# IDX G9 Biology S
# Study Guide Issue S1 Midterm
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**Contents:**



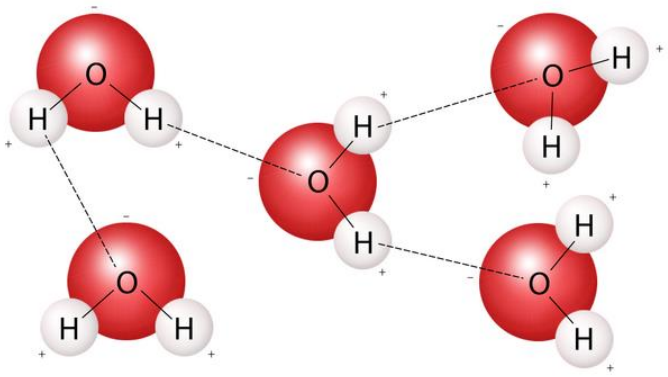
## 1.1 What is Science

- 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**.**

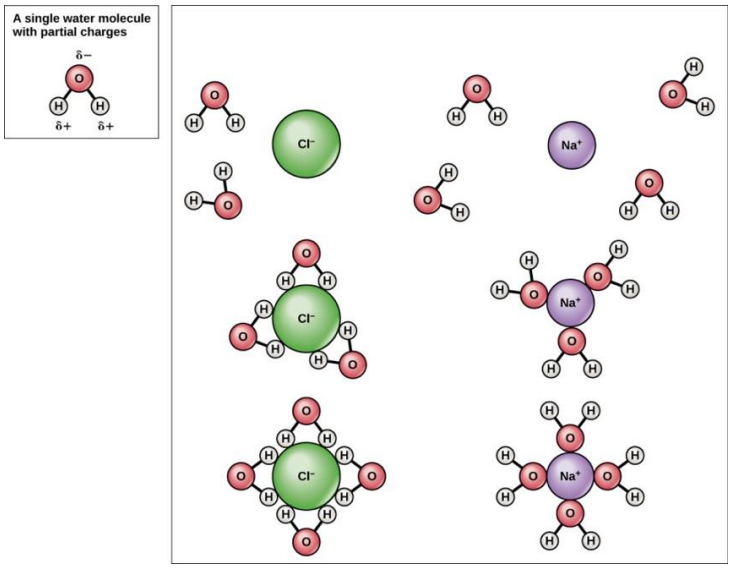

**2.2 Properties of Water**

- 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.



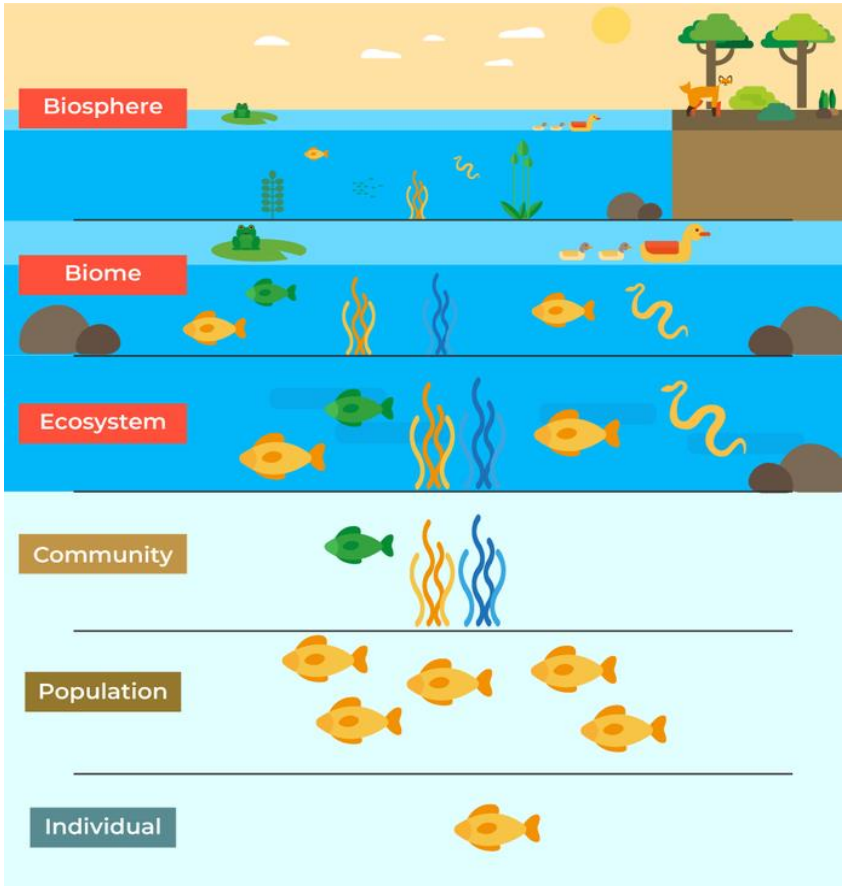
- Thus, makes water to stick on other substances, making water to perform **Capillary action**, the movement of a liquid through a narrow space or porous material without external force.




