



Core units: Exemplar – Year 9
Illustration 1: Biomes and ecosystems

World biomes

Major types of biome across the world include:

- forest and woodland
- grassland
- desert
- tundra
- alpine.

Forest and woodland biomes

Forest and woodland biomes are dominated by trees. Forests have very tall trees that are spaced relatively close together forming a closed canopy. Woodlands have smaller trees that are separated by some distance so there is an open canopy. The height and spacing of trees in a biome is generally influenced by the amount of rainfall received by the region. The higher the rainfall, the taller the trees and the more closely spaced they will be (increased productivity).

Tropical forests

Tropical forests are distributed in areas of the world near the equator and between the Tropic of Capricorn and the Tropic of Cancer. They are characterised by very hot temperatures and high average annual rainfall (greater than 1500 mm per annum). Regions which receive heavy rainfall all year round, with no distinct dry season, are referred to as tropical rainforests. Here the trees grow to over 40 metres high and their branches interlock to form a continuous canopy. They have higher productivity than any other biome. Regions which receive seasonal rainfall, influenced by changing monsoon winds, are referred to as monsoon forests. They are also characterised by trees more than 40 metres high forming an almost continuous canopy.

One of the most distinctive features of the tropical forest is the multi-storey arrangement, with each layer having its own particular characteristics which have adapted to both the climate and the microclimate within the forest. Examples of trees which grow to form the canopy include the African mahogany, the south-eastern Asian teak and the South American balsa. Some taller trees emerge above the canopy as they compete for sunlight. Smaller plants such as epiphytes and orchids also grow on the branches of the tall trees to gain access to light, while others (such as lianas) climb up the trees like vines to reach the light.

Beneath the canopy is the understorey. This layer contains the saplings of canopy trees and various species of palms and ferns which grow to approximately 15 metres high due to the restricted light. Nearer

to the forest floor plants are usually quite sparse. There may be a layer of palms, bamboo, ferns, orchids and mosses. The forest floor is also covered with the litter of leaves and branches which decompose relatively quickly due to the warm, moist conditions. This is turned into a shallow layer of humus. Despite the high productivity of tropical forests the soils are relatively infertile due to the heavy rainfall and subsequent leaching of minerals deep within the soil profile.

Temperate forests

There are two types of temperate forests – warm temperate forests and cool temperate forests. Both receive high average annual rainfall (greater than 1500 mm per year).

The warm temperate forest biome occurs in mid-latitude regions experiencing hot summers, cool to mild winters and moist conditions all year round. Examples of these areas include south-eastern USA, central-eastern China, southern Japan, southern Brazil and south-eastern Australia. Warm temperate forest plants have adapted into broad-leafed evergreen trees in response to the plentiful and evenly distributed rainfall. Forests in the northern hemisphere are dominated by oaks, laurels and camphor, while species of southern beech and eucalypts dominate the south.

The cool temperate forest biomes occur mainly in the mid to high latitude regions of the northern hemisphere. They are typical of areas including north-west Europe, north-east China and north-east USA. These regions have high rainfall with very cold winters. The trees have therefore adapted to losing their leaves and lying dormant during this time. Deciduous species include oak, maple, elm, ash, birch and chestnut.

Taiga forests

Also known as boreal or coniferous forest, the taiga biome occurs between 50 and 60 degrees latitude in the northern hemisphere. Taiga forests can be found in Eurasia, North America, Siberia, Scandinavia, Alaska, and Canada. Summers are moderately warm and wet with around 400 to 1000 mm of precipitation per year (including snow). Winters are long, cold, and dry. The length of the growing season in the taiga is approximately 130 days. Vegetation consists mostly of cold-tolerant evergreen conifers with needle-like leaves, such as pine, fir and spruce. Soils are thin, nutrient-poor and acidic.

Woodlands

Open canopy woodlands have evolved in parts of the world characterised by moderate and often seasonal rainfall (700–1200 mm per annum). They often form the transitional zone between areas of forests and shrub lands or grasslands. Two types of woodland are referred to in this text. Savanna woodlands are found in tropical regions characterised by hot, wet summers and warm, dry winters. Mediterranean woodlands are found in regions between 30 and 40 degrees north and south of the equator, characterised by warm to hot dry summers and cool to mild wet winters. Areas with savanna woodland include east Africa and central America. Mediterranean woodlands include places bordering the Mediterranean Sea and all places with similar latitudes, such as southern California, central Chile, the cape of South Africa and the south-west of Western Australia.

