1 Mathematics

1. $\lim_{x\to\infty} \frac{\sin x}{x} =$
   A. 0
   B. 1
   C. ∞
   D. does not exist
   E. None of the above

2. If $f(x) = x^{\sin x}$ then $f'(x) =$
   A. $x^{\sin x - 1}$
   B. $x^{\sin x} \ln x$
   C. $x^{\sin x - 1} \cos x$
   D. $x^{\sin x - 1} \cos x \ln x$
   E. $x^{\sin x} \left(\cos x \ln x + \frac{\sin x}{x}\right)$

3. A quality control inspector tests gadgets from a box. He begins by selecting two gadgets. If both gadgets are good, the box passes. If both gadgets are faulty, the box is rejected. If exactly one gadget if faulty, he selects two more gadgets without replacement of the first two selected, and tests them. If either of the gadgets in the second selection is faulty, he rejects the box. If both of the gadgets in the second selection are good, the box passes. In a box of 10 gadgets, four gadgets are faulty, what is the probability that the inspector will not reject the box?
   A. 0.4933
   B. 0.5000
   C. 0.5111
   D. 0.5238
   E. 0.5328

4. The region R is enclosed by the parabola $y = 2x - x^2$ and the x-axis. The volume of the solid obtained by rotating R around y-axis is
   A. $\frac{4\pi}{3}$
   B. $\frac{8\pi}{3}$
   C. $\frac{11\pi}{15}$
   D. $\frac{21\pi}{15}$
   E. Cannot be computed from these data

5. The maximum value of the function $f(x) = -x_1^2 - x_2^2 - 2x_1 + 4x_2 - 5$ at the condition that $4x_1^2 + x_2^2 \leq 4$, $x_1 + 2x_2 \leq 2$, $x_1 \geq 0$, and $x_2 \geq 0$ is
   A. -8
   B. -2
   C. 1
   D. 24
   E. None of the above options

2 Chemistry

6. The ionic strength of a solution depends on which of the following

   I. The charges on the ions
   II. The concentrations of the ions
   III. The sizes of the ions

   A. I only
   B. II only
   C. I and II only
   D. II and III only
   E. I, II, and III

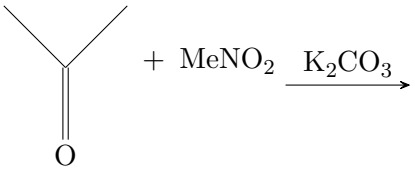
7. Which of the following describes a method of carrying out the reaction $NCCH_2CH_2CN \rightarrow HOOCCH_2CH_2COOH$?

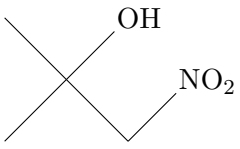
   A. Reduction
   B. Acylation
   C. Hydrolysis
   D. Alkylation
   E. Esterification

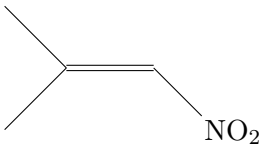
8. Which of the following reactions produces a colored solution?

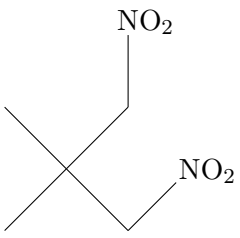
   A. $Ca^{2+} + CO_3^{2-} \rightarrow$
   B. $Ni + AgNO_3 \rightarrow$
   C. $P_4O_{10} + H_2O \rightarrow$
   D. $K_2O_2 + H_2O \rightarrow$
   E. $Zn + H_3O^+ \rightarrow$

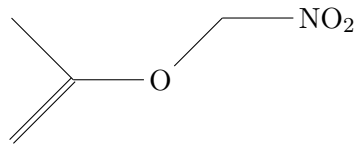
9. What is the final product of the reaction?

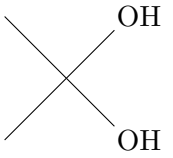


A. 

B. 

C. 

D. 

E. 