### 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.

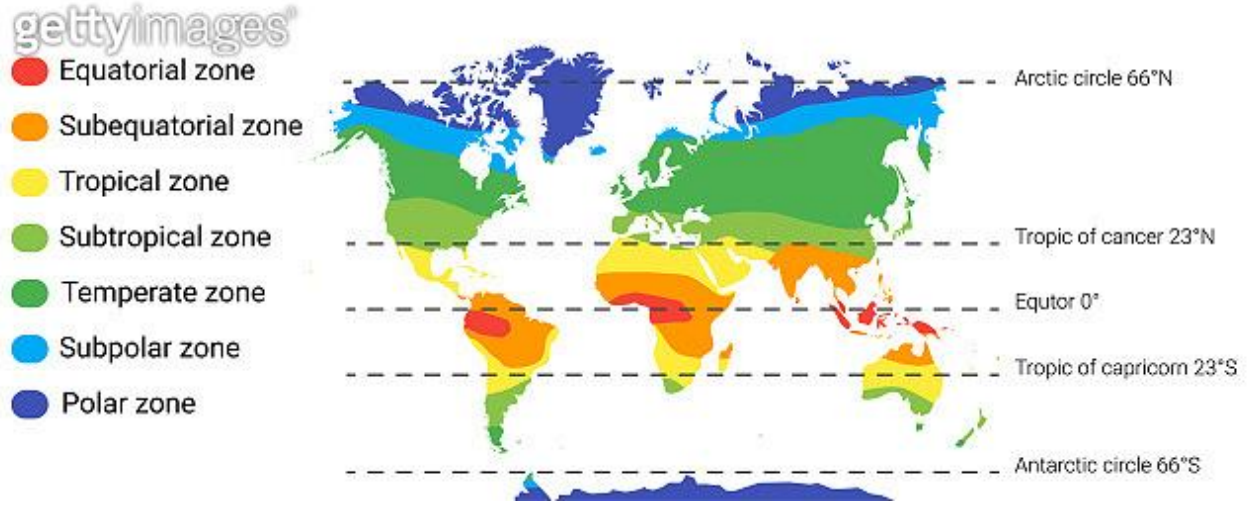
**Quick Review Questions**

- 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?

**4.1 Climate**

- Big Idea
  - Weather and climate are not the same. Climate is the long-term pattern of weather conditions in a region and is the primary factor determining the global distribution of biomes.
- Key Concepts
  - Weather vs. Climate:
    - Weather: **Day-to-day** conditions of Earth's atmosphere at a **particular time and place** (e.g., "It's sunny and 75°F today").
    - Climate: **Average conditions of temperature** and precipitation in a region **over a long period** (e.g., "Seattle has a temperate, rainy climate").
- What Causes Climate?
  - Climate is shaped by:
    - Solar Energy trapped in the biosphere: The greenhouse effect (a natural process where gases like $CO_2$ and methane trap heat) keeps Earth warm enough for life.
  - Latitude: This is a major driver of climate patterns.
  - Polar Zones: Cold areas where the sun's rays strike at a low angle. (66.5°-90° N/S)
  - Temperate Zones: Areas with seasonal climates, where the sun's angle varies. (23.5°-66.5° N/S)
  - Tropical Zone: Warm area where the sun's rays strike most directly. (23.5° N - 23.5° S)

- Heat Transport in the Biosphere: Winds and ocean currents redistribute heat around the planet, warming some areas and cooling others.




