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SECTION – I

BIOLOGY

BIOCHEMISTRY: NUMBER OF QUESTIONS ASKED IN IIT JAM EXAM (2005 to 2025)

TOPIC	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1 Structure of Atoms, molecules, bonds and interactions	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	2	-	-	1
2 Acid, pH, Buffer and Solution	-	-	-	-	-	-	1	1	-	1	1	-	1	-	-	-	2	-	-	1	1
3 Thermodynamics	-	-	2	1	1	1	1	1	1	2	-	-	-	-	-	1	-	1	-	3	1
4 Amino acids	1	3	1	1	2	-	1	1	-	-	-	1	-	1	-	-	-	-	1	-	-
5 Proteins	1	-	-	-	1	1	-	-	-	3	-	1	-	1	2	-	1	-	-	-	-
6 Carbohydrates and Glycobiology	1	2	1	2	2	-	2	1	-	-	-	-	-	-	1	1	1	1	-	-	-
7 Lipids	1	-	1	-	-	1	1	1	-	1	1	-	-	-	-	1	-	-	-	-	-
8 Nucleotides and Nucleic acids	1	-	-	-	1	-	-	1	-	3	-	1	-	1	-	1	1	1	-	1	-
9 Enzymes	3	1	2	1	1	-	2	2	2	4	3	1	3	2	1	1	-	1	-	-	-
10 Metabolism	3	3	5	4	4	2	6	1	2	3	-	1	3	2	2	2	2	3	-	-	2
11 Vitamins	1	1	1	-	1	1	-	1	-	1	-	-	-	1	-	1	-	-	-	-	-

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT - 2014)

- Aqueous environment in a spherical endosome – a closed vesicle of 100 nm diameter, is at a pH 5.0, in order to denature and hydrolyze the material internalized by a cell. Assuming Avogadro's number to be 6×10^{23} , the number of free protons in an endosome is closest to
 (1) 24 (2) 3
 (3) 2400 (4) 300

(IIT JAM BT - 2014)

- The number of water molecules present in a 300 residue soluble protein of spherical shape (diameter = 2nm) having 20% (V/V) water is closest to *Assume*: density of water = 1000 kg/m^3 , Avogadro's number = 6×10^{23}
 (1) 224 (2) 9
 (3) 140 (4) 28

(IIT JAM BT - 2016)

- Which of the following statements are TRUE for hydrogen bonds? Strength of hydrogen bond is
 (1) low in a solvent of high dielectric constant
 (2) low in a solvent of low dielectric constant
 (3) lower in water as compared to organic solvents
 (4) higher in water as compared to organic

(IIT JAM BT - 2022)

- The correct statement/s for bimolecular nucleophilic substitution reactions is/are
 (1) It goes through a carbocation formation
 (2) There is an inversion of configuration if the reacting center is chiral
 (3) Reaction is enhanced when carried out in polar solvents
 (4) The reaction intermediate is trigonal bipyramidal

(IIT JAM BT - 2022)

- What is the maximum number of hydrogen bonds that a water molecule can make in the liquid state?

(IIT JAM BT - 2025)

- The correct order of electronegativity of the given elements is
 (1) $B > C > N > O > F$ (2) $F > O > N > C > B$
 (3) $F > N > O > C > B$ (4) $O > F > N > C > B$

Answer Key

1	2	3	4	5	6
2	4	1,3	2,3	4	2

EXPLANATION

1. Explanation:-

Given that pH = 5

Hence concentration of H^+ ions = $10^{-5} \text{ mol L}^{-1}$

In order to find out the number of H^+ ions, we must calculate the volume of vesicle

Volume of sphere = $\frac{4}{3} \pi r^3$ as $r = 50 \text{ nm} = 5 \times 10^{-8} \text{ m}$

So, volume = $\frac{4}{3} \times \frac{22}{7} \times 125 \times 10^{-24} \text{ m}^3 = 5.2381 \times 10^{-22} \text{ m}^3$

Consider the environment as aqueous, (so $1 \text{ m}^3 = 1000 \text{ Litre}$)

Hence, $5.2381 \times 10^{-22} \text{ m}^3 = 5.2381 \times 10^{-19} \text{ moles}$

Number of moles of H^+ inside a vesicle

= concentration $\times$ volume

= $10^{-5} \times 5.2381 \times 10^{-19}$

= $5.2381 \times 10^{-24} \text{ moles}$

No. of protons = $6 \times 10^{23} \times 5.2 \times 10^{-24}$

= 3.19×10^0

= 3 protons

2. Explanation:-

To calculate the number of water molecules present in the protein, we need to determine the volume of the protein and the volume of water in it.

Given:

Diameter of the protein = 2 nm

Volume fraction of water = 20% (V/V)

Density of water = 1000 kg/m^3

Avogadro's number = 6×10^{23}

First, let's calculate the volume of the protein.