10. Which glucose-based polymer has only β-glycosidic bonds

    A. starch

    B. glycogen

    C. cellulose

    D. dextran

    E. None of the above options

3 Physics

11. Two particles start circular motion with radius $R = 15$ cm. The first particle has the radial acceleration 1.2 times larger than the second one. How many full circles will pass by the first particle until the particles will meet the next time?

    A. 5

    B. 10

    C. 11

    D. 15

    E. 18

12. The distance between two coherent light sources with a wavelength of 700 nm is 0.45 mm. Calculate the distance between the zero-order maximum and the first fringe on the screen which is placed at a distance 0.5 m from the sources of light.

    A. 0.2 mm

    B. 0 mm

    C. 0.8 mm

    D. 1.6 mm

    E. 0.1 mm

13. There are two identical isolated piston chambers with oxygen at normal conditions. The first one is adiabatically heated, so the gas temperature is increased two times. The second one is isobarically heated so that the gas temperature is also increased two times. Select the correct relation between the internal energies of the gas in the two chambers.

    A. $U_1 = U_2$

    B. $2\,U_1 = U_2$

    C. $U_1 = 2\,U_2$

    D. $4\,U_1 = U_2$

    E. $U_1 = 4\,U_2$

14. A 10 kg box slides horizontally without friction at a speed of 1 m/s. At on point, a constant force is applied to the box in the direction of its motion. The box travels 5 m with the constant force applied. The force is then removed, leaving the box with the speed of 2 m/s. Which of the following gives the magnitude of the applied force?

    A. 1 N

    B. 2 N

    C. 3 N

    D. 4 N

    E. 5 N

15. Three charges, $+q$, $+q$ and $-q$ in vacuum form an equilateral triangle with the side of length a. What is the electric field in the center of the triange? Here ε_0 is vacuum permittivity.

    A. $3q^2/4\pi\varepsilon_0 a^2$

    B. $3q^2/8\pi\varepsilon_0 a^2$

    C. $9q^2/4\pi\varepsilon_0 a^2$

    D. $9q^2/8\pi\varepsilon_0 a^2$

    E. $3q^2/2\pi\varepsilon_0 a^2$

4 Molecular Biology

16. The text AUUCGCGUAUUAGCC may indicate

    A. sequence of aminoacids in a protein

    B. sequence of nucleotides in RNA

    C. sequence of nucleotides in DNA

    D. typical promoter region

    E. typical ribosome binding site

17. Bacterial RNA polymerase has which the following activities?

    A. addition of a deoxyribonucleotide to the 3'-end of RNA

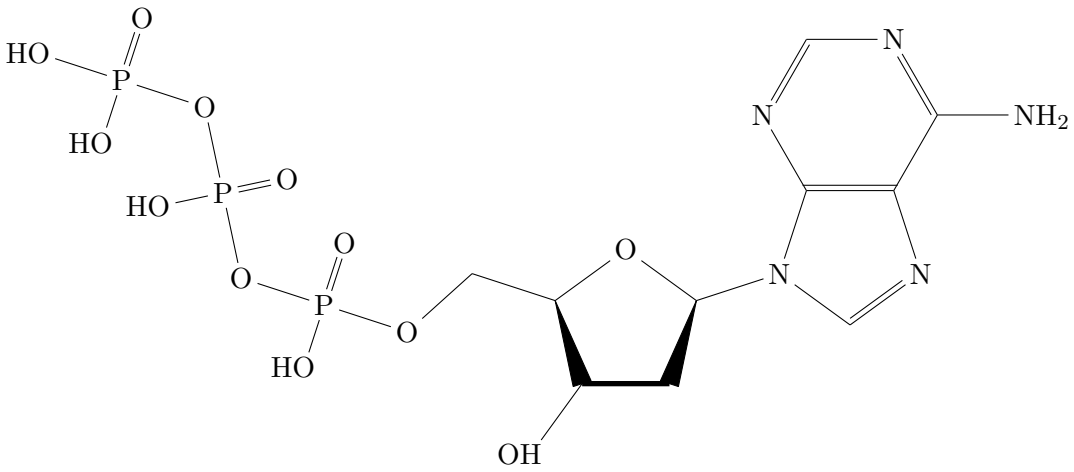
    B. addition of a ribonucleotide to the 5'-end of DNA

