary succession. (to same end point)
B. r-strategists are the first to colonize in primary succession while K-strategists colonize ~~first~~ in secondary succession.
C. Secondary succession usually produces habitats ~~more complex~~ than those from primary succession.
D. Primary succession is ~~always~~ followed by secondary succession.
E. Primary succession generally requires ~~shorter~~ time periods than does secondary succession.

49. During the spring overturn in a temperate zone lake

A. oxygen is carried from the surface to the bottom, and nutrients are carried from the bottom to the surface.
B. nutrients are carried from the surface to the bottom, and ~~oxygen is carried from the bottom to the surface~~.
C. nutrients and ~~oxygen~~ are carried from the bottom waters to the surface waters.
D. ~~nutrients~~ and oxygen are carried from the surface waters to the bottom waters.
E. oxygen concentration remains constant at all depths, and nutrients sink to the bottom. (both wrong)

50. Which of the following materials has a sedimentary cycle?

A. phosphorus
B. carbon
C. nitrogen
D. oxygen
E. water

51. **BONUS QUESTION**
A population of dragon flies live along the Thames River behind NCB. Below are population estimates from two successive years. Three genotypes are recognized by their body colours, black (EE), purple (Ee), blue (ee). From this information, calculate the Relative Fitness (W) of the **least fit** phenotype.

Year	EE	Ee	ee	N
Year 1	3,000	3,900	2,000	8,900
Year 2	3,800	4,400	1,800	10,000

Some of you may have recognized this as the exact question we did together in class, Lecture 2 of H-W examples. Please review your class notes.

A. W = 0.74 for Ee
B. W = 0.00 for ee
C. W = 0.71 for EE
D. W = 1.00 for ee
E. It cannot be determined for this population since it is not in H-W equilibrium.