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1. Which of the following happens LAST during mitosis?
   a. Microtubules emerge from the centrosomes.
   b. Tetrads form.
   *c. The sister chromatids separate.
   d. Sister chromatids align on the metaphase plate.
   e. The spindles start to pull on the kinetochores of sister chromatids.

2. Which of the following best describes the flow of energy through an ecosystem?
   a. chemical energy enters, is converted to other forms of chemical energy, and is washed out of the ecosystem as medium-sized molecules
   b. sunlight energy enters, is converted to chemical energy then is permanently stored as fossil fuels
   c. heat enters, is converted to chemical energy and is released as light energy
   *d. sunlight energy enters, is converted to chemical energy and is released as heat
   e. heat enters, turns into biotic chemicals, then is converted back to heat and released

3. Red flowers show incomplete dominance. If you cross a P generation of plants with red flowers (RR) and white flowers (rr), what phenotypic ratio of flower color would you predict in the F2 generation?
   *a. 1 red: 2 pink: 1 white
   b. 2 red: 1 pink: 1 white
   c. all pink
   d. 3 red: 1 white
   e. 1 pink: 3 white

4. Cats reproduce sexually, are diploid and have 38 chromosomes (n=19). Where do the chromosomes in a cat zygote come from?
   a. all 38 from each gamete
   b. all 38 from an egg
   c. all 38 from the mitotic division of a gamete
   d. all 38 from a sperm cell
   *e. 19 from a sperm cell, 19 from an egg
5. If you look at cells under a microscope, in eukaryotes, but NOT prokaryotes, you would expect to see

   a. no membrane-bound organelles.
   *b. endoplasmic reticulum.
   c. a single circular chromosome.
   d. a plasma membrane.
   e. ribosomes.

6. What happens in the rough endoplasmic reticulum?

   a. Cellular respiration
   b. Sugars are added to DNA.
   c. Sugars are added to mRNA.
   *d. Translation of some proteins
   e. Photosynthesis

7. The R on the diagram of an amino acid represents

   a. the site where one amino acid binds to the next in a polymer of amino acids (protein).
   b. RNA subunits.
   c. the reaction site.
   *d. a functional group that can vary from one type of amino acid to another.
   e. a functional group that is too big to write out, but that is the same for all amino acids.

8. Why do we have many definitions of species?

   a. because we need different definitions for plants versus animals
   *b. because we have different questions and different data in various situations
   c. to distinguish between species that reproduce sexually and those that reproduce asexually
   d. to confuse biology students
   e. because there is no evidence for evolution

9. The shape of a protein determines

   a. which codon makes hydrogen bonds to particular anticodons.
   b. the sequence of the ribonucleotides in the mRNA that codes for that protein.
   *c. the function of the protein.
   d. the sequence of the DNA that codes for that protein.
   e. the sequence of amino acids in the protein.
10. Consider all of the stages of cellular respiration from the beginning to the end. In cellular respiration

   a. ATP is converted to ADP and Pi.
   b. insulin is converted to glucagon.
   *c. glucose, oxygen, ADP and Pi are converted to carbon dioxide, water and ATP.
   d. carbon dioxide, water and ATP are converted to glucose, oxygen, ADP and Pi.
   e. carbon dioxide and energy are converted to glucose.

11. Lactose affects the expression of the lac operon, by _______ the expression of genes that make _______.

   *a. increasing, enzymes that break down lactose
   b. decreasing, enzymes that synthesize lactose
   c. decreasing, enzymes that break down lactose
   d. increasing, enzymes that synthesize lactose

12. The average net productivity of open ocean and of tundra are roughly equal to each other and are each about 150 g/m²/yr. The Earth has more open ocean than it has tundra. From this information you would predict that

   a. added together the open oceans and tundra of the Earth produces 300 g/yr of biomass.
   b. less of the Earth’s net primary production is from open ocean, than from tundra.
   c. added together the open oceans and tundra of the Earth produces 150 g/yr of biomass.
   *d. more of the Earth’s net primary production is from open ocean, than from tundra.
   e. an equal amount of the Earth’s net primary production is from open ocean and from tundra.

13. Assume Mendelian genetics for this question. If T is for the dominant tall-plant trait and t is for the recessive short-plant trait, then which of the following would be the possible genotype(s) of short plants?