Radius of the protein = Diameter / 2 = $2 \text{ nm} / 2 = 1 \text{ nm}$

Volume of the protein

= $\left(\frac{4}{3}\right) \times \pi \times (\text{radius})^3 = \left(\frac{4}{3}\right) \times \pi \times (1 \text{ nm})^3$

Now, let's calculate the volume of water in the protein.

Volume of water = Volume of the protein $\times$ Volume fraction of water = $\left[\left(\frac{4}{3}\right) \times \pi \times (1 \text{ nm})^3\right] \times 0.2$

Next, let's convert the volume of water to cubic meters.

$$1 \text{ nm} = 1 \times 10^{-9} \text{ m}$$

$$\text{Volume of water (in } m^3) = \text{Volume of water (in } nm^3) \times (1 \times 10^{-9})^3 = [(4/3) \times \pi \times (1 \text{ nm})^3] \times 0.2 \times (1 \times 10^{-9})^3$$

Now, let's calculate the mass of the water present in the protein.

$$\text{Mass of water} = \text{Volume of water (in } m^3) \times \text{Density of water} = [(4/3) \times \pi \times (1 \text{ nm})^3] \times 0.2 \times (1 \times 10^{-9})^3 \times 1000 \text{ kg/m}^3$$

Now, let's convert the mass of water to the number of water molecules.

Mass of water (in grams)

$$\begin{aligned} &= \text{Mass of water (in kg)} \times 1000 \\ &= [(4/3) \times \pi \times (1 \text{ nm})^3] \times 0.2 \\ &\quad \times (1 \times 10^{-9})^3 \times 1000 \\ &\quad \times 1000 \text{ grams} \end{aligned}$$

$$\begin{aligned} \text{Number of water molecules} &= \text{Mass of water (in grams)} / (\text{Molar mass of water} \times \text{Avogadro's number}) \\ &= [(4/3) \times \pi \times (1 \text{ nm})^3] \times 0.2 \times (1 \times 10^{-9})^3 \times 1000 \times 1000 \text{ grams} / (18 \text{ grams/mole} \times 6 \times 10^{23}) \end{aligned}$$

Therefore, the number of water molecules present in the protein is closest to (4) 28.

3. **Explanation:-** Option 1 is correct because hydrogen bond is an ionic interaction. We know that ionic interactions are weak in polar solvent which has high dielectric constant.

Option 3 is correct because the strength of hydrogen bond is inversely proportional to the dielectric constant. The strength of hydrogen bond is low in water compared to organic solvents because water has higher dielectric constant than organic solvents.

4. **Explanation:-**

- 1) This option is not correct because in unimolecular nucleophilic substitution reaction carbocation is formed.
- 2) This option is correct because during replacement of ligand starts in a chiral centre is needed to occur an inversion of configuration.
- 3) This option is correct because $sn2$ reaction is favourable in polar aprotic solvents like acetone, DMSO, acetonitrile etc.
- 4) This option is incorrect because the reaction intermediate in a bimolecular nucleophilic

substitution reaction is tetrahedral, not trigonal bipyramidal.

5. **Explanation:-** The maximum number of hydrogen bonds is 4 in a water molecule in a liquid state because it has two hydrogen bond donor and two hydrogen bond acceptor.
6. **Explanation:-** Electronegativity measures an atom's ability to attract electrons. it increases across a period from left to right and decreases down a group. Fluorine is the most electronegative (3.98), followed by oxygen (3.44), nitrogen (3.04), carbon (2.55), and boron (2.04). Thus, the correct order is $F > O > N > C > B$.

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT - 2011)

1. An aqueous solution contains 0.01 mol of formic acid ($pK_a = 3.8$) and 0.1 mol of sodium formate. The pH of the solution is

(1) 3.8 (2) 4.8
(3) 2.8 (4) 1.8

(IIT JAM BT - 2012)

2. pK_a of acetic acid is 4.80. A 10mL of 1M solution of acetic acid is mixed with 5mL of 1M solution of NaOH. The pH of the resulting solution is

(1) 3.2 (2) 7.0
(3) 4.8 (4) 2.4

(IIT JAM BT - 2014)

3. The pH at the equivalence point when 50mL of 0.1M Acetic acid is titrated against 0.1M NaOH is closest to

(1) 6.0 (2) 7.0
(3) 8.0 (4) 9.0

(IIT JAM BT - 2015)

4. The pH of a 0.1M solution of monosodium succinate ($pK_{a1} = 4.19$ and $pK_{a2} = 5.57$) is ____.

(IIT JAM BT - 2017)

5. The $[H^+]$ of 0.1 N acetic acid solution is 1.33×10^{-3} . The pH of the solution (correct to two decimal places) is ____.

