IDX G9 Biology S
Study Guide Issue 1
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Contents:

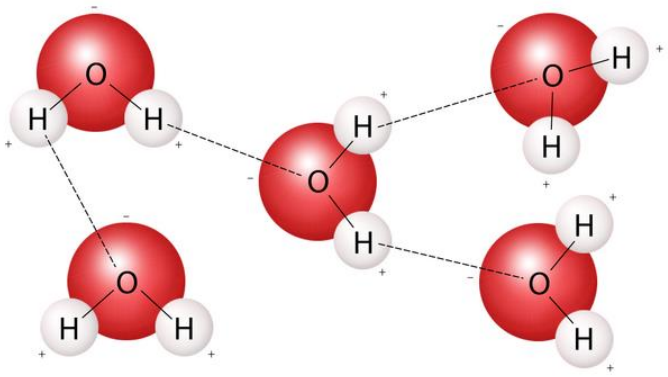
1.1 What is Science

- Definition: Science is an organized way of gathering and analyzing evidence about the natural world.
- Usage of Science: **To provide natural explanations** for events in the natural world. Use the explanations **to understand patterns in nature** and **predict natural events**
- **Scientific Methodology** are procedures to analyze data and make explanations**.**

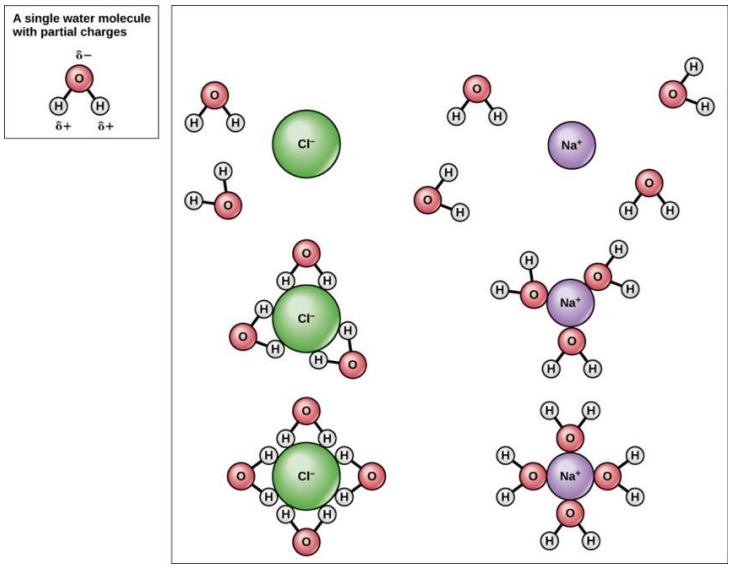
2.2 Properties of Water

- Water molecule
    - **Polar molecule**: able to form multiple hydrogen bonds, which account for many of water's special properties
- Polarity
    - Greater probability of finding share electrons in water close to its oxygen atom than near its hydrogen atoms
- List of properties
    - **Universal solvent**: matter that dissolves other substances
        - **Solute**: the substance that is dissolved
        - **Solvent**: the substance in which solute dissolves
    - **High heat capacity:** water is one of the substances with highest heat capacit y, 4.184 J/g°C. Important for regulating organisms body temperature and mo derating climate
    - **Cohesion**: Water is attracted to water; **Adhesion**: Water attracted to other sub stance

- First, water is **polar**, mean it has both negative charge and positive charge. Since negative charge is attracted to positive charge, the hydrogen (+) is attracted to oxygen (-), causing water molecules to stick. This creates a bond between molecules, creating a **high surface tension** of water.
- Second, because of its "polar" property, water molecules also attract other polar molecules.



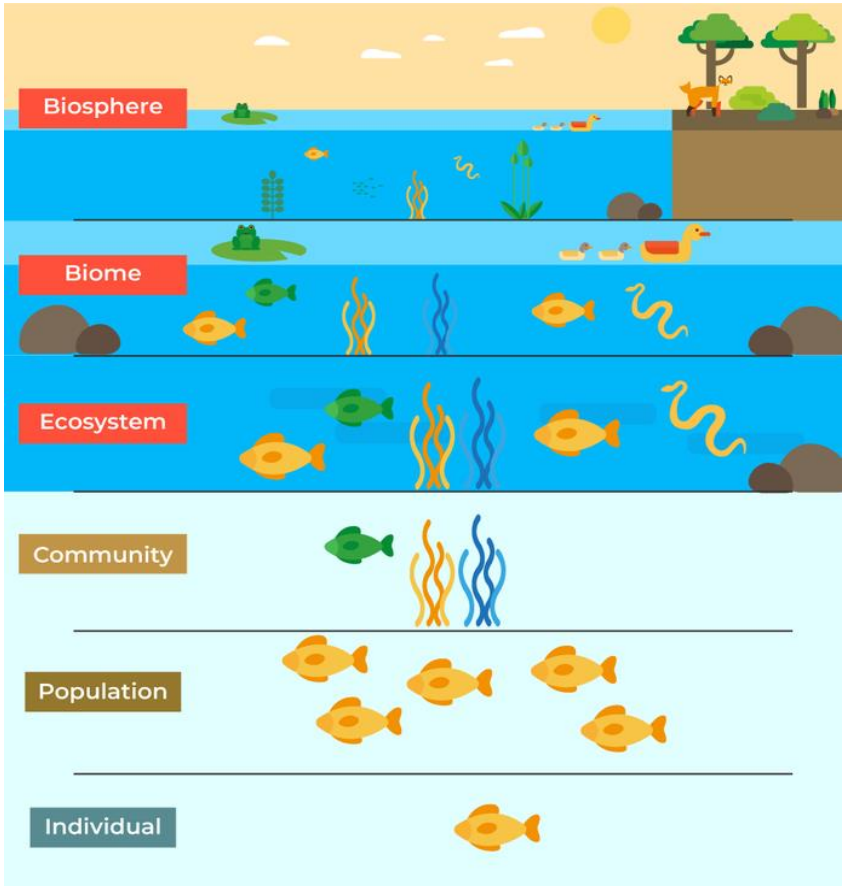
- Thus, makes water to stick on other substances, making water to perform **Capillary action**, the movement of a liquid through a narrow space or porous material without external force.



