

- I. Unfortunately, your microscope is very old and you no longer see what magnification your lens is. Luckily, you know the approximate size of the picture below.



**Approximately how long is the needle (blue bar) using the picture as a scale?**

- A. 0.1 micron
  - B. 1 micron
  - C. 10 microns
  - D. 100 microns
  - E. 1000 microns
2. You have found the new protein **RXVSD3E!** Which of the following amino acids are you least likely to find in the intermembrane portion of the protein?
- A. Alanine
  - B. Valine
  - C. Isoleucine

- D. Serine
- E. Methionine

**3. You are investigating the melting point of DNA strands. You test the following 5 strands in the lab and as you expect, you find that the strand with the highest melting point is:**

- A. AAAGCATT
- B. GGGCCCAA
- C. AGAGCAAA
- D. CCCCCCCC
- E. AAAAAAAAAA

**4. It's AP Biology, and your teacher is lecturing about signaling pathways. Suddenly, he poses an extra credit question to see if anybody actually read the book. He writes "if PKA(Protein Kinase A) is activated, which of the following amino acids would most likely be phosphorylated?" You correctly choose the following choice:**

- A. Serine
- B. Tyrosine
- C. Methionine
- D. Lysine
- E. Valine

**5. The disposal of ammonia in vertebrates is very important. What compound will be created if oxaloacetate is transaminated?**

- A. Aspartic Acid
- B. Glutamic Acid
- C. Asparagine
- D. Glutamine
- E. Glycine

**6. What is autophagy?**

- A. A cell digests another cell
- B. A cell commits suicide and digests itself
- C. A cell digests its own organelles
- D. A cell digests a cell of its own species
- E. A cell undergoes transformation

**7. What is the purpose of secondary antibody in Western Blotting?**

- A. To bind to target protein in case the primary antibody does not bind.
- B. To bind to the primary antibody and mark the location of the primary antibody.
- C. To bind to the proteins not bonded by the primary antibody.
- D. To block the membrane from binding primary antibody.
- E. To linearize the protein.

**8. The Michaelis-Menten enzyme kinetics model is an enzyme kinetics model useful in biochemistry. Select the statement below that is FALSE.**

- A. The Michaelis-Menten enzyme model can be applied to hemoglobin.
- B. A competitive inhibitor causes the  $K_m$  of a protein to increase but the  $V_{max}$  to remain the same.
- C. A noncompetitive inhibitor causes the  $K_m$  of protein to remain constant but the  $V_{max}$  to decrease.
- D. An uncompetitive inhibitor binds to the enzyme-substrate complex.
- E. An uncompetitive inhibitor affects both the  $V_{max}$  and the  $K_m$

**9. A 1 molar solution of acetic acid is created. What is the pH of the solution given that the  $K_a$  of acetic acid is  $1.8 \times 10^{-5}$ ?**

- A. 0
- B. 2.43
- C. 4.74
- D. 5.46
- E. 6.34

**10. Varun has been suffering from the bacteria *Ijustmadethisup*. Analysis of the DNA from his cells shows that his DNA is in many different fragments. The bacterium mostly likely interferes with which of the following enzymes?**

- A. Helicase
- B. Ligase
- C. Telomerase
- D. DNA Polymerase
- E. Primase

**11. What phase of the cell cycle is shown in the following image?**



- A. Prophase
- B. Metaphase
- C. Anaphase
- D. Telophase
- E. Interphase

**12. Which of the following compounds is not a terpenoid?**

- A. Rubber
- B. Cardiac Glycosides
- C. Isoprene
- D. Lignin
- E. Menthol

**13. A set of lettuce seeds is exposed to the following sequence of lights: far red, far red, far red, red. Will the seeds germinate?**

- A. The seeds will germinate since the last flash of light was red which causes germination.
- B. The seeds will not germinate since the last flash of light was red which prevents germination
- C. The seeds will germinate since there are more far red flashes than red flashes which cause germination
- D. The seeds will not germinate since there are more far red flashes than red flashes which will prevent germination.