(IIT JAM BT - 2021)

6. The molar concentration of water in pure water is _____ M (rounded -off to 1 decimal).

(IIT JAM BT - 2021)

7. 1.45 g of sucrose ($C_{12}H_{22}O_{11}$) is dissolved in 30.0 ml of water. Molality (rounded off to 3 decimals) of the resulting solution is _____ m.

(IIT JAM BT - 2024)

8. One molecule of the protein myoglobin contains one atom of iron. A myoglobin sample was found to contain 0.34% iron. The molecular weight of myoglobin is _____ $g\ mol^{-1}$ (rounded off to the nearest integer).

(Use $55.9\ g\ mol^{-1}$ as atomic mass of iron)

(IIT JAM BT - 2025)

9. A buffer solution is composed of 0.1 M acetic acid and 0.15 M sodium acetate. The change in pH of 1 L buffer solution upon addition of 50 mL of 1.0 M NaOH is _____. (rounded off to 2 decimals) [K_a of acetic acid = 1.75×10^{-5}]

Answer Key

1	2	3	4	5
3	3	4	4.80-4.90	2.86-2.89
6	7	8	9	
55.7	0.141	16441.18	0.42	

EXPLANATION

1. **Explanation:-** The formic acid and sodium formate will react to form a buffer solution. The pH of a buffer solution is given by the Henderson-Hasselbalch equation:

$$pH = pK_a + \log([A^-] / [HA])$$

where $[A^-]$ is the concentration of the conjugate base, $[HA]$ is the concentration of the acid, and pK_a is the acid's pK_a .

In this case, the pK_a of formic acid is 3.8, the concentration of the conjugate base is 0.1 mol, and the concentration of the acid is 0.01 mol. Plugging these values into the Henderson-Hasselbalch equation,

we get: $pH = 3.8 + \log(0.1 / 0.01) = 2.8$

Therefore, the pH of the solution is 2.8.

2. **Explanation:-** The acetic acid and NaOH will react to form sodium acetate, a salt. The pH of a solution of a salt of a weak acid and a strong base is equal to the pK_a of the weak acid.

In this case, the pK_a of acetic acid is 4.8, so the pH of the resulting solution will be 4.8.

Calculate the moles of acetic acid and NaOH:

Moles of acetic acid = $10\ mL \times 1\ M = 10\ mmol$

Moles of NaOH = $5\ mL \times 1\ M = 5\ mmol$

Calculate the moles of excess acetic acid:

Moles of excess acetic acid = $10\ mmol - 5\ mmol = 5\ mmol$

Calculate the pH of the solution:

$$\text{pH} = \text{pKa} + \log\left(\frac{[\text{A}^-]}{[\text{HA}]}\right)$$

$$[\text{A}^-] = \text{moles of NaOH} / \text{total volume} = 5 \text{ mmol} / 15 \text{ mL} = 0.333 \text{ M}$$

$$[\text{HA}] = \text{moles of acetic acid} / \text{total volume} = 5 \text{ mmol} / 15 \text{ mL} = 0.333 \text{ M}$$

$$\text{pH} = 4.8 + \log(0.333 / 0.333) = 4.8$$

Therefore, the pH of the resulting solution is 4.8.

3. **Explanation:-** Initial moles of acetic acid = 50mL * 0.1M = 5 mmol

$$\text{Initial moles of NaOH} = 50\text{mL} * 0.1\text{M} = 5 \text{ mmol}$$

$$\text{Moles of NaOH added} = 5 \text{ mmol}$$

$$\text{Moles of acetic acid neutralized} = 5 \text{ mmol}$$

$$\text{Moles of acetate formed} = 5 \text{ mmol}$$

$$\text{Total volume} = 50\text{mL} + 50\text{mL} = 100\text{mL}$$

$$[\text{Acetate}] = 5 \text{ mmol} / 100\text{mL} = 0.05\text{M}$$

$$\text{pH} = 14 - \text{pKa} - \log([\text{Acetate}])$$

$$\text{pH} = 14 - 4.8 - \log(0.05)$$

$$\text{pH} = 10.5 \text{ which is closest to } 9.0$$

4. **Explanation:-**

$$\text{pKa}_1 = 4.19$$

$$\text{pKa}_2 = 5.57$$

$$[\text{HA}_2^-] = 0.1\text{M}$$

$$[\text{HA}] = 0.1\text{M} - 0.1\text{M} = 0$$

$$\text{pH} = \text{pKa}_2 + \log([\text{A}_2^-] / [\text{HA}])$$

$$\text{pH} = 5.57 + \log(0.1 / 0)$$

$$\text{pH} = 5.57$$

The pH of the solution is 5.57. However, this is the pH of the solution after the first dissociation of monosodium succinate. The second dissociation of monosodium succinate will also contribute to the pH of the solution, so the pH will be slightly lower than 5.57.