- Key Vocabulary
  - Climate
  - Weather
  - Greenhouse Effect
- Study Questions
  - What is the difference between weather and climate?
  - Describe the three main climate zones and how their proximity to the equator affects their temperature.
  - Explain the natural greenhouse effect. Why is it essential for life on Earth?
  - How do wind patterns and ocean currents influence regional climates?

**4.2 Niches and Community Interactions**

- Big Idea
  - An organism's niche is its "job" or role in its environment, including how it interacts with both living and nonliving factors. These interactions determine where species can live and how they coexist.
- Key Concepts
  - The Niche:
    - A niche describes not just where an organism lives, but how it lives and how it interacts with the environment.

        - It includes the range of physical and biological conditions in which a species lives and the way the species obtains what it needs to survive and reproduce.
        - Examples: What it eats, what eats it, its temperature range, how it finds shelter, its reproductive strategies.
    - Competitive Exclusion Principle:
        - A fundamental rule in ecology: No two species can occupy the same niche in the same habitat at the same time.
        - Direct competition for the same resources will lead to one species being more successful and eventually excluding the other.
    - Dividing Resources:
        - Instead of competitive exclusion, species often evolve to use resources differently, a concept known as resource partitioning.
        - Example: Different species of warblers may feed in different parts of the same tree. This can lead to character displacement, where competing species become more different in their physical characteristics (e.g., beak size) where their ranges overlap.
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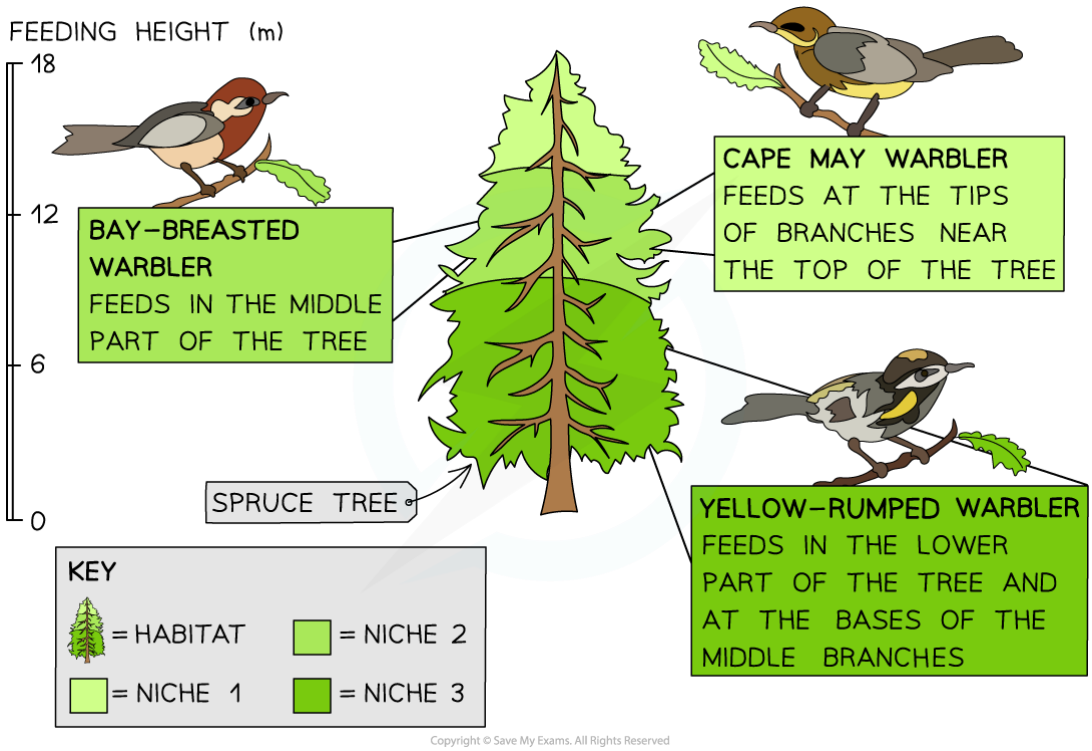