These problems were created by Yilun Du and Varun Mangalick and are the intellectual property of them and their biology tutoring business, Study of Life. If you have any questions, email us at [studyoflife.info@gmail.com](mailto:studyoflife.info@gmail.com)

**14. This dicot flowering family consists of herbs, shrubs and trees. Leaves are often alternate and can be simple or compound. This family has perigynous perfect actinomorphic flowers. Fruits of the family are diverse ranging from achenes, follicles, pomes, to drupes. The flowers typically have 5 petals and many stamen and few to many ovaries. This flower family also contains many of the important cultivated fruits. What is this dicot flower family?**

- A. Rosaceae
- B. Ranunculaceae
- C. Brassicaceae
- D. Cactaceae
- E. Asteraceae

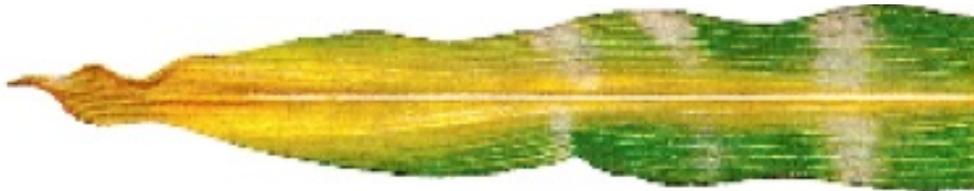
**15. Which of the following does not take part in the cyclic photosynthesis?**

- A. Ferredoxin
- B. Cytochrome Complex
- C. Photosystem I
- D. NADP Reductase
- E. Plastocyanin

**16. Which of the following statements about the alternation of generations in plants is correct?**

- A. Bryophytes have a dominant sporophyte generation
- B. The gametophyte generation produces gametes by mitosis
- C. The sporophyte generation produces gametes by mitosis
- D. The sporophyte generation is haploid
- E. Ferns have a dominant gametophyte generation

**17. What nutrient is missing from the image of plant leaf given below?**

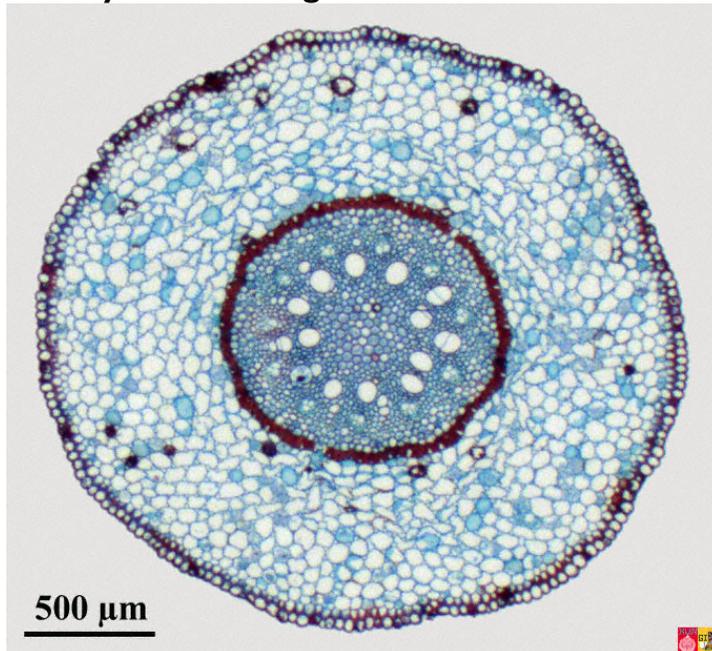


- A. Nitrogen
- B. Potassium
- C. Phosphorous
- D. Calcium
- E. Boron

**18. Which of the following statements best describes the function of lignin in plants?**

- A. Lignin helps make the cell walls of cells in the xylem to be more hydrophobic, allowing better water conduction
- B. Lignin helps strengthen wood.
- C. Lignin helps attract pollinators.
- D. Both A and B
- E. Both B and C

**19. Identify the following tissue slice.**



- A. Monocot Stem
- B. Monocot Root
- C. Dicot Stem
- D. Dicot Root
- E. Conifer Root

