**Biology 12 – Biologically Important Molecules – Study Guide ANSWERS**

1. 5 characteristics of living things:

* Made of cells
* Grow and develop
* Reproduce
* Respond to stimuli
* Maintain homeostasis
* (also acceptable: use energy, evolve/adapt)

Forest Fire:

* *Alive indicators*: grows, spreads, uses energy, responds to environment (wind, fuel).
* *Non-living indicators*: not made of cells, no DNA, cannot reproduce on its own.

2.  
a) Scientific Method = process of investigation involving observation, hypothesis, experiment, analysis, and conclusion.  
b) Importance: ensures objectivity, repeatability, reliability; minimizes bias; builds scientific knowledge.

3.  
a) Hypothesis = testable prediction. Theory = well-tested explanation supported by evidence.  
b) Examples:

* Hypothesis: “If plants get more sunlight, then they will grow taller.”
* Theory: Cell Theory, Theory of Evolution.

4.  
a) Control = part of experiment kept unchanged for comparison.  
b) Example: placebo group in a drug trial.  
c) Role: shows whether observed results are due to independent variable.

5. PainDrain® experiment

* Hypothesis: PainDrain reduces headaches more than placebo.
* Groups: experimental group (PainDrain) vs control (placebo).
* Large sample, randomized, double-blind.
* Measure headache relief (time, severity scale).
* Collect/analyze data, conclude effectiveness.

6.  
Homeostasis = maintaining internal stability despite external changes.  
Examples:

* Body temperature regulation
* Blood glucose regulation
* Water balance (osmoregulation)

7.  
Negative feedback = system where a change triggers a response that reverses/reduces that change, restoring balance.

8.  
Examples:

* Blood glucose regulation: ↑ glucose → insulin lowers it. ↓ glucose → glucagon raises it.
* Body temperature: too hot → sweating/vasodilation; too cold → shivering/vasoconstriction.  
  (Diagrams: feedback loops with stimulus → response → return to set point.)

9.  
a) Positive feedback = response increases the change, moving system further from balance.  
b) Example: childbirth (oxytocin → stronger contractions → more oxytocin).

10.  
a) Ionic bond = transfer of electrons (NaCl).  
b) Covalent bond = sharing of electrons (H₂O, CO₂).  
c) Hydrogen bond = weak attraction between partial charges (between H₂O molecules).

11.  
Water molecule diagram: O atom bonded to 2 H atoms, bent shape, polar.  
Unique properties: cohesion, adhesion, high heat capacity, solvent abilities, ice floats.

12.  
Polar nature allows:

* Dissolving substances (solvent for life).
* Temperature regulation (heat capacity).
* Capillary action in plants.
* Surface tension.

13.  
Acid = substance releasing H⁺ ions.  
Examples: HCl, H₂SO₄.  
pH < 7.

14.  
Base = substance releasing OH⁻ or absorbing H⁺.  
Examples: NaOH, NH₃.  
pH > 7.

15.  
Pure water = neutral (pH 7) → neither acid nor base.

16.  
pH 2 vs pH 7 = 10⁵ times more acidic (100,000×).

17.  
Maintaining pH critical → enzyme activity & metabolic processes depend on narrow pH range.

18.  
Buffer = system that resists changes in pH. Important to keep blood/cells stable.

19.  
Carbonic acid–bicarbonate buffer:

* +H⁺ → binds to HCO₃⁻ → forms H₂CO₃.
* +OH⁻ → H₂CO₃ donates H⁺ → water + HCO₃⁻.

20.  
a) Polymer = large molecule of repeating monomers.  
b) Built by dehydration synthesis, broken by hydrolysis.  
c) Examples: proteins, nucleic acids, polysaccharides, lipids.

21.  
Functions of proteins: structural (keratin), enzymes, transport (hemoglobin), defense (antibodies), hormones (insulin).

22.  
Elements in proteins: C, H, O, N, sometimes S. → Nitrogen is most characteristic.

23.  
a) General amino acid: central C, H, carboxyl group, amino group, R group.  
b) 20 amino acids.  
c) Differ by R group.

24.  
Dehydration synthesis = removal of H₂O to form peptide bond.  
Hydrolysis = add H₂O to break bond.  
Diagram: amino acids joining → peptide + water.

