KVPY-SA-2016 (BIOLOGY)

PART-I

1. What is the length of human DNA containing 6.6×10^9 bp?
(A) 22 nm (B) 0.22 nm
(C) 2.2 m (D) 22 m

2. The *Diptheria*, *Pertussis* ,*Tetanus* (DPT) vaccine consists of
(A) live attenuated strains of *Diptheria*, *Pertussis*, *Tetanus*
(B) toxoid of *Diptheria*, *Tetanus* , and heat killed whole cells of *Pertussis*
(C) whole cell lysate of *Diptheria*, *Pertussis*, *Tetanus*
(D) heat killed strains of *Diptheria*, *Pertussis*, *Tetanus*

3. Which of the following is NOT an enzyme?
(A) Lipase (B) Amylase
(C) Trypsin (D) Bilirubin

4. The pH of the avian blood is maintained by
(A) HCO_3^- (B) $H_2PO_4^-$
(C) CH_3COO^- (D) Cl^-

5. Podocyte layer that provides outer lining to the surface of glomerular capillaries are found in
(A) bowman's capsule (B) loop of Henle
(C) renal artery (D) ureter

6. If a dsDNA has 20% adenine, what would be its cytosine content?
(A) 20% (B) 30%
(C) 40% (D) 80%

7. Which one of the following is incapable of curing Pellagra?
(A) Niacine (B) Nicotine
(C) Nicotinamide (D) Tryptophan

8. In *Escherichia coli*, how many codons code for the standard amino-acids?
(A) 64 (B) 60
(C) 61 (D) 20

9. *Bombyx mori* (silk worm) belongs to the order
(A) Lepidoptera (B) Diptera
(C) Hymenoptera (D) Coleoptera

10. The source of mammalian hormone "Relaxin" is
(A) ovary (B) stomach
(C) intestine (D) pancreas

11. Which one of the following animals is a connecting link between reptiles and mammals?
(A) Platypus (B) Bat
(C) Armadillo (D) Frog

12. What is the number of chromosomes in an individual with Turner's syndrome?
(A) 44 (B) 45
(C) 46 (D) 47

13. Chipko movement in the year 1974 in Garhwal Himalayas involved
(A) protecting tigers
(B) preventing soil erosion by planting trees
(C) preventing pollution by closing down industries
(D) hugging trees to prevent the contractors from felling them

14. Which of the following amino acids is NOT involved in gluconeogenesis?
(A) Alanine (B) Lysine
(C) Glutamate (D) Arginine

15. Which of the following entities causes syphilis?
(A) *Treponema pallidum* (B) *Neisseria gonorrhoea*
(C) *HIV* (D) *Hepatitis B*

PART-I

16. The atmospheric pressure is 760 mm Hg at the sea level. Which of the following ranges is nearest to the partial pressure of CO_2 in mm Hg?
(A) 0.30–0.31 (B) 0.60–0.61
(C) 3.0–3.1 (D) 6.0–6.1

17. A breeder crossed a pure bred tall plant having white flowers to a pure bred short plant having blue flowers. He obtained 202 F1 progeny and found that they are all tall having white flowers. Upon selfing these F1 plants, he obtained a progeny of 2160 plants. Approximately, how many of these are likely to be short and having blue flowers?
(A) 1215 (B) 405
(C) 540 (D) 135

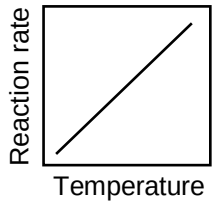
18. Match the different types of heart given in column A with organisms given in the column B. Choose the correct combination.

	Column A		Column B
P	Neurogenic heart	(i)	Human
Q	Bronchial heart	(ii)	King crab
R	Pulmonary heart	(iii)	Shark

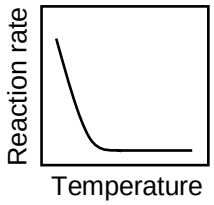
(A) P-(ii), Q-(iii), R-(i) (B) P-(iii), Q-(ii), R-(i)
(C) P-(i), Q-(iii), R-(ii) (D) P-(ii), Q-(i), R-(iii)

19. Given below are the four schematics that describe the dependence of the rate of an enzymatic reaction on temperature. Which of the following combinations is true for thermophilic and psychrophilic organisms?

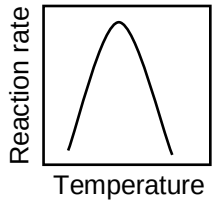
P.



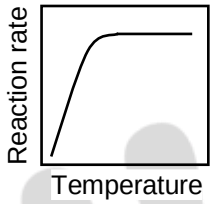
Q.



R.



S.



