2.4 Climate and biomes

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS biome • climograph • precipitation • tricellular model • Hadley cell • savanna

Objective

Build the skills to answer exam questions on **climate** and **biomes**: what controls where biomes are, the **tricellular model**, productivity in different biomes, and how climate change moves biomes.

You must be able to:

- explain how temperature and precipitation control the distribution of biomes
- read climographs and identify the biome
- explain the tricellular model of atmospheric circulation
- compare productivity in biomes, and explain how climate change shifts biomes

1 Key knowledge and worked examples

Climate and biomes

A **biome** is a group of ecosystems with a similar climate and similar vegetation, e.g. tropical rainforest, desert, tundra. Its location depends mostly on **temperature** and **precipitation**, which control photosynthesis, respiration and decomposition.

biome	temperature	precipitation	NPP
tropical rainforest	high all year ($\approx 27\,^\circ$C)	high ($>$ 2000 mm a year)	highest on land
hot desert	very hot days, cold nights	very low ($<$ 250 mm)	very low: water limits
temperate forest	warm summers, cool winters	moderate	medium
tundra	very cold, short summer	low	very low: cold and short season limit

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A **climograph** shows the monthly mean temperature (line) and precipitation (bars) for one place.

Tricellular model. The Sun heats the equator most. Warm air rises at the equator, cools and drops heavy rain (rainforests); it moves towards the poles, sinks at about 30° N and S, warming and drying (hot deserts) – the **Hadley cell**. **Ferrel** and **polar** cells form between 30°–60° and 60°–90°; rising air at about 60° brings wet, stormy weather.

Climate change: as temperatures rise, biomes shift **towards the poles** and **up mountains**; some may pass tipping points (e.g. parts of the Amazon rainforest drying towards savanna).

Worked example. A place with 3000 mm of rain and 26–28 °C every month is tropical rainforest: warm and wet all year, so high NPP.

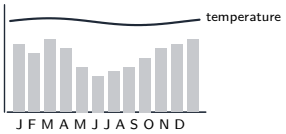
Answer shapes: link the biome to both temperature **and** water, then to productivity.

2 Practice

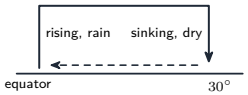
2.1 State the **two** climate factors that most control the distribution of biomes. [2]



2.2 The climograph shows monthly temperature (line) and precipitation (bars). Identify the biome, and give **two** reasons from the data. [3]



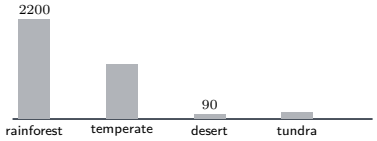
2.3 Use the tricellular model to explain why many hot deserts lie near 30° N and S. [3]



3 Exam-style questions

3.1 Tropical rainforest has an NPP of about 2200 g m^{-2} yr^{-1}; hot desert has about 90 g m^{-2} yr^{-1}.

(a) Explain the difference in NPP. [2]



(b) Suggest why tundra also has low NPP, although it is not dry. [2]

3.2 Mountain plant zones are moving uphill as the climate warms.

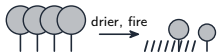
(a) Explain why the zones move uphill. [2]

(b) Explain why species at the top of the mountain are most at risk. [3]



3.3 Scientists warn that parts of the Amazon rainforest may change to savanna.

Discuss whether the Amazon rainforest is approaching a tipping point. [6]



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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

temperature; precipitation

2.2

tropical rainforest; high temperature all year, about 26–28 °C; high rainfall every month, so no dry season

2.3

air heated at the equator rises, cools and loses its moisture as rain; the dry air moves towards the poles and sinks at about 30°; sinking air warms and creates high pressure, so clouds and rain rarely form

3.1

(a) rainforest has high temperature, light and water all year, so photosynthesis is fast; in the desert, lack of water limits plant growth and cover

(b) low temperatures slow enzyme reactions and photosynthesis; the growing season is short and soils are frozen or poor in nutrients

3.2

(a) temperature falls with height; as the climate warms, each species' suitable temperature range is found higher up

(b) the area of land gets smaller towards the top, so populations shrink; they cannot move higher than the summit; species moving up from below compete with them

3.3

award up to [6]: the forest recycles much of its own rain through transpiration; deforestation and warming reduce this, so dry seasons get longer; drier forest burns more easily, and fire kills trees: positive feedback; past a threshold, savanna may become a new stable state that does not return to forest; but the size and timing of the threshold are uncertain, and protection and regrowth can slow the change; conclusion supported by the evidence, e.g. parts of the south-east already lose more carbon than they take in, so the risk is real

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