The exact pH of the solution will depend on the relative concentrations of the first and second dissociated forms of monosodium succinate.

$$\text{pKa}_2 = 5.57$$

$$[\text{A}_2^-] = 0.1\text{M}$$

$$[\text{HA}] = 0.1\text{M} - 0.01 = 0.09$$

$$\text{pH} = \text{pKa}_2 + \log([\text{A}_2^-] / [\text{HA}])$$

$$\text{pH} = 5.57 + \log(0.1 / 0.09)$$

$$\text{pH} = 4.88$$

5. **Explanation:-**

To determine the pH of the acetic acid solution, we can use the equation relating pH and the concentration of hydrogen ions ($[\text{H}^+]$):

$$\text{pH} = -\log[\text{H}^+]$$

Given that the $[\text{H}^+]$ of the 0.1 N (normal) acetic acid solution is $1.33 \times 10^{-3} \text{ M}$, we can substitute this value into the equation:

$$\text{pH} = -\log(1.33 \times 10^{-3})$$

Using a calculator, we find:

$$\text{pH} \approx 2.88$$

Therefore, the pH of the 0.1 N acetic acid solution is approximately 2.88.

6. **Explanation:-**

The molar concentration of water in pure water can be calculated using the fact that water has a density of 1 g/cm^3 , which is equivalent to 1000 kg/m^3 . The molar mass of water (H_2O) is approximately 18.015 g/mol .

The molar concentration (C) can be calculated using the formula:

$$C = \text{density} / \text{molar mass}$$

Substituting the values, we have:

$$C = 1000 \text{ kg/m}^3 / 18.015 \text{ g/mol}$$

Converting the units to match ($1 \text{ g} = 0.001 \text{ kg}$, $1 \text{ mol} = 6.022 \times 10^{23} \text{ molecules}$), we get:

$$C = (1000 \text{ kg/m}^3 / 18.015 \text{ g/mol}) \times (1 \text{ mol} / 1000 \text{ g}) \times (6.022 \times 10^{23} \text{ molecules} / 1 \text{ mol})$$

$$C \approx 55.56 \text{ mol/m}^3$$

Rounding off to one decimal place, the molar concentration of water in pure water is approximately 55.6 M.

7. **Explanation:-**

To calculate the molality of the resulting solution, we need to determine the number of moles of sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) and the mass of water.

The molar mass of sucrose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) can be calculated as follows: $12(12.01 \text{ g/mol}) + 22(1.008 \text{ g/mol}) + 11(16.00 \text{ g/mol}) = 342.34 \text{ g/mol}$

Given that 1.45 g of sucrose is dissolved, we can calculate the number of moles of sucrose: $\text{moles of sucrose} = \text{mass of sucrose} / \text{molar mass of sucrose} = 1.45 \text{ g} / 342.34 \text{ g/mol} \approx 0.00424 \text{ mol}$

The mass of water is given as 30.0 mL, which we need to convert to grams using the density of water (1 g/mL): $\text{mass of water} = \text{volume of water} \times \text{density of water} = 30.0 \text{ mL} \times 1 \text{ g/mL} = 30.0 \text{ g}$

Now we can calculate the molality (m) of the solution: $\text{molality} = \text{moles of solute} / \text{mass of solvent (in kg)} = 0.00424 \text{ mol} / (30.0 \text{ g} / 1000) = 0.1413 \text{ mol/kg}$

Rounding off to three decimal places, the molality of the resulting solution is approximately 0.141 m.

8. Explanation:

To calculate the molecular weight of myoglobin based on it containing 0.34% iron, we use the given information:

Atomic mass of iron (M_{Fe}) = 55.9 g mol^{-1}

Percentage of iron in myoglobin = 0.34%

The formula to calculate the molecular weight of myoglobin ($M_{Myoglobin}$) is rearranged from the proportion of iron in myoglobin:

$$\text{Percentage of iron} = \frac{M_{Fe}}{M_{Myoglobin}} \times 100\%$$

$$\text{Substituting the values: } M_{Myoglobin} = \frac{55.9}{0.34} \times 100$$

$$M_{Myoglobin} = 16441.18 \text{ g mol}^{-1}$$

9. Explanation:-

i. **Initial pH:** Use the Henderson-Hasselbalch equation:

$$\text{pH} = \text{pKa} + \log \left(\frac{[A^-]}{[HA]} \right)$$

Where: $\text{pKa} = -\log(K_a) = -\log(1.75 \times 10^{-5}) \approx 4.76$,

$[A^-]$ = concentration of acetate (0.15 M), $[HA]$ = concentration of acetic acid (0.1 M)

$$\text{pH (initial)} = 4.76 + \log \left(\frac{0.15}{0.1} \right)$$

$$= 4.76 + 0.18 = 4.94$$

ii. **Moles of reactants:**

Moles of acetic acid (HA): $0.1 \text{ mol/L} \times 1 \text{ L} = 0.1 \text{ mol}$