**20. Which of the following glands is directly controlled by neurons?**

- A. Posterior Pituitary
- B. Anterior Pituitary
- C. Adrenal Cortex
- D. Testes
- E. Ovaries

**21. What type of epithelium is found in the small intestine?**

- A. Simple Columnar
- B. Simple Squamous
- C. Psuedostratified Columnar
- D. Stratified Squamous
- E. Stratified Columnar

**22. From what tissue layer are germ cells derived from?**

- A. Ectoderm
- B. Mesoderm
- C. Endoderm

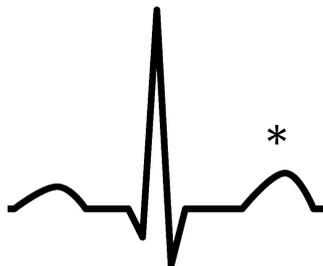
**23. Select *all* of the following hormones that are secreted by the anterior pituitary.**

- A. Prolactin
- B. ADH
- C. Oxytocin
- D. TSH
- E. Growth Hormone

**24. Varun is experiencing weight gain, high blood pressure, irritability, and fatigue. In addition, he has an impaired immune system. Which of the following hormone imbalances does he most likely have?**

- A. Cortisol
- B. Thyroxine
- C. Aldosterone
- D. Growth Hormone
- E. Insulin

**25. Consider the image of the ECG picture below. What happens in the portion labeled with an \*?**



- A. Depolarization of the Atrium
- B. Repolarization of the Atrium
- C. Depolarization of the Ventricle
- D. Repolarization of the Ventricle

**26. If we were to follow the path of an erythrocyte starting from an artery that lead to the hypothalamus, and then tracked it as it entered the pituitary gland until eventually it reached the left atrium of the heart, how many capillary beds will it have gone through?**

- A. 1
- B. 2
- C. 3
- D. 4
- E. 5

**27. Select all of the following choices in which the vitamin deficiency is matched to its symptoms.**

- A. Thiamine - Beri-beri
- B. Vitamin D - rickets
- C. Vitamin C - scurvy
- D. Niacin – decreased blood clotting

**28. Which of the following statements about immunoglobins is *false*?**

- A. IgG is the most commonly produced immunoglobulin and is passed down through passive immunity
- B. IgA is the immunoglobulin produced in salivary secretions and is often passed to the infant in breast milk
- C. IgD is the first immunoglobulin produced and resides on the membrane of T cells.
- D. IgE is involved in the allergic response
- E. IgM forms pentamers and are primarily responsible for blood agglutination after a blood transfusion.

**29. Select *ALL* of the following organisms that use uric acid to dispose of nitrogenous wastes.**

- A. Birds
- B. Insects
- C. Humans
- D. Reptiles
- E. Sharks

**30. Acetylcholine is one of the major neurotransmitters in the human body. Which of the following statements about acetylcholine is FALSE?**

- A. Sarin gas leads to the build up of acetylcholine in the synaptic cleft that leads to paralysis.
- B. Botulism prevents the release of acetylcholine from the presynaptic terminal.
- C. The metabotropic acetylcholine receptor in the heart is excitatory.
- D. The acetylcholine receptor in the neuromuscular junctions is inotropic.
- E. Nicotine activates neuromuscular junctions.

**31. Select the order of cells through which light passes in the eye:**

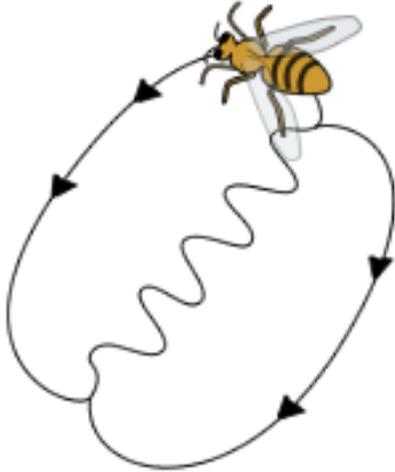
- I. Optic Nerve
- II. Horizontal Cell
- III. Amacrine Cell
- IV. Rod Cell
- V. Ganglion Cell