3.1 What is Ecology?

- **Definition**: Ecology is the scientific study of **interactions** among organisms and between **organisms** and their **physical environment**
- **Biosphere**: where living organisms live (atmosphere, land, water…) from 8km above surface to 11km below surface
    - Atmosphere, lithosphere, hydrosphere
- Levels of organism

- Individual organisms: a **species** (a group of similar organisms) that can breed and produce fertile offspring
- Population: a group of same species
- Community: different populations living in a same area
- Ecosystem: community + physical environment (water, soil, sky, temperature)



- Biotic and abiotic factors
  - Biotic Factors: **Living organisms** that shapes the environment (Ex: Plants, Algae, Plankton, Bacteria, Fungi…)
  - Abiotic Factors: **Physical components** of an ecosystem (Ex: Sunlight, humidity, precipitation, wind, water currents…)
  - Environmental Factors: (Ex: Air, water, climate, landforms, soil, temperature…)
- **Methods of Ecological Study**
  - **Observation** – asking questions and making direct/indirect observations.
  - **Experimentation** – testing hypotheses in the lab or natural settings.
  - **Modeling** – using models (often mathematical) to study large-scale or long-term phenomena, like climate change.

3.2 Energy, Producers, and Consumers

- **Primary Producers (Autotrophs)**: Organisms that make their own food (plants, algae, some bacteria).
    - **Photosynthesis**: using sunlight to make food.
    - **Chemosynthesis**: using chemical energy (like deep-sea vent bacteria).
- **Consumers (Heterotrophs)**: Rely on other organisms for energy. Types include:
    - **Herbivores** – eat plants.
    - **Carnivores** – eat animals.

      Omnivores – eat both plants and animals.
    - **Scavengers** – eat dead animals.
    - **Decomposers** – break down organic matter (bacteria, fungi).
        - They consume the organism from their exterior
    - **Detritivores** – eat detritus/decaying matter (worms, shrimp). - They consume the organism from their interior

3.3 Energy Flow in Ecosystems

- **Food Chain**: A simple, linear flow of energy (grass → rabbit → fox).
- **Food Web**: Complex network of interconnected food chains.
- **Trophic Levels**: Steps in a food chain/web (producers = 1st, consumers = higher).
    - Producer => primary consumer => secondary consumer => tertiary consumer
    - The energy is passed with the 10% rule for each level starting from the primary producer
    - E.g. 100% (primary producers) → 10% (1^{st})→ 1%(2^{nd}) → 0.1% (3^{rd})→ 0.01
- **Ecological Pyramids**: Diagrams showing relative amounts of energy/matter:
    - **Energy Pyramid** – only ~10% of energy transfers to the next level.
    - **Biomass Pyramid** – total living tissue at each level.
    - **Numbers Pyramid** – number of organisms at each level.

3.4 Cycles of Matter

- Energy flows **one way**, but **matter is recycled**.
    - This is because energy is lost as a heat during organisms' metabolic processes
- **Key Cycles:**
    - **Water Cycle**
        - Evaporation: water => water vapor

        - Condensation: water vapor => droplets around dust particles
        - Precipitation: water fall from cloud => rain, sleet, snow, hail
        - Transportation: water loss from plant leaves
        - Runoff: flow of water
        - Percolation: downward movement of water through soil or rock layers – an underground phenomenon – replenished underground aquifers

    - **Carbon Cycle** – photosynthesis (removes CO2 => organic C), respiration (organic C => CO2), feeding (eating food from C), decomposition (decay), fossilization (tree dies underground), combustion (burning)
    - **Nitrogen Cycle**
        - **Nitrogen Fixation** (N2 => NH3)
            - Bacteria convert nitrogen gas into **ammonia NH3** that plants can use.
            - Small amount of nitrogen gas convert to usable forms by lightening called **atmospheric nitrogen fixation.**
        - **Nitrification** (NH3/NH4+ => HO2- => HO3-)
            - Other soil bacteria convert NH3/NH4+ into nitrites and nitrates that primary producers can use to make proteins and nucleic acids.
        - **Ammonification**
            - Decomposers break down organic nitrogen compounds in waste and dead organisms to release **ammonium NH4+**.
        - **Denitrification**
            - Ions form => gas form
            - Other bacteria convert nitrates, nitrites back to nitrogen gas.

- Nutrient limitation
    - A **limiting nutrient** is the nutrient in shortest supply that limits ecosystem productivity (often nitrogen or phosphorus).
    - Too many nutrients lead to problems like **algal blooms** (The phenomenon is called **eutrophication**)
- **Interdependence and Human Impact**
    - All organisms are connected in a **web of interdependence**.
    - Humans rely on ecological processes (food, water, oxygen).
    - Human activities (fossil fuels, farming, deforestation) alter cycles and ecosystems.

Quick Review Questions

- What are the six levels of ecological organization?
- What's the difference between biotic and abiotic factors?
- What are the three methods ecologists use to study ecosystems?
- How is energy flow different from matter cycling?
- Why is nitrogen fixation important?