Moles of acetate (A^-): $0.15 \text{ mol/L} \times 1 \text{ L} = 0.15 \text{ mol}$

Moles of NaOH added: $1.0 \text{ mol/L} \times 0.05 \text{ L} = 0.05 \text{ mol}$

iii. **Reaction:** NaOH reacts with acetic acid: $HA + OH^- \rightarrow A^- + H_2O$

iv. **New concentrations:**

Moles of HA remaining: $0.1 \text{ mol} - 0.05 \text{ mol} = 0.05 \text{ mol}$

Moles of A^- formed: $0.15 \text{ mol} + 0.05 \text{ mol} = 0.2 \text{ mol}$

New concentrations (in 1.05 L):

$$[HA] = \frac{0.05 \text{ mol}}{1.05 \text{ L}} = 0.0476 \text{ M}$$

$$[A^-] = \frac{0.2 \text{ mol}}{1.05 \text{ L}} = 0.1905 \text{ M}$$

v. **Final pH:** Use the Henderson-Hasselbalch equation again:

$$\text{pH (final)} = 4.76 + \log \left(\frac{0.1905}{0.0476} \right)$$

$$= 4.76 + 0.60 = 5.36$$

vi. **Change in pH:**

$$\Delta \text{pH} = \text{pH (final)} - \text{pH (initial)} = 5.36 - 4.94 = 0.42$$

∴ Change in pH approximately **0.42**.

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2009)

1. Kupffer cells are found in

- (1) Stomach (2) Liver
(3) Small intestine (4) Large intestine

(IIT JAM BT 2011)

2. Identify the correct combination between the groups

Group-I	Group-II
P. Mast cells	1. Cytotoxic effect on tumour cells
Q. Macrophage	2. Release of histamine
R. Natural Killer cells	3. Production of immunoglobulins
S. B cells	4. Ingestion of particulate antigen

- (1) P-2, Q-4, R-1, S-3 (2) P-4, Q-1, R-3, S-2
(3) P-1, Q-3, R-2, S-4 (4) P-4, Q-3, R-2, S-1

(IIT JAM BT 2019 MSQ)

3. Which of the following cell types can develop from myeloid lineage?

- (1) Macrophages (2) T lymphocytes
(3) B lymphocytes (4) Erythrocytes

(IIT JAM BT 2020)

4. T cells and B cells are

- (1) Lymphocytes (2) Erythrocytes
(3) Epithelial cells (4) Squamous cells

Answer Key			
1	2	3	4
2	1	1,4	1

EXPLANATIONS

1. **Explanation:-** Kupffer cells are resident liver macrophages and play a critical role in maintaining liver functions. Under physiological conditions, they are the first innate immune cells and protect the liver from bacterial infections.

2. **Explanation:-** Mast cells release histamine, which is a chemical that causes inflammation. This inflammation can help to protect the body from infection.

Macrophages are phagocytic cells, which means that they can ingest and destroy foreign particles. They

also produce cytokines, which are signaling molecules that help to coordinate the immune response.

Natural killer cells are a type of lymphocyte that can kill virus-infected cells and tumor cells. They do this by releasing perforins and granzymes, which are proteins that damage the cell membrane and nucleus of the target cell.

B cells are a type of lymphocyte that produce antibodies. Antibodies are proteins that bind to specific antigens, which are molecules that are found on the surface of pathogens. This binding can help to neutralize the pathogen or mark it for destruction by other immune cells.

3. **Explanation:-** Macrophages are phagocytic cells that can ingest and destroy foreign particles. They also produce cytokines, which are signaling molecules that help to coordinate the immune response. Macrophages develop from a type of myeloid progenitor cell called the monoblast.

Erythrocytes are red blood cells that carry oxygen throughout the body. They develop from a type of myeloid progenitor cell called the proerythroblast. Both macrophages and erythrocytes are part of the myeloid lineage, which is a branch of the hematopoietic system that gives rise to all of the blood cells except for lymphocytes. The other cells that develop from the myeloid lineage are neutrophils, basophils, eosinophils, and dendritic cells.

4. **Explanation:-** T cells and B cells are types of lymphocytes, which are a type of white blood cell that plays a key role in the immune system. Lymphocytes are produced in the bone marrow and then mature in the thymus (T cells) or the bone marrow (B cells).

Erythrocytes are red blood cells, which are responsible for carrying oxygen throughout the body. Epithelial cells are cells that line the surfaces of the body, such as the skin and the lining of the gut. Squamous cells are a type of epithelial cell that is flat and scale-like.