- A. I, V, II, III, IV
- B. I, V, III, II, IV
- C. IV, III, II, V, I
- D. IV, II, III, V, I
- E. V, I, II, III, IV

**32. What is the coefficient of relatedness between 2 first cousins?**

- A.  $1/16$
- B.  $1/8$
- C.  $1/4$
- D.  $1/2$
- E. I
- F. Cannot Be Determined

**33. You have been observing a bee colony for the past hour. You notice the following dance from a bee. Given that the sun is pointing east, what direction are the flowers?**



- A. Northwest
- B. Southwest
- C. Southeast
- D. Northeast
- E. North

**34. You have a tank full of piranhas. You decided to try an experiment and drop a plastic fish in the tank. Initially, the piranhas try biting the fish before finally given up. You proceed to drop a plastic fish into the tank every single day. However, by the end of the week, none of the piranhas react after you drop the plastic fish. What type of learning has occurred?**

- A. Habituation
- B. Classical Conditioning
- C. Operant Conditioning
- D. Altruism
- E. Symbolic Reasoning

**35. Anna and Mark want to have a baby, but they want to know the probability that their baby will be colorblind. Anna's mother was color blind while her father had normal vision. Mark's mother had normal vision and his father was colorblind. Neither parent is colorblind. What is the probability that their child is male and has normal vision?**

- A.  $\frac{1}{4}$
- B.  $\frac{1}{2}$
- C.  $\frac{1}{3}$
- D.  $\frac{1}{6}$
- E. None of the Above

**36. In Earth Aleph, there are two alleles that determine eye color, allele A and a. If a person's genotype is AA or Aa, then the person has brown eyes, and if their genotype is aa, they'll have blue eyes. Unfortunately, people who have blue eyes have a 50% chance of dying. Given that the initial frequency of both A and a alleles is 50%, what will be the frequency of the A allele after 1 generation?**

- A. 66.7%
- B. 50%
- C. 75%
- D. 57.1%
- E. None of the Above

**37. You have just tested positive for the disease Insertsomediseasehere. However, your doctor tells you that they need a second test to truly tell if you actually have the disease. You know the disease is found in 1 in 1000 people and that the diagnostic test has a sensitivity of 0.99 and specificity of 0.999. What is the actual probability that you have the disease, given the first positive result?**

- A. 100%
- B. 99%
- C. 75%
- D. 50%
- E. 10%

**38. An inbred strand of plants has a height 24cm. Another inbred strand of plants have a height of 28cm. When you breed these two strands of plants together, the F1 generation have a uniform height of approximately 26cm. However, upon breeding the F2 generation, you find an almost Gaussian looking distribution of heights. Out of the 1000 F2 generation you have approximately 15 plants that are 20cm high and the same number approximately 32cm high. What is the probability that your plant will be 24cm high? (Assume that each gene contributes the same height)**

- A. None
- B.  $\frac{3}{4}$
- C.  $\frac{9}{16}$
- D.  $\frac{15}{64}$
- E. None of the Above

**39. Farmer Bob has been attending his lawn with Roundup for the past year. However, recently he has noticed a large increase in plants resistant to Roundup. What is the best explanation for the appearance of these plants resistant to Roundup?**

- A. The genes encoding resistance were already in the population
- B. Directional Selection caused mutations that lead to resistance to Roundup
- C. Roundup stimulated plants to develop resistance genes
- D. Roundup caused rapid mutation that lead to the development of resistance genes

**40. During which of the following eras were oxygen levels on Earth the highest?**

- A. Carboniferous
- B. Permian
- C. Triassic
- D. Devonian
- E. Cenozoic

**41. Colchicine is a microtubule polymerization inhibitor and is often used to produce diploid plant spores. To manufacture seedless watermelons, diploid watermelon pollen is produced through colchicine treatment, which is then used to fertilize the ovaries in watermelon plants. Given that  $n=11$  in watermelon, how many chromosomes do the resultant embryo have?**

