Biology

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1. A method called PCR is employed to:

    1) clone cells
    2) introduce DNA into cells
    3) cleave DNA
    4) copy specific DNA sequences
    5) produce recombinant RNA

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2. Ribosomal units are assembled in:

    1) cisternae
    2) nuclei
    3) Golgi complex
    4) centrioles
    5) nucleoli

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3. A chromosome map unit is called:

    1) centimendel
    2) milistern
    3) miliclintock
    4) centimorgan
    5) centisutton

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4. Simple diffusion:

   A) acts against concentration gradient
   B) may be enhanced with increased temperature
   C) transports charged particles
   D) is a passive process

    1) C, D are valid
    2) A, B, C are valid
    3) B, D are valid
    4) A, B, D are valid
    5) only D is valid

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5. How many chromatids are found in human diploid cell in G2 phase?

    1) 84
    2) 23
    3) 92
    4) 69
    5) 46

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6. In replication of DNA, the helix is opened and unwound by:

   1) endonuclease
   2) polymerase
   3) helicase
   4) methylase
   5) ribase

7. Basal bodies are not associated with:

   1) microtubules
   2) tubulin
   3) centrioles
   4) fungal cells
   5) animal cells

8. Crossing over occurs in:

   1) prophase of the 1st meiotic division
   2) prophase of both the 1st and the 2nd meiotic division
   3) metaphase of the 2nd meiotic division
   4) metaphase of the 1st meiotic division
   5) prophase of the 2nd meiotic division

9. Plasmids:

   1) belong to prokaryotic organelles
   2) exist in all bacterial cells
   3) represent self-replicating RNA molecules
   4) are required for bacterial reproduction
   5) are small circular DNA molecules

10. The term glycocalyx refers to:

    1) glycoprotein-polysaccharide layer on the surface of plasma membrane
    2) carbohydrate metabolism of bacteria
    3) composition of lysosomal membrane
    4) plant cell wall
    5) a set of glycoproteins in the membrane of endoplasmic reticulum

11. Among discrete human traits is(are) included:

    A) cleft chin
    B) blood pressure
    C) color of the skin
    D) height

    1) only C is valid
    2) only A is valid
    3) A, D are valid
    4) A, C, D are valid
    5) A, B, D are valid

12. Choose dominantly heritable single-gene conditions:

A) Hungtington´s chorea
B) Tay-Sachs disease
C) Rett syndrome
D) cystic fibrosis

    1) B, D are valid
    2) C, D are valid
    3) A, B, C are valid
    4) A, B, D are valid
    5) A, C are valid

13. In eukaryotes, "stop" codons are:

A) UAG
B) UAA
C) UGA
D) UGG

    1) B, C are valid
    2) A, C, D are valid
    3) B, C, D are valid
    4) A, B, C are valid
    5) A, B, D are valid

14. Choose the <u>incorrect</u> statement:

    1) mitotic spindle is formed from microtubules
    2) cytokinesis of plant cells occurs via contractile ring
    3) the longest phase of the cell cycle is G_1
    4) chromosomes are visible in M phase
    5) during S phase, DNA is replicated

15. Choose a bacterial disease:

    1) rabies
    2) diphteria
    3) measles
    4) mumps
    5) polio

16. In X-linked recessive inheritance:

    1) one allele is sufficient for phenotypic expression of the trait
    2) females never express the trait
    3) female to male transmission occurs
    4) ratio between males and females expressing the trait is equal
    5) direct male to male transmission occurs

17. Glyoxisomes are found in:

     1) none of the mentioned options
     2) plant cells
     3) animal cells
     4) viruses
     5) prokaryotes

18. The random loss of alleles in a population is called:

     1) migration
     2) random selection
     3) genetic drift
     4) mutation
     5) gene flow

19. Lyonization:

     1) is detectable in adulthood in all women
     2) results in appearance of Barr bodies in both sexes
     3) is the mechanism explaining X chromosome inactivation
     4) occurs both in males and females
     5) represents a pathological condition

20. A phage integrated into a cellular genome is called:

     1) virulent virus
     2) microphage
     3) lytic virus
     4) provirus
     5) virion

21. Mitochondrial enzymes for oxidative metabolism are:

     1) in the thylakoid membrane
     2) located in intermembrane space
     3) anchored in the stroma
     4) floating freely in the matrix
     5) on or with the surface of cristae

22. Plasmorhisis describes behavior of:

     1) plant cells in concentrated salty water
     2) fungal cells in any water solution
     3) animal cells in concentrated salty water
     4) plant cells in distilled water
     5) animal cells in distilled water

23. Eukaryotic DNA enwraps around proteins to form:

　　1) nucleic acids
　　2) nucleotides
　　3) nucleoli
　　4) nuclei
　　5) nucleosomes

24. Prokaryotic DNA:

A) is naked
B) is circular
C) is smaller than eukaryotic one
D) occurs in the nucleus

　　1) A, D are valid
　　2) A, B, C are valid
　　3) B, C, D are valid
　　4) A, C are valid
　　5) all (A-D) are valid

25. The first scientist to observe cells with a light microscope was:

　　1) J. G. Mendel
　　2) L. Pasteur
　　3) A. van Leuwenhoek
　　4) M. Schleiden
　　5) R. Hook

26. Let us have a reaction of ethanol with benzoic acid under optimal conditions. Which of the following can contribute to an increased yield of this reaction?