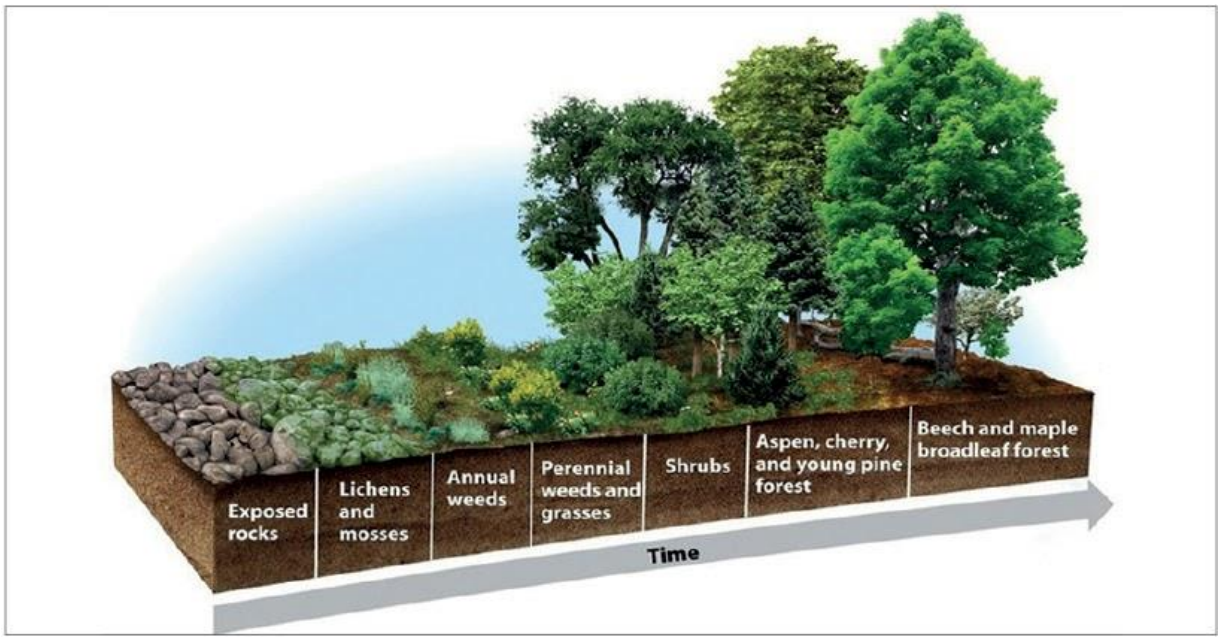
- Key Vocabulary
    - Niche

    - Competitive Exclusion Principle
    - Resource Partitioning
    - Predation
    - Herbivory
    - Keystone Species
- Study Questions
    - What is the difference between a habitat and a niche? (Hint: Habitat is the "address," niche is the "profession.")
    - State the Competitive Exclusion Principle in your own words.
    - What is resource partitioning? Give a real or hypothetical example.
    - Define predation and herbivory. How do these interactions shape a community?
    - What is a keystone species, and why is its effect on a community so significant? (Hint: Think of the sea otter example from the text.)

**4.3 Succession**

- Big Idea
    - Ecosystems are dynamic and change over time, especially after a disturbance. This process of change is called ecological succession.
- Key Concepts
    - Primary Succession:
        - Occurs on surfaces where no soil exists.
        - Pioneer Species are the first to colonize these barren areas (e.g., lichens and mosses on bare rock).
        - They break down rock and help form soil.
        - Example: Succession on rocks after a volcanic eruption creates new land, or on rubble left by a retreating glacier.
    - Secondary Succession:
        - Occurs when a disturbance affects the community without destroying the soil.
        - Happens much faster than primary succession because seeds, roots, and nutrients are still present in the soil.

        - Example: Succession after a wildfire, hurricane, or human activity like farming.
    - Why Succession Happens:
        - Early species modify the environment (e.g., create shade, enrich soil), making it more suitable for new species to move in.
        - These new species may then compete with and replace the earlier species.
            - This process continues until a relatively stable, mature climax community is established.