- A. 11
- B. 22
- C. 33
- D. 44
- E. Cannot be determined

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

- A. A viceroy butterfly is similarly colored to the poisonous monarch butterfly.
- B. Snakes that are venomous are all often brightly colored
- C. A poisonous dart frog is very brightly red colored
- D. An iguana changes its colors to blend into its environment
- E. A song bird mimics the song that its parent sings

**43. Yilun is trying to grow as much bacteria as possible. Suppose that each Petri dish has a carrying capacity of 10000 bacteria. To harvest bacteria at the fastest rate possible, how large should Yilun grow each colony?**

- A. 10000
- B. 5000
- C. 1000
- D. 500
- E. 100

**44. Varun is surveying the relationship between the diversity of species and land area. He notes that a 1 meter by 1 meter plot of land has a total of 50 species and that a 10 meter by 10 plot of land has a total of 100 species. How many species does he expect a 100 meter by 100 meter plot of land to have?**

- A. 150
- B. 200
- C. 1000
- D. 2000
- E. 5000

**45. According to the island hypothesis of diversity, which of the following island would have the most diversity?**

- A. Large island close to land
- B. Large island far from land
- C. Small island close to land
- D. Small island far from land

**46. Your colleague proposes that exactly 40% of the sharks in your area are female. You decide to test your colleague's claim and capture 100 sharks in your region and find that exactly 50% of the sharks are female and the same percentage male. Do you have sufficient information to reject your colleague's? Use the chi square table given below, and assume significance level of 0.05.**

$r$	$P(X \leq x)$							
	0.010	0.025	0.050	0.100	0.900	0.950	0.975	0.990
$r$	$\chi^2_{0.99}(r)$	$\chi^2_{0.975}(r)$	$\chi^2_{0.95}(r)$	$\chi^2_{0.90}(r)$	$\chi^2_{0.10}(r)$	$\chi^2_{0.05}(r)$	$\chi^2_{0.025}(r)$	$\chi^2_{0.01}(r)$
1	0.000	0.001	0.004	0.016	2.706	3.841	5.024	6.635
2	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210
3	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.34
4	0.297	0.484	0.711	1.064	7.779	9.488	11.14	13.28
5	0.554	0.831	1.145	1.610	9.236	11.07	12.83	15.09
6	0.872	1.237	1.635	2.204	10.64	12.59	14.45	16.81
7	1.239	1.690	2.167	2.833	12.02	14.07	16.01	18.48
8	1.646	2.180	2.733	3.490	13.36	15.51	17.54	20.09
9	2.088	2.700	3.325	4.168	14.68	16.92	19.02	21.67
10	2.558	3.247	3.940	4.865	15.99	18.31	20.48	23.21

- A. Yes, P is above 0.05
- B. Yes, P is below 0.05
- C. No, P is above 0.05
- D. No, P is below 0.05

**47. Select ALL of the following that are indicators of the biodiversity of an ecosystem.**

- A. Potential Evapotranspiration
- B. Species Diversity
- C. Relative Diversity
- D. Actual Evapotranspiration
- E. Ratio between animal and plant species

**48. Rank the following ecosystems from most to least productive (per unit area).**

- I. Estuary
- II. Temperate Forest
- III. Savanna
- IV. Open Ocean
- V. Grassland

- A. I, II, III, V, IV
- B. I, II, V, III, IV
- C. II, I, III, V, IV
- D. II, I, V, III, IV
- E. II, V, III, I, IV

**49. Which of the following flowering families is a dicot?**

- A. Liliaceae
- B. Orchidaceae
- C. Poaceae
- D. Asteraceae

**50. Bats are in the order Chiroptera, which is in the class Mammalia. As such, they the following derived characteristics:**



- I. Hypothalamus
- II. Mammary Glands
- III. Hair
- IV. A Diaphragm separating the thoracic and abdominal cavities
- V. The three middle ear bones- malleus, stapes, and incus
- VI. Enucleated Red Blood Cells

- A. I, II, III, VI
- B. II, III, IV, V, VI
- C. I, II, III, V
- D. I, II, III, IV, VI
- E. II, III, IV, V, VI