Woodland plants are generally adapted to periods of seasonal drought. Most trees have evolved as evergreen species such as oaks, olives and eucalypts. They have developed waxy, leathery leaves to reduce water loss through transpiration and have thick, rough barks to insulate themselves against the heat and protect them from fires. Laterisation appears to be the main soil-forming process, and soils tend

to have a hard, gravelly upper horizon which plants have also adapted to. Some species have wide-spreading roots to gather as much water as possible when rain falls, while others have thick, strong tap roots which enable them to penetrate through the rock and access the water table.

Grassland biomes

Grassland areas are found in the moderately drier parts of the world. The two main divisions of grasslands include savanna grasslands and temperate grasslands.

Savanna grasslands

Savanna grasslands cover almost half the surface of Africa and large areas of Australia, South America and India. They are always found in climates with relatively hot, wet summers and warm, dry winters where the annual rainfall ranges from approximately 500 to 1000 mm per year.

Different savannas support different grasses depending on the amount of rainfall received and soil conditions. For example, in drier areas such as the Serengeti plains or Kenya's Laikipia plateau, the dominant grasses are Rhodes grass and red oat grass. Throughout the East African region, star grasses are dominant. The soil of the savannah grasslands is porous, with rapid drainage of water. It has only a thin layer of humus (the organic portion of the soil created by partial decomposition of plant or animal matter) which provides vegetation with nutrients.

Temperate grasslands

Major temperate grassland areas occur in the veldts of South Africa, the puszta of Hungary, the pampas of Argentina and Uruguay, the steppes of Russia, and the plains and prairies of central North America. They are characterised by hot summers and cold winters with moderate seasonal rainfall. The amount of rainfall received influences the height of grassland vegetation, with taller grasses (prairies) in wetter regions and short grasses (steppes) in the drier regions. Examples of grass species include purple needlegrass, blue grama, buffalo grass, and galleta.

The soil of the temperate grasslands is deep and dark, with fertile upper layers. It is nutrient-rich from the growth and decay of deep, multi-branched grass roots. The rotted roots hold the soil together and provide a food source for living plants.

Desert biomes

Desert biomes have very dry, arid climates and are usually characterised as receiving less than 250 mm of rainfall per year. Hot deserts (such as the Sahara) are found around the tropics while cold deserts (such as Antarctica) are found in higher latitudes. The main focus of this section will be on the hot deserts.

The inland location and continental effect of deserts means that seasonal temperature ranges are quite high. While daytime temperatures are very high (encouraging high rates of evaporation) night temperatures are relatively low. As evaporation exceeds precipitation in the desert biome, upward movement of minerals means that soils are usually poorly developed and very shallow. They lack humus, are salty and are generally infertile.

Desert vegetation tends to be stunted and widely spaced, having adapted to both limited moisture and poorly developed soils. Plants known as xerophytes have evolved to suit severe drought conditions and can be categorised into four main groups: drought evaders, drought escapers, drought resisters and water conservers.

Drought evaders are only short-lived with life cycles of approximately two to six weeks. Their seeds lie dormant in the ground and germinate only when there has been sufficient rainfall. Sturt's desert pea of Australia is an example of this type of plant.

Drought escapers are plants that are able to find alternative water supplies to rainfall. Species such as the ocotillo have wide-spreading roots to gather as much moisture as possible, and the Australian ghost gum has deep roots which are able to find underground water.

Drought resisters are plants which have adapted by reducing the amount of water lost through transpiration. Plants like cactus have leaves with reduced surface areas so there is less moisture loss.

Water conservers are plants which store water to use during very dry periods. Succulents (plants with fleshy stems) have this ability.

Tundra biomes

The tundra biome is found in the very cold regions of the northern hemisphere from the Arctic Circle to the North Pole. It is bound to the south by the coniferous forests of the taiga biome. Extremely low temperatures, little precipitation, poor nutrients and short growing seasons are all factors which have contributed to this treeless landscape.