(A) P and P
(B) P and S
(C) P and R
(D) R and R

20. Match the enzymes in Group I with the reactions in Group II. Select the correct combination.

	Group I		**Group II**
P	Hydrolase	(i)	Inter-conversion of optical isomers
Q	Lyase	(ii)	Oxidation and reduction of two substrates
R	Isomerase	(iii)	Joining of two compounds
S	Ligase	(iv)	Removal of a chemical group from a substrate
		(v)	Transfer of a chemical group from one substrate to another

(A) P-(iv), Q-(ii), R-(iii), S-(i)
(B) P-(v), Q-(iv), R-(i), S-(iii)
(C) P-(iv), Q-(i), R-(iii), S-(v)
(D) P-(i), Q-(iv), R-(v), S-(ii)

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ANSWER KEYS

1. (C)	2. (B)	3. (D)	4. (A)	5. (A)	6. (B)	7. (B)	8. (C)	9. (A)	10. (A)
11. (A)	12. (B)	13. (D)	14. (B)	15. (A)	16. (A)	17. (D)	18. (A)	19. (D)	20. (B)

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Solution
Part - I

1. (C)
The distance between two consecutive base pairs is 0.34 nm (0.34×10^9 m). The length of DNA for human diploid cell is 6.6×10^9 bp $\times$ 0.34×10^9 m =2.2 metres. This length is far greater than the dimension of a typical nucleus which is approximately 10*6 m. The long-sized DNA can be accommodated in the small area only through packaging or compaction.

2. (B)
The DPT vaccine or DTP vaccine is a class of combination vaccines against three infectious diseases in humans: diphtheria, pertussis (whooping cough), and tetanus. The vaccine components include diphtheria and tetanus toxoids and either killed whole cells of the bacterium that causes pertussis or pertussis antigens. The doses are given at two, four, and six months of age and at 17 to 20 months of age.

3. (D)
Enzymes are biological catalysts which catalyze biochemical reactions during cellular metabolism. The enzymes are mostly made up of proteins except for a small minority of catalytic RNA molecules.
Amylase digests carbohydrates, lipase digests fats, and trypsin digests proteins. These digestive enzymes are released from the cells of the Acini and flow into the pancreatic duct.
Bilirubin (BR) is a yellow compound that occurs in the normal catabolic pathway that breaks down heme in vertebrates.

4. (A)
The bicarbonate buffer system is an acid-base mechanism involving the balance of carbonic acid (H_2CO_3), bicarbonate ion (HCO_3^-), and carbon dioxide (CO_2) in order to maintain pH in the blood and duodenum, among other tissues, to support proper metabolic function. Catalyzed by carbonic anhydrase, carbon dioxide (CO_2) reacts with water (H_2O) to form carbonic acid (H_2CO_3), which in turn rapidly dissociates to form a bicarbonate ion (HCO_3^-) and a hydrogen ion (H^+) in As with any buffer system. The pH is balanced by the presence of both a weak acid(for example, H_2CO_3) and its conjugate base (for example, HCO_3^-) so that any excess acid or base introduced to the system is neutralized. Failure of this system to function properly results in acid-base imbalance such as acidemia (pH<7.35) and alkemia (pH>7.45) in the blood.

5. (A)
Podocytes are cells in the Bowman's capsule in the kidneys that wrap around capillaries of the glomerulus. Podocyte cells make up the epithelial lining of Bowman's capsule, the third layer through which filtration of blood takes place. The Bowman's capsule filters the blood, retaining large molecules such as proteins while smaller molecules such as water, salts, and sugars are filtered as the first step in the formation of urine.

6. (B)

According to Chargaff's rule, the DNA has equal ratio of pyrimidine (cytosine and thymine) and purine (adenine and guanine). In DNA, the number of adenine is equal to thymine, that is A = T. Similarly, the number of guanine is equal to cytosine, that is G = C. In the given problem, adenine content is 20%. Hence, thymine content will be 20%. Hence, the percentage of A + T content is 40%. Also, the percentage of C + T content will be 60%. Out of this 60%, 30% will be cytosine content and remaining 30% will be guanine content.

7. (B)

Pellagra is a disease caused by a lack of the vitamin niacin (vitamin B_3). Symptoms include inflamed skin, diarrhoea, dementia, and sores in the mouth. Areas of the skin exposed to either sunlight or friction are typically affected first. Treatment is with either niacin or nicotinamide supplementation. Nicotinamide is another form of vitamin B_3.

8. (C)

The genetic code is degenerate. Some amino acids are encoded by more than one codon. As we know, there are 64 possible base triplets and only 20 amino acids. In fact, 61 of the 64 possible triplets specify particular amino acids and 3 triplets (called stop codons) designate the termination of translation. In *E. coli*, a total of 40 different tRNAs are used to translate the 61 codons.

9. (A)

Bombyx mori, the silkworm, belongs to the order Lepidoptera in the phylum Arthropoda. Its larvae, which feed on mulberry leaves, are farmed for the production of silk (sericulture) and are thus of great economic importance. Although, before the Neolithic age, silk moths were unlikely to have been domestically bred.