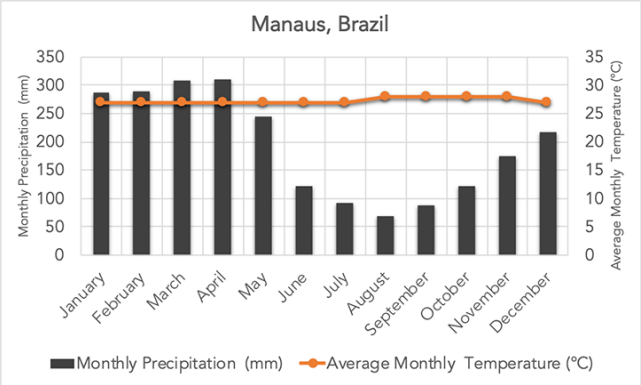



- Key Vocabulary
    - Ecological Succession
    - Primary Succession
    - Secondary Succession
    - Pioneer Species
    - Climax Community
- Study Questions
    - What is the main difference between primary and secondary succession?
    - What role do pioneer species play in primary succession?
    - List two natural and two human-caused events that could lead to secondary succession.

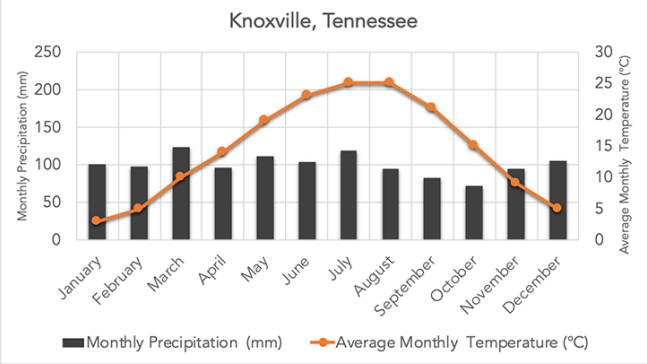
- Draw a simple flowchart showing the stages of secondary succession from a disturbed area to a climax community.

## 4.4 Biomes

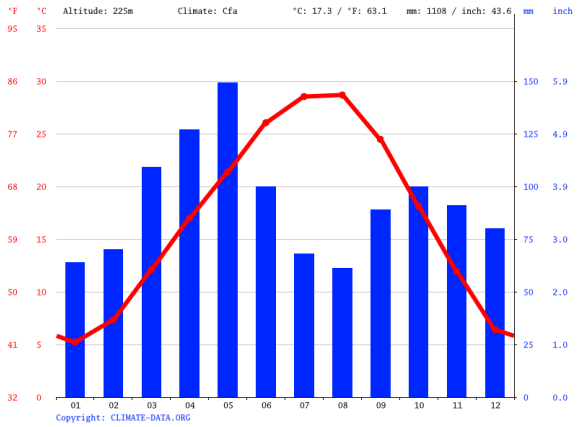
- Big idea: Biome is a different form of an ecosystem in which a large land area with a distinct climate and plants and animal species exist. This is way mountain ranges or ice caps are not a biome.
    - Key concepts: there are many types of biomes and need to remember the differences between the precipitation-temperature graphs for each biome.
- **Tropical Rain Forest:**
    - The tropical rainforest biome is characterized by high temperatures and high rainfall year-round, with no distinct dry season. Tropical rainforests are found near the equator, with major rainforests located in South America (the Amazon), Central Africa (the Congo), and Southeast Asia.



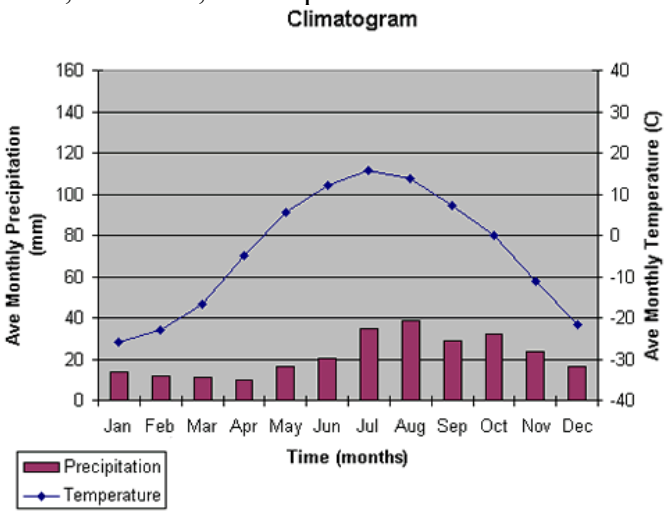

- **Temperate Forest:**
    - The temperate forest biome consists of forests that grow in the temperate zones (the region located between the tropics and the polar regions) of both hemispheres. Temperate forests experience four distinct seasons.