A) a removal of ethyl benzoate
B) an addition of corresponding enzyme
C) an increase in pressure
D) an addition of water

   1) none (A-D) is valid
   2) only A is valid
   3) B, D are valid
   4) A, C are valid
   5) only D is valid

27. Choose (a) correct statement/s on the reaction:
       $2\,SO_2 + O_2 \rightarrow 2\,SO_3$ (reaction heat $\Delta H < 0$)
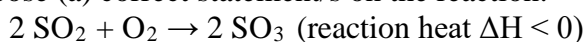
A) oxygen is donor of electrons
B) sulphur dioxide is a reducing agent
C) heat is released
D) heat is absorbed in this reaction

   1) A, D are valid
   2) A, B, D are valid
   3) B, D are valid
   4) A, B, C are valid
   5) B, C are valid

28. Four mL of $H_2\,SO_4$ stock solution (c=0.005 mol/L) were diluted by distilled water to a final volume 25 mL. What is the pH of the final solution?

   1) 0.3
   2) 4.3
   3) 2.8
   4) 4.6
   5) 3.1

29. The compound with the summary formula C_3H_6O could be named:

A) ethyl methyl ether
B) propenol
C) propanal
D) vinyl alcohol

   1) only D is valid
   2) A, B are valid
   3) A, B, C are valid
   4) B, C are valid
   5) B, D are valid

30. Choose the conjugated acid to HPO_4^{-2} (according to the Brønstedt-Lowry concept):

   1) H_2O
   2) $H_2PO_4^-$
   3) H_3PO_4
   4) H^+
   5) PO_4^{-3}

31. What is the oxidation number of phosphorus in $K_4P_2O_7$?

   1) 8
   2) 7
   3) 10
   4) 3
   5) 5

32. The most probable reaction of butanone will be:

   1) esterification
   2) electrophilic substitution
   3) oxidation
   4) polymerization
   5) reduction

33. Choose the compounds with the same number of nitrogen atoms in their molecules:

   A) 2, 4, 6-trinitrotoluene
   B) cytosine
   C) pyridine
   D) ammonium nitrate

      1) A, B, D are valid
      2) A, D are valid
      3) C, D are valid
      4) A, B are valid
      5) B, C are valid

34. Which of the following salts is dissolved in distilled water to form an alkaline solution?

      1) iron(II) nitrate
      2) ammonium chloride
      3) sodium sulphate
      4) silver iodide
      5) potassium cyanide

35. Choose the weakest acid from those mentioned bellow:

      1) HNO_3
      2) HCl
      3) HF
      4) HBr
      5) $HClO_3$

36. Fifty mL of the blood serum contain 0.3 mg of bilirubin. Calculate the concentration of bilirubin in $\mu mol/L$. (m. w. bilirubin = 585)

    1) 0.026
    2) 10.26×10^3
    3) 0.01
    4) 10.26
    5) 2.57×10^{-5}

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37. Reaction of ethanal with ethanol:

A) could result in the formation of hemiacetal
B) results in the formation of diethyl ether
C) results in the formation of ethyl acetate
D) is an example of electrophilic substitution

    1) B, C are valid
    2) only A is valid
    3) only D is valid
    4) B, D are valid
    5) A, C are valid

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38. The tertiary structure of proteins could be stabilised by:

A) formation of hemiacetals
B) disulphide bonds
C) electrostatic interactions
D) hydrophobic interactions

    1) all (A-D) are valid
    2) C, D are valid
    3) only A is valid
    4) B, C, D are valid
    5) B, D are valid

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39. Choose the most electropositive element from those mentioned bellow:

    1) magnesium
    2) barium
    3) silicon
    4) lead
    5) tin

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40. Glucose:

A) is a component of sucrose
B) could be reduced to an alcohol
C) is an aldopentose
D) is a ketohexose

    1) A, B are valid
    2) A, C are valid
    3) only D is valid
    4) A, B, D are valid
    5) B, C are valid