   *a. only tt
   b. Tt or TT
   c. tt or Tt
   d. tt or TT
   e. tt, TT or Tt

14. Which of the following do you have less of at the end of cellular respiration than at the beginning?

   a. Co-enzyme A
b. the proteins of the electron transport chain
*c. glucose
d. NADH
e. ATP synthase

15. What is a similarity between transcription and DNA replication?

a. They both result in two new double helices.
b. They both make new RNA nucleic acids.
c. They both occur in the cytoplasm.
d. They both create new DNA nucleic acids.
*e. They both require a polymerase.

16. The cardiovascular system does NOT

a. carry the carbon dioxide generated by the muscles.
b. carry the nutrients absorbed by the digestive system.
*c. carry the ATP generated by cellular respiration.
d. carry the oxygen inhaled via the pulmonary system.
e. carry the hormones released by the endocrine system.

17. In an ecosystem, photosynthesis occurs in the

a. decomposers.
b. primary consumers.
c. secondary consumers.
*d. primary producers.
e. tertiary consumers.

18. Assume dog coat color is Mendelian. The B allele is dominant for a brown coat. Black coats (b) are recessive. Which of the following dogs is homozygous recessive?

a. a dog with genotype Bb
*b. a dog with a black coat
c. a dog with genotype BB
d. a dog with a brown coat
e. None of the other answers is correct.

19. Which of the following is the phase of cellular respiration that happens last?

a. the citric acid cycle
b. grooming of pyruvate
c. fermentation
d. glycolysis
*e. chemiosmosis
20. Complementary base pairing of A to T and G to C is essential for
   a. transcription
   b. cellular respiration
   c. mRNA synthesis
   d. translation
   *e. DNA replication

21. During oxidative phosphorylation
   a. glucose is oxidized to pyruvate.
   b. ATP is used to make high energy molecules, such as NADH and FADH₂.
   c. ATP is broken down into ADP and Pi by hydrolysis.
   d. oxygen carries electrons through ATP synthase molecules to make NADH.
   *e. the energy in a proton (H⁺) gradient makes ATP by chemiosmosis.

22. Which happens next after gametes are made in the human life cycle?
   *a. fertilization
   b. differentiation of cell types
   c. mitosis of diploid cells
   d. meiosis of diploid cells
   e. mitosis of haploid cells

23. In a biological system being maintained in homeostasis, ___________ is used to bring the parameter back into the homeostatic range.
   a. temperature
   b. diabetes
   *c. negative feedback
   d. insulin
   e. glucagon

24. Plants contain starches and cellulose. Starch and cellulose are polysaccharides (polymers of sugars). The carbon in starches comes from
   a. cellulose from the dirt.
   b. the process of cellular respiration.
   c. pesticides.
   d. minerals from the dirt.
   *e. carbon dioxide.

25. There is a population of 1000 crickets. 500 of the crickets are heterozygous for leg length, and 500 are homozygous for short legs.
Long legs are recessive. What is the phenotype frequency of long legs in this population of crickets?

a. 25%
b. 75%
c. 250 crickets
d. 50%
*e. 0%

26. Which of the following best describes how information is transferred in a cell of a plant or animal?

a. DNA is translated into mRNA molecules, which are transcribed into proteins.
b. DNA is transcribed into proteins, which are translated into mRNA molecules.
c. DNA is simultaneously translated into mRNA and transcribed into proteins.
d. DNA is translated into proteins, which are transcribed into mRNA molecules.
*e. DNA is transcribed into mRNA molecules, which are translated into proteins.

27. Hydrogen bonds

a. are the strongest type of bonds.
b. are a type of covalent bond.
c. are a type of peptide bond.
d. hold sequential nucleotides in a DNA molecule together along the backbone.
*e. help determine the shape of a protein.

28. Phospholipids

a. are usually hormones.
b. are hydrophilic, not amphipathic.
c. are usually enzymes.
d. are usually hormone receptors.
*e. make the bilayer of the plasma membrane.

29. If a region of a protein is located in the cytoplasm, you would predict that the region of the protein in the cytoplasm

*a. has hydrophilic amino acids.
b. has hydrophobic amino acids.
c. has amino acids with no charges and no partial charges.
d. has more A and T than C and G.
e. has a mix of hydrophobic and hydrophilic amino acids.
30. How many double helices of DNA are in one chromosome?