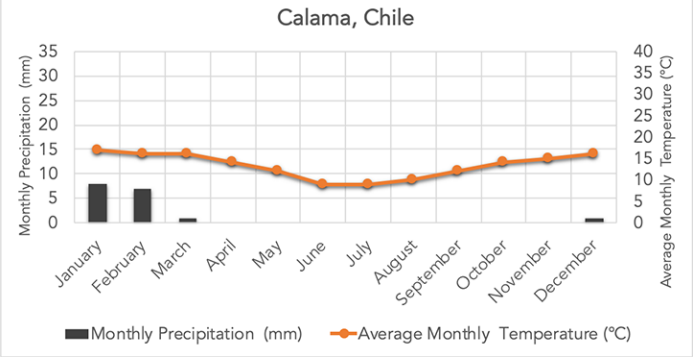
- **Tropical Savanna:**
    - warm temperatures; seasonal rainfall; compact soil; frequent fires set by lightning. Distributed in large parts of eastern Africa, southern Brazil, northern Australia



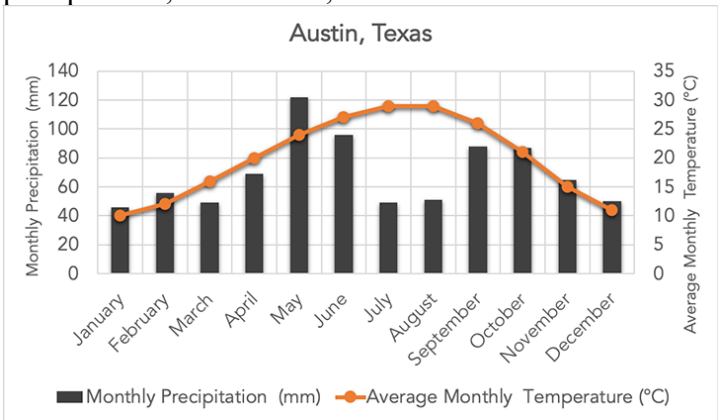

- **Tropical Dry Forest:**
    - warm year-round; alternating wet and dry seasons; rich soils subject to erosion. They are located near tropical rainforests in Africa, South and Central America, Mexico, India, Australia, and tropical islands



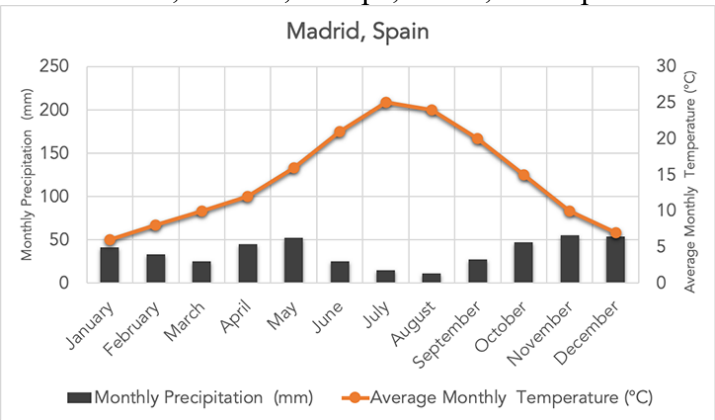

- **Desert:**
    - Most of these deserts concentrate around 15-30° latitude south and north of the Equator. the average annual rainfall is only about 1 inch (250 millimeters). In summer, the temperature ranges between 95°F to 104°F (35°C to 40°C), while winter temperature fluctuates between 68°F to 86°F (20°C to 30°C).