10. (A)

Relaxin is a hormone produced by the ovary and the placenta with important effects in the female reproductive system and during pregnancy. In preparation for childbirth, it relaxes the ligaments in the pelvis and softens and widens the cervix. Relaxin also promotes the development of the nipples and mammary glands in pregnant mammals. Because of these effects, relaxin was initially thought to serve only as a pregnancy hormone.

11. (A)

The duck-billed platypus is a semi-aquatic egg-laying mammal found in Tasmania and Australia. It swims with the help of its webbed feet and flattened tail. It has mammary glands but lacks nipples. It is a connecting link between reptiles and mammals as it has both characteristics of reptiles and mammals.

12. (B)

The chromosomes contain genes, which determine an individual's characteristics, such as eye color and height. Girls typically have two X chromosomes (or XX), but girls with Turner syndrome have only one X chromosome or a part of one X chromosome missing. While most people have 46 chromosomes, people with Turner syndrome usually have 45. Signs and symptoms vary among those affected. Often, a short and webbed neck, low-set ears, low hairline at the back of the neck, short stature, and swollen hands and feet are seen at birth.

13. (D)

Chipko movement in the year 1974 in Garhwal Himalayas involved hugging trees to prevent the contractors from felling them. This movement was started in March 1974 in Gopeshwar in Chamoli District and was headed by Chandi Prasad Bhatt of Gopeshwar and Sunder Lal Bahuguna of silyara in Tehri region. It was started for protecting trees. Local women showed enormous bravery in protecting trees from the axe of contractors by hugging them. People all over the world have acclaimed the Chipko Movement.

14. (B)

The primary carbon skeletons used for gluconeogenesis are derived from pyruvate, lactate, glycerol, and the amino acids alanine and glutamine. The liver is the major site of gluconeogenesis, the kidney and the small intestine also have important roles to play in this pathway.

Ketogenic amino acids are unable to be converted to glucose as both carbon atoms in the ketone body are ultimately degraded to carbon dioxide in the citric acid cycle. In humans, two amino acids – leucine and lysine – are exclusively ketogenic.

15. (A)

Syphilis is a sexually transmitted infection (STI) caused by a type of bacteria known as Treponema pallidum. Syphilis is only spread through direct contact with syphilitic chancres. It can't be transmitted by sharing a toilet with another person, wearing another person's clothing, or using another person's eating utensils. The first sign of syphilis is a small, painless sore. It can appear on the sexual organs, rectum, or inside the mouth.

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PART-II

16. (A)
The partial pressure of carbon dioxide in the blood of the capillary is about 45 mm Hg, whereas its partial pressure in the alveoli is about 40 mm Hg.

17. (D)
In a dihybrid cross, the ratio of F2 generation is 9:3:3:1.
Here, 9 = white flowered and tall plants
3 = white flowered and dwarf plants
3 = blue flowered and tall plants
1 = blue flowered and dwarf plants
If the total number of F2 progeny is 2016, then the number of short plants with blue flowers (double) recessive will be 1*2160/16, which is 135 plants.

18. (A)
P. Neurogenic heart is the heart which contracts in response to a nerve impulse or stimulus. It is found in crustaceans such as King crab.
Q. Bronchial heart is also known as myogenic heart which contracts on its own without any nerve impulse. It is found in Shark.
R. Pulmonary heart has two types of circulation in which deoxygenated blood is carried away from the heart to lungs where it becomes oxygenated and returns to the heart. From the heart, the oxygenated blood is circulated in the body. Such a type of heart is found in Humans.

19. (D)
Thermophiles are living at very high temperature while psychrophiles live in the range of –20°C to +10°C. The rate of an enzyme-catalyzed reaction increases as the temperature is raised. A ten degree Centigrade rise in temperature will increase the activity of most enzymes by 50 to 100%. Variations in reaction temperature as small as 1 or 2 degrees may introduce changes of 10 to 20% in the results. In the case of enzymatic reactions, this is complicated by the fact that many enzymes are adversely affected by high temperatures. The reaction rate increases with temperature to a maximum level, then abruptly declines with further increase of temperature. Because most animal enzymes rapidly become denatured at temperatures above 40°C, most enzyme determinations are carried out somewhat below that temperature.

20. (B)
Hydrolase is an enzyme that catalyzes the hydrolysis of a chemical bond. Enzymatic hydrolysis is a process in which enzymes facilitate the cleavage of bonds in molecules with the addition of the elements of water.
Isomerases catalyze transfer of groups within molecules to obtain their isomers.
Ligases catalyze synthesis of one compound by two or more substrates via formation of C-C, C-S, C-O, and C-N bonds by the condensation reactions and utilizes ATP.
Lyases catalyze addition of groups to double bonds and thus forming single bonds or formation of double bonds by removal of groups.