The arctic is known for its cold, desert-like conditions. The average winter temperature is -34°C , and the average summer temperature is approximately 12°C which enables this biome to sustain life. Rainfall varies in different regions of the arctic with annual precipitation ranging from 150 to 250 mm. The growing season lasts between 50 to 60 days.

Soil is formed slowly and consists of a layer of permanently frozen subsoil called permafrost. The permafrost consists mostly of gravel and finer material. When water saturates the upper surface, bogs and ponds may form, providing moisture for plants. There are no deep root systems in the vegetation of the Arctic tundra. However, there is still a wide variety of plants that have adapted to the cold climate. About 1700 kinds of plants are known in the region, including low shrubs, sedges, mosses and grasses, lichens and about 400 varieties of flowers. All of the plants are adapted to strong winds, group together to resist the cold temperatures and can carry out photosynthesis at low temperatures and low light intensities.

Alpine biomes

As you travel up a mountain you will experience a number of different biomes as temperatures drop with altitude. For example the North American Rockies are characterised by a desert biome at the base, but as you move progressively higher you will experience the deciduous forest, grasslands, steppe and taiga before reaching the alpine biome at the top.

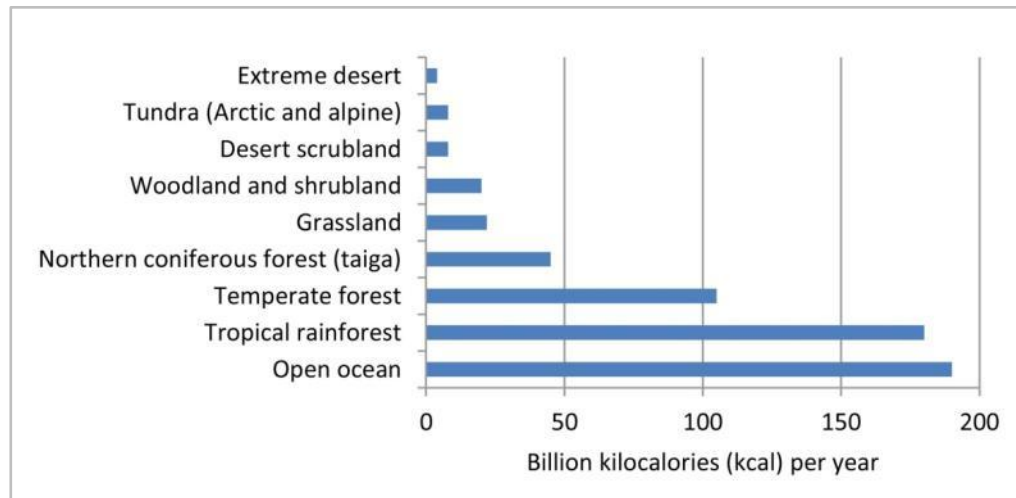
Alpine biomes throughout the world are located at high altitudes on mountains just below the snowline. Temperatures vary according to latitude, altitude and aspect (direction in which the slope faces) but in general, are below freezing in the winter and rise to approximately 10°C in the summer, making them too cold to support trees.

Plants of the alpine region have adapted to both high altitudes and extreme climate. For example, many plants are still able to photosynthesise even though the amount of carbon dioxide is significantly lower at these heights. Most plants include low perennial groundcover, small-leafed shrubs and heaths. They protect themselves from the cold and wind by growing close to the ground. When plants die in the region they don't decompose very quickly because of the cold. This makes for thin, sandy and rocky soil conditions, which the plants have also adapted to.

Student activities

1. The graph below shows the world's average net primary production (NPP). Put simply, net primary production (NPP) is the amount of energy or nutrients taken in by a plant from the atmosphere or oceans, minus the carbon dioxide it emits during respiration.

Study this graph, then discuss the following questions and tasks with members of your class.