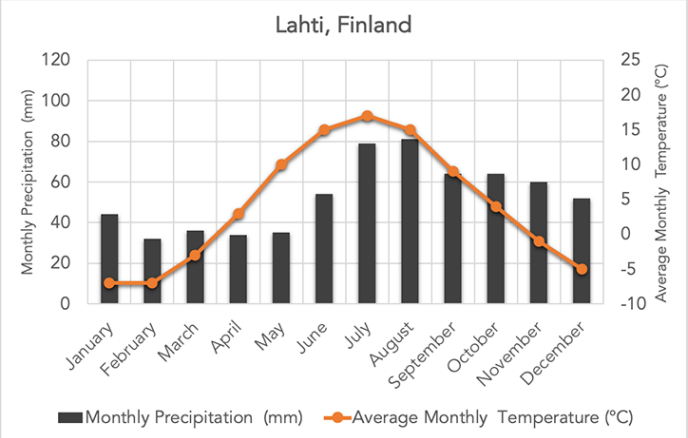
- **Temperate grassland:**
  - Grasslands are generally open and continuous, flat areas of grass. They are often located between temperate forests at high latitudes and deserts at subtropical latitudes. It has warm to hot summers; cold winters; moderate, seasonal precipitation; fertile soils; occasional fires.



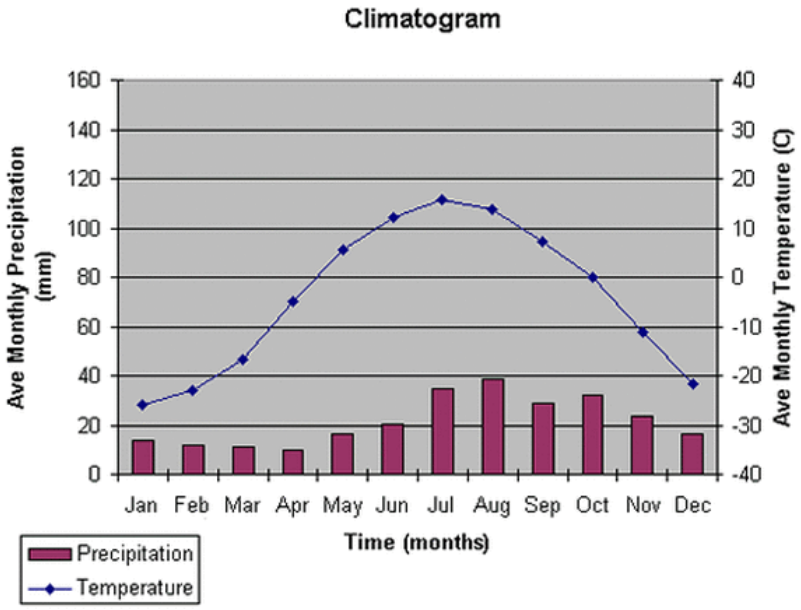

- **Temperate Woodland:**
  - The temperate woodland biome is characterized by deciduous trees and mixed forests, typically found in temperate climates with moderate rainfall. It is in Eastern United States, Canada, Europe, China, and Japan.




- **Northwestern Coniferous Forest:**
  - The coniferous forest is sandwiched in between the tundra to the north and the deciduous forest to the south. One type of coniferous forest, the northern boreal forest, is found in 50° to 60°N latitudes. Countries with large areas of coniferous forests include Sweden, Finland, Norway, Russia, Japan, Canada and the United States of America.



- **Boreal Forests:**
  - The boreal forest covers about 11% of Earth's land mass. It is in the northern hemisphere. It extends from around 50° North latitude to 65° N latitude. This soil in this biome is acidic, thus has low fertility. Typical temperatures range from 21 °C in summer to -54 °C in winter. The precipitation in this biome is moderate. It ranges from 200 to 600 mm per year. Droughts are rare. Countries with Boreal Forest biomes are Canada, China, Finland, Japan, Norway, Russia, Sweden and the United States.




- **Tundra:**
  - Tundra is the coldest of all the biomes. Tundra comes from the Finnish word *tunturi*, meaning treeless plain. It is known for extremely low temperatures, little precipitation, poor nutrients, and short growing seasons. The growing season ranges from 50 to 60 days. The average winter temperature is -34° C, but the average summer temperature is 3-12° C
  - Tundra is found in the regions just below the ice caps of the Arctic, extending across North America, to Europe, and Siberia in Asia. Much of Alaska and about half of Canada are in the tundra biome.