*a. 1  
b. 4  
c. 8  
d. 23  
e. 2

31. The purpose of the meiosis is

*a. to get exactly one copy of each type of chromosome into each daughter cell.  
b. to make more copies of a cell for wound healing.  
c. to make more exact copies of a cell.  
d. to cause cancer.  
e. merge a sperm cell with an egg.

32. Which of the following would you predict would be used to carry energy in the bloodstream from one cell to another?

a. NADH  
*b. glucose  
c. ATP  
d. pyruvate  
e. ADP

33. In a Mendelian monohybrid cross of a pea plant with dominant tall (T) plants with a plant with recessive short (t) plants, how many offspring of 100 plants in the $F_2$ generation would you predict will be heterozygous?

a. 100  
b. 75  
c. 25  
*d. 50  
e. none

34. Which of the following happens LAST of the steps of meiosis listed below?

*a. sister chromatids separate  
b. tetrads align on the metaphase plate  
c. tetrads of duplicated homologous chromosomes form  
d. homologous chromosomes separate  
e. spindle microtubules from opposite centrosomes attach to the kinetochores of sister chromatids, aligning sister chromatids towards opposite centrosomes
35. The activation energy of a reaction
   a. is equal to the amount of energy released by the reaction.
   b. determines whether a reaction is endergonic or exergonic.
   c. is positive for endergonic reactions and negative for exergonic reactions.
   *d. can be decreased by enzymes.
   e. determines whether the product will be potential energy or kinetic energy.

36. When two individuals live in the same general area, but not the same ecological niche, then it is an example of
   *a. habitat isolation, which is a prezygotic reproductive barrier.
   b. gametic isolation, which is a prezygotic reproductive barrier.
   c. habitat hybrid viability, which is a postzygotic reproductive barrier.
   d. reduced hybrid fertility, which is a postzygotic reproductive barrier.
   e. behavioral isolation, which is a prezygotic reproductive barrier.

37. Covalent bonds between sugars and phosphate groups are found
   a. between amino acids in polypeptides.
   b. binding two molecules of DNA to each other across the middle of a double helix.
   c. binding nitrogenous bases to the deoxyribonucleic acid monomer.
   *d. between neighboring deoxyribonucleic acid monomers in a molecule of DNA.
   e. holding water to DNA.

38. Assume Mendelian genetics for this question. A genetically dominant allele
   *a. will determine the phenotype if there is at least one copy of that allele present.
   b. codes for a trait that gives more evolutionary fitness to the individual than the recessive allele.
   c. codes for a trait than makes an individual physically stronger than a recessive trait.
   d. is more frequent than a recessive allele in a population.
   e. will be present in 100% of the gametes of an individual that is heterozygous for that gene.

39. How does carbon dioxide get to the atmosphere from the tissues of the body?
a. the endocrine system
b. the musculoskeletal system
c. oxidative phosphorylation
d. the digestive system
*e. the pulmonary and cardiovascular systems

40. Assume Mendelian genetics for this question. If yellow seed color (Y) is dominant to green seeds (y), what are the probabilities of possible genotype(s) of the gametes of a plant with yellow seeds that has the genotype Yy?

a. 100% Y, 0% y
b. 100% Yy
c. 75% Y, and 25% y
d. 25% yy, 50% Yy, and 25% YY
*e. 50% Y, and 50% y

41. When a gene is expressed, it means that the protein that it codes for is being made by transcription and translation. Imagine two genes in a eukaryote. One is gene X. The other is gene A. In the cells you are studying, gene X is being expressed, and gene A is not being expressed. Which prediction below is most likely true in these cells?

a. There are more operons for gene X than for gene A.
b. There are more promoters for gene A than gene X.
c. There are more copies of gene A than gene X.
d. There is more mRNA for gene A than for gene X.
*e. There are more activators for gene X than for gene A.

42. Assuming no mutations and before crossing over, sister chromatids

a. have different alleles.
b. are joined during fertilization.
c. have centromeres in the same locations.
d. have different lengths.
e. have different gene loci.

43. Assuming no mutations, in one individual, two cells in different tissues have

*a. different activated transcription factors.
b. different RNA polymerase.
c. the exact same set of mRNA molecules.
d. different DNA sequences.
e. the exact same set of proteins.

44. The purpose of mitosis is
a. to get exactly one copy of each chromosome into each daughter cell.
b. get both copies of every other chromosome into each daughter cell.
c. replicate the DNA.
d. stop cell division if there is a mistake in DNA replication.