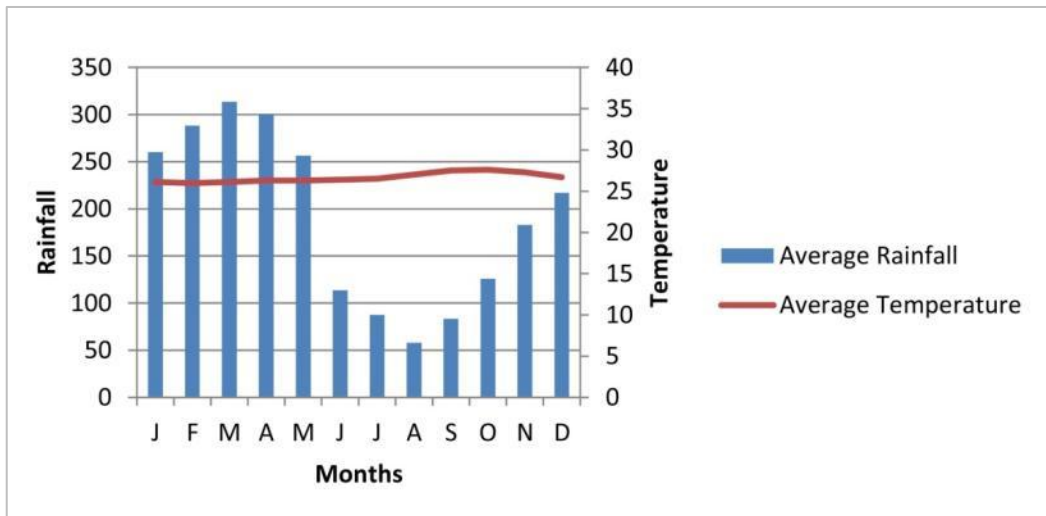


Average net primary production (NPP) of world biomes

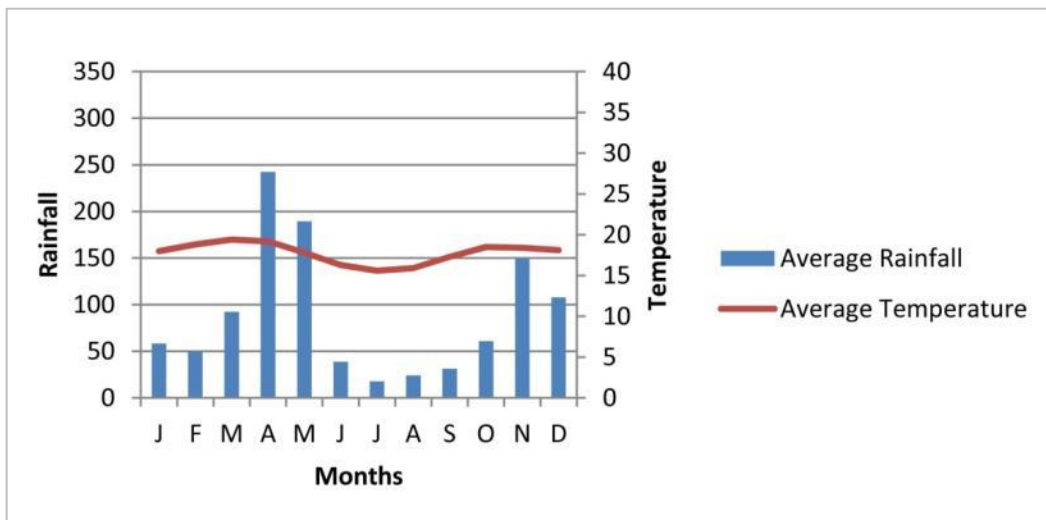
- Which biome has the highest average world net primary production? Specify this figure.
- Which of the terrestrial biomes has the highest average world net primary production? Specify this figure.
- Which of the terrestrial biomes has the lowest average world net primary production? Specify this figure.
- From what you have learnt about the various world biomes, describe the factors you believe lead to the highest net primary production.
- Describe the factors which lead to the lowest net primary production.