41. Choose (a) compound/s that can form cis-trans isomers:

A) propenoic acid
B) isoprene
C) but-2-ene
D) but-2-yne

1) none (A-D) is valid
2) only D is valid
3) only C is valid
4) A, B, C are valid
5) A, B are valid

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42. CH_3-CH_2-CO-CH_2-CH_3 could be named:

A) pentan-3-one
B) ethoxy propene
C) ethyl propanoate
D) diethyl ketone

1) only B is valid
2) A, D are valid
3) only C is valid
4) only D is valid
5) A, B are valid

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43. $CH_2 = CH- COO - CH_3$ is:

A) a derivative of propenoic acid
B) a ketone
C) an ester
D) an anhydride

1) A, D are valid
2) A, C are valid
3) only B is valid
4) only A is valid
5) only D is valid

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44. Sodium carbonate:

A) is known as baking soda
B) is an oxidising agent
C) is insoluble in water
D) forms an alkaline solution in water

1) A, C are valid
2) none (A-D) is valid
3) B, D are valid
4) only A is valid
5) only D is valid

45. Phenol:

    A) is a derivative of benzene
    B) is oxidised to benzaldehyde
    C) is oxidised to quinone
    D) can dissociate

        1) A, B are valid
        2) only D is valid
        3) A, D are valid
        4) A, C are valid
        5) none (A-D) is valid

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46. A greenish compound (3 g) was analysed. It contained 2.0526 g of chromium and 0.9474 g of oxygen. Calculate the simplest formula of this compound. A.m.: O = 16.0; Cr = 52.0.

        1) Cr_2O_7
        2) Cr_2O_3
        3) CrO
        4) Cr_2O
        5) CrO_3

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47. Calculate the **pH** of NaOH solution with c = 40 µmol/L.

        1) 10.4
        2) 4.4
        3) 11.3
        4) 9.6
        5) 11.6

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48. Barium sulphide will be prepared by reduction of barium sulphate by carbon. How many **grams** of barium sulphate would you weigh to prepare 25 g of barium sulphide? A.m.: Ba = 137; S = 32; O = 16; C = 12

        1) 11.5
        2) 69.0
        3) 22.9
        4) 45.8
        5) 34.5

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49. Choose a heterocycle that is present in the molecule of thymine:

        1) imidazole
        2) purine
        3) pyridine
        4) pyrimidine
        5) indol

50. Balance given redox reaction:

potassium permanganate + hydrochloric acid → Cl_2 + manganese(II) chloride + potassium chloride + water

   1) 2, 16 → 5, 2, 2, 8
   2) 1, 8 → 2, 1, 1, 4
   3) 3, 16 → 3, 4, 2, 12
   4) 2, 10 → 5, 2, 2, 8
   5) 2, 5 → 3, 1, 2, 4

Physics

Use only the values of constants provided in the test. Round the final result, not the partial result in the middle of your calculations. The result should be rounded to three valid digits if not specified otherwise. The results have to be presented in the main (derived SI) physical units if not specified otherwise.

Use these constants:

$(pi) = 3.14$

$g = 9.81$ m.s^{-2}

$R = 8.314$ J.K^{-1}.mole^{-1}

$k = 1.381*10^{-23}$ J.K^{-1}

$0\,^oC = 273.15$ K

$e = 1.602*10^{-19}$ C

$h = 6.63*10^{-34}$ J.s

$m_e = 9.11*10^{-31}$ kg

relative atomic mass of oxygen $= 16$

relative atomic mass of nitrogen $= 14$

Avogadro's number $= 6.023*10^{23}$ mole^{-1}

permittivity of vacuum $= 8.854*10^{-12}$ F.m^{-1}

specific heat capacity of water $= 4186$ J.K^{-1}.kg^{-1}

specific melting heat of ice $= 334\,000$ J.kg^{-1}

density of water $= 1000$ kg.m^{-3}

density of iron $= 7860$ kg.m^{-3}

refractive index of water $= 1.5$

speed of light in air $= 3*10^8$ m.s^{-1}

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51. What is the critical angle for total internal reflection when light of wavelength 550 nm travels through plastic (a refractive index 1.2) to air (a refractive index 1.0)?

    1) 0.675 rad
    2) 0.598 rad
    3) 0.895 rad
    4) 0.985 rad
    5) no answer is correct

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52. An electron, initially at rest, is accelerated by a 10 kV accelerating potential. What is the change in kinetic energy of the electron?

    1) $5.2*10^{-16}$ J
    2) no answer is correct
    3) $1.6*10^{-15}$ J
    4) $3.2*10^{-13}$ J
    5) $2.6*10^{-14}$ J

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53. What is the mass of 1000 m^3 of ideal gas at normal atmospheric pressure (101.3 kPa) at 20 ^oC if the gas is composed of 21 % oxygen and 79 % nitrogen?