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2018)

1. Which of the following feature(s) should be present in a protein to generate strong immune response (antibody production) in an animal?
- I. At least one B-cell epitope
 - II. At least one T-cell epitope
 - III. Proteolytic cleavage site(s)
- (1) I only (2) II and III
(3) I and III (4) I, II and III

Answer Key

1

4

EXPLANATION

1. **Explanation:-** B-cell epitopes are small, linear sequences of amino acids that are recognized by B cells. T-cell epitopes are small, discontinuous sequences of amino acids that are recognized by T cells. Proteolytic cleavage sites are sites in a protein where it can be cleaved by enzymes. In order to generate a strong immune response, a protein needs to have both B-cell epitopes and T-cell epitopes. Proteolytic cleavage sites are not essential, but they can help to increase the number of B-cell epitopes that are exposed on the surface of the protein.

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2005)

1. How many antigen-binding sites does a pentameric IgM molecule contain?

- (1) Two (2) Five
(3) Ten (4) Fifteen

(IIT JAM BT 2006)

2. Choose the correct match from A, B, C and D

Group I	Group II
P. IgA	1. Basophils
Q. IgE	2. δ heavy chain
R. IgG	3. Secretory component
S. IgM	4. Pentamer
	5. Crosses placenta

Code:

- (1) P-3, Q-1, R-5, S-4 (2) P-3, Q-5, R-2, S-1
(3) P-2, Q-3, R-5, S-4 (4) P-2, Q-1, R-3, S-5

(IIT JAM BT 2008)

3. Choose the correct set of match between Group I and Group II.

Group I	Group II
P. IgM	1. Present in various body secretions
Q. IgE	2. Antigen presentation
R. IgA	3. Allergic reaction
S. MHC	4. Complement activation
	5. Ten heavy chains and ten light chains

Code:

- (1) P-4, Q-3, R-1, S-5 (2) P-5, Q-3, R-1, S-2
(3) P-5, Q-3, R-4, S-1 (4) P-3, Q-2, R-4, S-5

(IIT JAM BT 2009)

4. The antibody class that can pass from the mother to the fetus in humans is

- (1) Ig A (2) Ig D
(3) Ig G (4) Ig M

(IIT JAM BT 2012)

5. The most abundant immunoglobulin in human blood is

- (1) IgM (2) IgA
(3) IgD (4) IgG

(IIT JAM BT 2013)

6. Secretory IgA (sIgA) can exist in a protease rich mucosal environment because

- (1) The secretory component masks the sites susceptible to proteases
- (2) The action of proteases is neutralized by *slgA*

- (3) sIgA is secreted in vesicles and hence protected from proteases

- (4) The J chain masks the protease-susceptible sites

(IIT JAM BT 2014)

7. The antigen binding sites in immunoglobulin IgG are present at

- (1) Variable region of heavy chains
- (2) Variable region of light chains
- (3) Constant region of heavy chains
- (4) Variable region of heavy and light chains

(IIT JAM BT 2017)

8. The antigen binding site of an antibody is present

- (1) At the constant region
- (2) At the C-terminal
- (3) At the variable region

- (4) Between the constant and the variable region

(IIT JAM BT 2021)

9. When the molecular weight of human immunoglobulin light chain is 24 kDa, the total molecular weight of human IgG is _____ kDa.

(IIT JAM BT 2023)

10. Which one of the following pairs of antibodies contains 'J-chain' in their multimeric form?

- (1) IgD and IgG (2) IgA and IgM
(3) IgA and IgE (4) IgD and IgE

(IIT JAM BT - 2024)

11. Which one of the following immunoglobulins crosses the human placenta?

- (1) IgA (1) IgE
(3) IgG (4) IgM

Answer Type									
1	2	3	4	5	6	7	8	9	10
3	1	2	3	4	1	4	3	140-160	2
11									
3									

EXPLANATIONS

1. Explanation:- A pentameric IgM molecule is composed of 10 heavy (μ) chains, 10 light chains and usually one joining (J) chain. Each heavy chain has two antigen-binding sites, so a pentameric IgM molecule has a total of 10 antigen-binding sites.

2. Explanation:- IgA is the main antibody found in secretions such as saliva, tears, and mucus. It is also found in breast milk. IgA is associated with a secretory component, which helps it to survive in the harsh environment of the gut and other mucous membranes. IgA crosses the placenta, providing passive immunity to the newborn.

IgE is associated with allergies. It is also involved in the defense against parasitic infections. IgE binds to mast cells and basophils, which release histamine and other chemicals when they are triggered. These chemicals can cause allergic symptoms such as hives, swelling, and difficulty breathing.

IgG is the most abundant antibody in the blood. It is also found in tissues throughout the body. IgG is able to cross the placenta, providing passive immunity to the newborn. IgG is the main antibody involved in long-term immunity.

IgM is the first antibody produced by B cells in response to an infection. It is a pentamer, meaning that it is made up of five identical subunits. IgM is not as effective as IgG at clearing infections, but it is better at activating the complement system.

3. Explanation:- IgM is a pentamer, meaning that it is made up of five identical subunits. It is the first antibody produced by B cells in response to an infection. IgM is good at activating the complement system, which helps to clear infections.