2. Study the four climate graphs below.

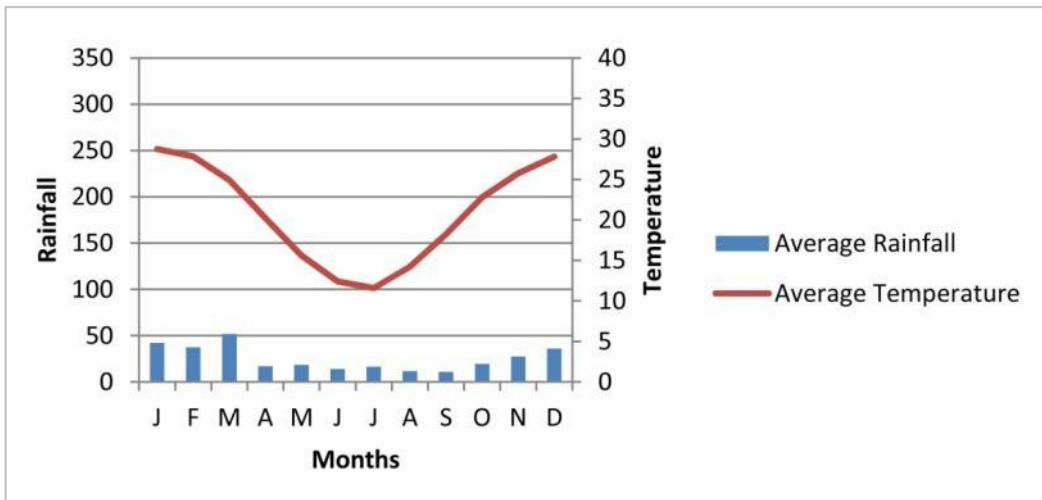
- Describe the seasonal temperature and rainfall characteristics of each location. In your descriptions refer to actual data including:
 - total annual rainfall
 - average maximum temperature
 - average minimum temperature
 - seasonal temperature range.
- Which biome do you think is represented by each of the graphs? Give reasons for your choices.



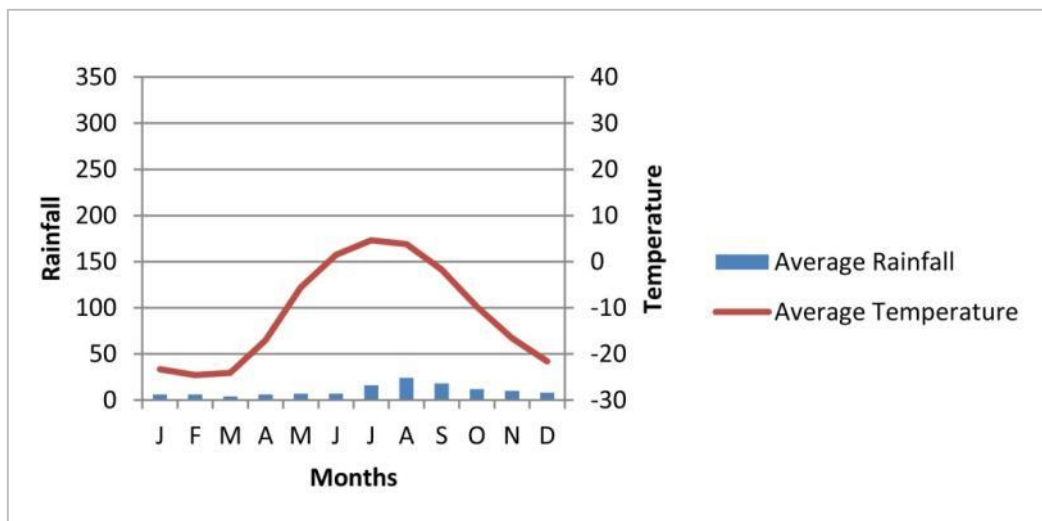
Climate graph – Manaus, Brazil



Climate graph – Nairobi, Kenya



Climate graph – Alice Springs, Australia



Climate graph – Thule, Greenland

3. Study the five photographs below.

- Describe the vegetation characteristics shown in each photograph.
- Decide which biome is represented in each photograph. Give reasons for your answers.



Photograph 1

Source: © Tamara Boyer



Photograph 2

Source: © Tamara Boyer



Photograph 3

Source: Malcolm Massie, Scotch College Adelaide



Photograph 4

Source: Malcolm Massie, Scotch College Adelaide



Photograph 5

Source: Malcolm Massie, Scotch College Adelaide