    1) 1200 kg
    2) 1100 kg
    3) 1400 kg
    4) no answer is correct
    5) 1300 kg

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54. What is the wavelength of X-ray of energy 100 keV in air?

   1) $2.34*10^{-11}$ m
   2) no answer is correct
   3) $3.44*10^{-10}$ m
   4) $1.24*10^{-11}$ m
   5) $4.54*10^{-12}$ m

55. A muscle cell has a potential difference of -90 mV between the inside and outside of the cell membrane (inside is negatively charged). How much energy is required to pump a single Na^+ ion from the inside to the outside of the cell?

   1) $355*10^{-23}$ J
   2) no answer is correct
   3) $233*10^{-19}$ J
   4) $433*10^{-14}$ J
   5) $144*10^{-22}$ J

56. How long is a simple pendulum with a period of 2 s?

   1) 0.665 m
   2) no answer is correct
   3) 0.775 m
   4) 0.995 m
   5) 0.885 m

57. An object is placed 0.25 m away from a lens. The lens forms an image that is 0.02 m away from the lens, inverted, and on the opposite side of the lens as the object. What is the optical power of the lens?

   1) 24 D
   2) no answer is correct
   3) 45 D
   4) 54 D
   5) 36 D

58. Your coffee is too hot to drink at 80 °C, you need to cool it to 50 °C. What mass of ice cube (0 °C) do you need to add to it to achieve the required temperature? The mass of coffee is 300 g.

   1) 78.4 g
   2) 54.7 g
   3) no answer is correct
   4) 69.3 g
   5) 87.5 g

59. A man pushes on a car of mass 500 kg with a force 400 N and moves it 10 m (in the direction of the force). What is the final speed of the car?

    1) 5 m/s
    2) no answer is correct
    3) 7 m/s
    4) 4 m/s
    5) 6 m/s

60. A sphere of iron is hung on a rope and whole volume is submerged in the water. The tension force in the rope is 100 N less when the sphere is submerged in the water than it is not (it is in air). Calculate the radius of the sphere. A buoyancy force in air is negligible.

    1) no answer is correct
    2) 14.3 cm
    3) 41.3 cm
    4) 34.1 cm
    5) 13.5 cm

Mathematics

61. Find the radius of a circle which is given by the equation $x^2 - 4x + y^2 - 6y - 12 = 0$

    1) 7
    2) 6
    3) 5
    4) 3
    5) 4

62. Find the term independent of x in the expansion $\left(\dfrac{3}{x^3} - \dfrac{x}{3}\right)^8$

    1) 28/81
    2) 28/55
    3) 56/81
    4) no answer is correct
    5) 32/55

63. Simplify the formula: $\dfrac{\sin 2x \cdot \cos 2x}{(1+\tan x)\cdot(1-\cotan x)\cdot\sin^2 x\cdot\cos^2 x}$

    1) 3
    2) -2
    3) -0.5
    4) 2
    5) 1.5

64. The intensity of light I in an absorber decreases in distance d (in meters) according to the formula: $I = I_0 \cdot e^{-10d}$ where I_0 is the original intensity ($d = 0$). Find the distance d for which the intensity decreases by 25 %.

    1) 0.025
    2) 0.0122
    3) 0.0288
    4) no answer is correct
    5) 0.0345

65. Find an area of a perpendicular triangle in the plane xy, which sides are a parts of lines $x = -4$, $y = 0$ and $4y + 3x - 12 = 0$

    1) 36
    2) no answer is correct
    3) 12
    4) 24
    5) 48

66. Find the y coordinate of a point of the cycle $x^2 + y^2 - 6x - 8y = 0$ in the plane xy which has a maximal distance from the point $(3,10)$.

    1) -3
    2) 2
    3) -1
    4) 5
    5) 1

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67. Find the slope of the tangent to the function $y = 2x^3 - 3x^2 - 2x + 5$ at the point $(1, -3)$.

    1) -5
    2) -2
    3) -4
    4) no answer is correct
    5) -3

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68. Find the acute („sharp") angle between two lines $x - y = 3$, $2y + x = 6$

    1) 47.6 º
    2) 71.6 º
    3) 68.6 º
    4) 56.6 º
    5) no answer is correct

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69. Let us have 12 coloured balls, 3 of them are white. In how many ways can group of 4 balls be selected to include at least one white ball?

    1) 189
    2) 369
    3) 254
    4) 495
    5) no answer is correct

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70. The car moves with a constant acceleration and its path is described by the equation $d = 10t^2 + 20t$, where d is the distance in meters and t is the time in seconds. Find its velocity (in m.s^{-1}) at time $t = 5$ s after flying start.

    1) 120
    2) no answer is correct
    3) 350
    4) 240
    5) 175