IgE is associated with allergies. It binds to mast cells and basophils, which release histamine and other chemicals when they are triggered. These chemicals can cause allergic symptoms such as hives, swelling, and difficulty breathing.

IgA is the main antibody found in secretions such as saliva, tears, and mucus. It is also found in breast milk. IgA is associated with a secretory component, which helps it to survive in the harsh environment of the gut and other mucous membranes. IgA does not cross the placenta.

MHC stands for major histocompatibility complex. MHC molecules are found on the surface of all cells

in the body. They present antigens to T cells, which help to coordinate the immune response.

4. Explanation:- IgG is the only antibody class that can pass from the mother to the fetus in humans. It is able to cross the placenta because it is small and has a high affinity for FcRn, a protein that is expressed on the surface of placenta cells. IgG provides passive immunity to the newborn, helping to protect them from infection until their own immune system matures.

5. Explanation:- IgG is the most abundant immunoglobulin in human blood, which is accounting for 70-75 % of total immunoglobulin. It is found in the blood, tissues, and other body fluids. IgG is responsible for providing long-term immunity against pathogens.

6. Explanation:- Secretory IgA (sIgA) is a type of antibody that is found in secretions such as saliva, tears, and mucus. It is also found in breast milk. sIgA is associated with a secretory component, which helps it to survive in the harsh environment of the gut and other mucous membranes.

The secretory component is a glycoprotein that is produced by epithelial cells. It binds to the Fc region of sIgA molecules, protecting them from being degraded by proteases. The secretory component also helps to transport sIgA across epithelial cells, allowing it to be secreted into the environment.

7. Explanation:- The antigen binding site of an antibody is present in the variable region of the heavy and light chain. The variable regions are composed of 7 amino acid segments; three of which are hypervariable regions or CDR and heavy and light chains. Hence option 4 is the correct answer.

8. Explanation:- The antigen binding site of an antibody is located in the variable region of the heavy and light chains. The variable region is so named because it is the region of the antibody that is most variable in sequence. This variability allows the antibody to bind to a wide variety of antigens. The constant region of the antibody is the region that is least variable in sequence. The constant region determines the effector functions of the antibody, such as its ability to activate the complement system or to bind to Fc receptors on cells.

- 9. Explanation:-** The molecular weight of human immunoglobulin G (IgG) can be calculated by summing the molecular weights of its components. IgG is composed of two identical heavy chains and two identical light chains. The molecular weight of a typical human IgG heavy chain is approximately 50 kDa.

To calculate the total molecular weight of human IgG, we need to consider the molecular weights of two heavy chains and two light chains. Given that the molecular weight of a human immunoglobulin light chain is 24 kDa, the calculation would be as follows:

$$\begin{aligned}\text{Total molecular weight of IgG} &= (2 * \text{Molecular weight of heavy chain}) + (2 * \text{Molecular weight of light chain}) \\ &= (2 * 50 \text{ kDa}) + (2 * 24 \text{ kDa}) \\ &= 100 \text{ kDa} + 48 \text{ kDa} \\ &= 148 \text{ kDa}\end{aligned}$$

Therefore, the total molecular weight of human IgG is approximately 148 kDa.

- 10. Explanation:-** The J-chain is a polypeptide that plays a role in the formation of multimeric antibodies. It is involved in the polymerization of immunoglobulins, specifically IgA and IgM, into their multimeric forms. IgA antibodies exist in two forms: monomeric IgA (found in the circulation) and dimeric IgA (found in secretions such as saliva, tears, and mucosal surfaces). The dimeric form of IgA is created through the addition of a J-chain, which connects two monomeric units.

IgM antibodies are naturally multimeric and exist as pentamers. The pentameric structure of IgM is stabilized by the J-chain, which connects the individual monomeric units.

- 11. Explanation:** IgG is the only class of immunoglobulin that can cross the placenta, as its Fc portion binds to the receptors present on the surface of the placenta. It provides passive immunity to the fetus during pregnancy. This transfer of IgG from the mother to the fetus helps protect the newborn against infections early in life.

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2005)

- Which of the following does NOT form the basis of an antigen-antibody binding?
 - (1) Hydrogen bond
 - (2) Ionic interactions
 - (3) Covalent bond
 - (4) Hydrophobic interactions

(IIT JAM BT 2005)

- Myoglobin contains multiple distinct epitopes but only a single copy of each epitope. Identify the condition under which antigen-antibody precipitation reaction would occur
 - (1) When monoclonal antibody is use
 - (2) When specific polyclonal antiserum is used
 - (3) When monovalent Fab fragments are used
 - (4) When any of the above conditions are fulfilled

(IIT JAM BT 2014)

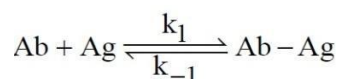
- The standard pregnancy kit, used to detect Human Chorionic Gonadotrophin (HCG) in urine, is based on
 - (1) Gene amplification through PCR
 - (2) Antigen-antibody interaction
 - (3) Biotin-streptavidin interaction
 - (4) Nickel affinity chromatography