    C. addition of a ribonucleotide to the 3'-end of DNA

    D. removal of a ribonucleotide from the 3'-end of RNA

    E. addition of a ribonucleotide to another ribonucleotide

18. What is depicted below?



A. dATP

B. GDP

C. ATP

D. cAMP

E. UTP

19. Lactose operone is regulated by

A. a repressor whose binding to the small molecule is anticooperative (mutually exclusive) with binding to DNA and an activator whose binding to another small molecule is cooperative with (stimulates) binding to DNA

B. a repressor whose binding to the small molecule is anticooperative (mutually exclusive) with binding to DNA and an activator whose binding to another small molecule is anticooperative (mutually exclusive) with binding to DNA

C. a repressor whose binding to the small molecule is cooperative with (stimulates) binding to DNA and an activator whose binding to another small molecule is cooperative with (stimulates) binding to DNA

D. a repressor whose binding to the small molecule is cooperative with (stimulates) binding to DNA and an activator whose binding to another small molecule is anticooperative (mutually exclusive) with binding to DNA

E. binding of lactose to the RNA polymerase sigma subunit

20. What is the main function of tRNA?

A. to carry amino acids corresponding to the tRNA anticodon to the ribosome for inclusion into the protein being synthesized

B. to terminate protein synthesis

C. to terminate transcription

D. to regulate binding of repressor proteins to operator sequences

E. to transfer glucose and lactose

5 General Biology

21. What is the stage of the cell cycle shown in the pictire?

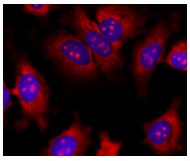
A. Prometaphase
B. Metaphase
C. Anaphase
D. Telophase and cytokinesis
E. None of the above

22. Which of the following is NOT synthesized by the human pituitary gland?
    A. Growth hormone
    B. Oxytocin
    C. Luteinizing hormone
    D. Prolactin
    E. Thyroid-stimulating hormone

23. Transmission of the nervous impuls across the axon is unidirectional because
    A. the brief refracrory period prevents depolarization in the direction from which the impuls came
    B. the nodes of Ranvier support conduction only in one direction
    C. the body of the neurone has a higher potential then the tipof the axon
    D. ions can flow across the axon only in one direction
    E. voltage sensitive sodium and potassiom channels have a polarity and are oriented across the axis of axon in such a way that ony one direction of propagation of the signal is possible

24. Build the genetic map of the chromosome based on the recombination frequencies of the linked genes: A,B,C and D A-D 4%, A-C 14%, A-B 12%, C-D 18%, D-B 16%.
    A. A B C D
    B. A D C B
    C. D A B C
    D. B D C A
    E. D C B A

25. Bright red dots in the pictire are



    A. Centrioles
    B. Lysosomes
    C. Mitochondria
    D. Nucleoli
    E. Lysosomes

Neurobiology

26. The nucleus in the thalamus that contains a map of the hand

A. Is called VPL

B. Is located in the cerebellum

C. Is convoluted

D. Does not exist because the hand is not represented in the thalamus

E. Contains only cholinergic neurons

27. Excitatory neurons

A. Are found only in the cortex

B. Use GABA as their neurotransmitter

C. Are vastly different from pyramidal cells

D. Excite their target neurons

E. Are active only during sleep

28. Muscle spindles

A. Slowly rotate

B. Are receptors located in muscles

C. Have low sensitivity to vibration

D. Are short bursts of discharges ("spindles") that occur under anesthesia

E. Represent obsolete terminology

29. Proprioception

A. Is generated by the visual system

B. Is generated by rods and cones

C.Neverreachessomatosensorycortex

D.Isrelatedtorewardpredictionerror

E.Canbegeneratedbymusclespindles

30. Motoneurons

A. Receive tonic spikes from the striatum

B. Develop only smooth tetanus when electrically stimulated

C. Innervate muscles

D. Contain actin and myosin

E. Respond only to dopamine