25.  
Bond between amino acids = peptide bond.

26.  
Polypeptide = chain of amino acids.  
Protein = folded, functional polypeptide.

27.  
Protein structures:

* Primary = sequence of amino acids.
* Secondary = α-helix, β-sheet.
* Tertiary = 3D folding.
* Quaternary = multiple polypeptides.

28.  
Function determined by shape/structure.

29.  
Denatured = protein loses shape → loses function.  
Causes: heat, pH changes, chemicals (e.g., alcohol).

30.  
a) Carbohydrate = sugar, general formula Cₙ(H₂O)ₙ.  
b) Elements: C, H, O (2:1 H:O).  
c) Functions: energy, storage, structure.

31.  
a) Diagrams: ribose (5C), glucose (6C).  
b) Pentose = 5 carbons, hexose = 6 carbons.  
c) Names end in “-ose”.

32.  
a) Glucose formula = C₆H₁₂O₆.  
b) Main energy source for cells (ATP production).

33.

* Monosaccharide = 1 sugar (glucose).
* Disaccharide = 2 sugars (sucrose).
* Polysaccharide = many sugars (starch, glycogen, cellulose).

34.

| Polysaccharide | Structure | Function |
| --- | --- | --- |
| Glycogen | Branched glucose chains | Animal energy storage |
| Starch | Coiled glucose chains | Plant energy storage |
| Cellulose | Straight chains, H-bonded | Plant cell walls, structure |

35.  
a) Glycogen stored in liver & muscles.  
b) Stored there for quick energy release during activity.

36.  
a) Lipids = non-polar macromolecules.  
b) Functions: energy storage, insulation, hormones, membranes.  
c) Insoluble in water.  
d) Types: fats, phospholipids, steroids.

37.  
a) Polar molecule = unequal sharing of electrons, non-polar = equal sharing.  
b) Polar: water, ammonia. Non-polar: O₂, fats.

38.  
Hydrophilic = water-loving (polar).  
Hydrophobic = water-fearing (non-polar).

39.  
a) Neutral fats = glycerol + 3 fatty acids.  
b) AKA triglycerides.  
c) Function = long-term energy storage.

40.  
a) Glycerol + 3 fatty acids → triglyceride.  
b) Reaction = dehydration synthesis.

41.  
a) Saturated = no double bonds, straight chain. Unsaturated = ≥1 double bond, kinked chain.  
b) Unsaturated → liquid at room temp (oils).  
c) Saturated → solid at room temp (butter).  
d) Saturated fats linked to heart disease.

42.  
a) Phospholipids = membrane structure.  
b) Glycerol + 2 fatty acids + phosphate.  
c) Differs from triglyceride (has phosphate group).  
d) Bilayer diagram.  
e) Small nonpolar molecules (O₂, CO₂) pass easily.

43.  
a) Steroids = lipids with 4 fused rings.  
b) Functions: hormones (testosterone, estrogen), membrane stability.  
c) Derived from cholesterol.  
d) Cholesterol diagram.  
e) Not inherently bad; needed in membranes.  
f) Excess cholesterol = diet, liver overproduction.

44.  
Fats/oils don’t disperse in water because they are non-polar.

45.  
Emulsification = breaking fats into droplets (bile action) so enzymes can digest them.

46.  
a) Nucleic acids store/transmit genetic info.  
b) DNA & RNA.

47.  
Nucleotides = sugar + phosphate + nitrogen base.  
Purines (A, G) = 2 rings.  
Pyrimidines (C, T, U) = 1 ring.

48.  
DNA molecule diagram = double helix, sugar-phosphate backbone, base pairs (A-T, G-C).

49.  
a) ATP = adenine + ribose + 3 phosphates.  
b) Function = main energy currency.  
c) Energy stored in phosphate bonds.

50.

| **Polymer** | **Function** | | **Unit Molecule** |
| --- | --- | --- | --- |
| Protein | Structure, enzymes, etc. | | Amino acid |
| Starch | Plant energy storage | | Glucose |
| Glycogen | Animal energy storage | | Glucose |
| Cellulose | Plant structure | | Glucose |
| DNA | Genetic information | | Nucleotide |
| **Molecule** | **Function** | **Units** | | |
| Triglyceride | Energy storage | Glycerol + FA (fatty acid) | | |
| Phospholipid | Membrane structure | Glycerol + FA + phosphate | | |
| Steroid | Hormones, membrane | Cholesterol | | |
| ATP | Energy currency | Adenine + ribose + phosphate | | |