(IIT JAM BT 2015 MSQ)

- Which of the following statements about antigen-antibody (Ag-Ab) complexes is (are) TRUE?
 - (1) Hydrogen bonds and van der Waals forces participate in Ag-Ab interactions
 - (2) Ionic bonds and hydrophobic bonds participate in Ag-Ab interactions
 - (3) The combined strengths of all interactions between a single antigen binding site on an antibody and a single epitope is called avidity
 - (4) Antibody elicited by one antigen can cross react with an unrelated antigen

(IIT JAM BT 2017)

- Antigen and antibody interaction is shown by the following scheme



where Ab is antigen and Ab – Ag is antigen-antibody complex. The values of k_1 and k_{-1} are $5 \times 10^{-5} \mu M^{-1} s^{-1}$ and $2 \times 10^{-7} s^{-1}$, respectively. The dissociation constant for the complex is _____ nM.

(IIT JAM BT 2018)

- Antibody binds to antigen in solution through
 - (1) Ionic interactions.
 - (2) Hydrogen bonds.
 - (3) Van der Waals interactions.
 - (4) Hydrophobic interactions.

Answer Key

1	2	3	4	5	6
3	2	2	1,2,4	4-4	1,2,3,4

EXPLANATIONS

- Explanation:-** Binding of antigen to antibody is through non-covalent interactions like hydrophobic interaction, hydrogen bonds, vander waals force and electrostatic interactions. So covalent bond do not participate in the formation of antigen-antibody complex.
- Explanation:-** A polyclonal antiserum is a mixture of antibodies that are produced by different clones of B cells. This means that the antibodies in a polyclonal antiserum will recognize multiple epitopes on an antigen. This is in contrast to monoclonal antibodies, which are produced by a single clone of B cells and only recognize a single epitope.
Because a polyclonal antiserum recognizes multiple epitopes on an antigen, it is more likely to cause an antigen-antibody precipitation reaction than a monoclonal antibody. This is because the multiple antibodies in a polyclonal antiserum can bind to different epitopes on the antigen, forming a lattice that precipitates out of solution.

3. **Explanation:-** Pregnancy kits work by detecting the presence of the hormone human chorionic gonadotropin (hCG) in urine. hCG is a hormone that is produced by the placenta after conception.

The pregnancy kit contains a strip of paper that is coated with antibodies that specifically bind to hCG. When urine is applied to the strip, the hCG molecules in the urine bind to the antibodies. This binding causes a color change in the strip, indicating that the woman is pregnant.

The other options are not correct. PCR is a technique that is used to amplify DNA. It is not used to detect hCG in pregnancy kits. Biotin-streptavidin interaction and nickel affinity chromatography are techniques that are used to separate molecules. They are not used to detect hCG in pregnancy kits.

4. **Explanation:-**

- (1) Hydrogen bonds and van der Waals forces participate in Ag-Ab interactions: Antigen-antibody interactions involve various non-covalent interactions, including hydrogen bonds and van der Waals forces. These interactions contribute to the binding between the antigen and antibody.
- (2) Ionic bonds and hydrophobic bonds participate in Ag-Ab interactions: Ionic bonds, formed between positively and negatively charged amino acids, and hydrophobic bonds, formed between nonpolar regions, can also participate in antigen-antibody interactions. These interactions contribute to the overall stability and specificity of the Ag-Ab complex.
- (3) The combined strengths of all interactions between a single antigen binding site on an antibody and a single epitope is called avidity: This statement is incorrect. Avidity refers to the overall strength of binding between an antibody and an antigen, but it is not specific to a single antigen binding site on an antibody and a single epitope.
- (4) Antibody elicited by one antigen can cross-react with an unrelated antigen: Cross-reactivity refers to the ability of an antibody to bind to an antigen that is structurally similar, but not identical, to the original immunizing antigen. Cross-reactivity can occur when there are shared epitopes or structural similarities between the antigens. Thus, an antibody elicited by one antigen can indeed cross-react with an unrelated antigen.

Therefore, the true statements are (1), (2), and (4).

5. **Explanation:-** Dissociation constant $= K^{-1}/K_1$
 $= 2 \times 10^{-7} \text{ s}^{-1} / 5 \times 10^{-5} \mu\text{M s}^{-1}$
 $= 2 \times 10^{-7} \times 10^5 / 5 \mu\text{M}$
 $= 2000 / 5 \times 10^{-2}$
 $= 4 \text{ nM}$

6. **Explanation:-** Binding of antigen to antibody is through non-covalent interactions like hydrophobic interaction, hydrogen bonds, vander waals force and electrostatic interactions. So covalent bond does not participate in the formation of antigen-antibody complex.