

Natural Systems

Nature is complicated... really complicated. So sometimes it's useful to cheat a little bit and imagine all those natural processes as a nice, well-ordered system. It's a simplification, but it makes things so much easier to understand...

Systems are Made Up of Stores, Flows, Boundaries, Inputs and Outputs

1) You need to **learn** what these **parts** of a **system** are:

- **Inputs** — when matter or energy (e.g. solar energy) is **added** to the system.
- **Outputs** — when matter or energy **leaves** the system.
- **Stores** (or components) — where matter or energy **builds up**.
- **Flows** (or transfers) — when matter or energy **moves** from one store to another.
- **Boundaries** — the **limits** of the system.

Matter is any physical substance involved in a system, e.g. water or carbon.

Example

In a **drainage basin system**, water enters as rain (**input**). The system's watershed is the **boundary**. Some water is **stored** in the soil and in vegetation. Water travels from the drainage basin to the river and then down the river (**flows**). It leaves the system where the river meets the sea (**output**).

Natural systems like drainage basins often have multiple inputs, outputs, stores etc. See pages 6-7 for more on drainage basin systems.

2) Systems can be **open** or **closed**:

Open Systems

- Both **energy** and **matter** **CAN** enter and leave an open system — there are inputs and outputs of both.
- Example: **drainage basins** (see p.6) are **open systems** — energy from the Sun enters and leaves the system. Water is input as precipitation, and output as river discharge into the sea.

Systems can also be isolated (neither matter nor energy can enter or leave) but these aren't found in nature.

Closed Systems

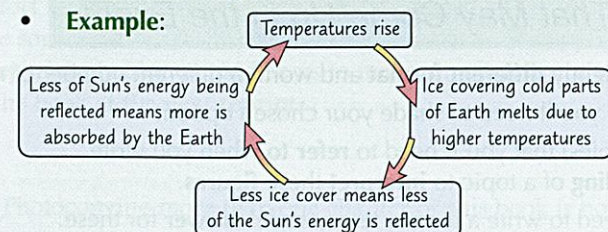
- **Matter** **CAN'T** enter or leave a closed system — it can only cycle between stores.
- **Energy** **CAN** enter and leave a closed system — it can be input or output.
- Example: the **carbon cycle** (see p.10) is a **closed system** — energy is input (e.g. from the sun by photosynthesis) and output (e.g. by respiration), but the **amount** of carbon on Earth stays the **same** because there are **no inputs or outputs** of matter.

Systems are Affected by Feedbacks

- 1) If the inputs and outputs of a system are **balanced**, the system is in **equilibrium** — flows and processes continue to happen, but in the same way at all times, so there are no overall changes to the system.
- 2) However, in reality there are lots of small **variations** in the inputs and outputs of a system (e.g. the amount of precipitation entering a drainage basin system constantly varies). These variations are usually small, so the inputs and outputs remain about **balanced** on average. The system is said to be in **dynamic equilibrium**.
- 3) **Large, long-term** changes to the balance of inputs and outputs can cause a system to change and establish a **new** dynamic equilibrium.
- 4) Changes can trigger **positive** or **negative** feedback:

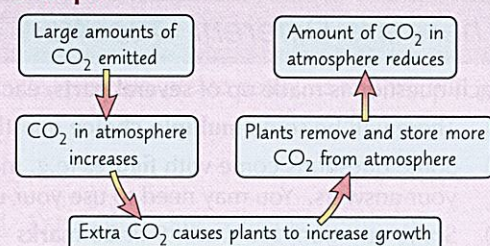
1 Positive Feedback

- **Positive feedback** mechanisms **amplify** the change in the inputs or outputs.
- This means the system responds by **increasing** the effects of the change, moving the system even **further** from its **previous state**.
- **Example:**



2 Negative Feedback

- **Negative feedback** mechanisms **counteract** the change in the inputs or outputs.
- This means that the system responds by **decreasing** the effects of the change, keeping the system **closer** to its **previous state**.
- **Example:**



Natural Systems

The Earth Can be Seen as One System Made Up of Lots of Subsystems

- 1) The Earth can be seen as a **closed system** — **energy** is **input** from the **Sun** and **output** to **space**, but **matter** is **not input or output** to space (except for the odd space probe).
- 2) The whole Earth system can be **broken down** into **smaller** parts called **subsystems**:

1 Cryosphere

The cryosphere includes all the parts of the Earth system where it's **cold** enough for water to **freeze**, e.g. **glacial landscapes** (see pages 54-55).



2 Lithosphere

The lithosphere is the **outermost** part of the Earth. It includes the **crust** and the **upper parts** of the **mantle** (see p.74).



"No outputs of matter to space?" scoffed Sam. "We'll see about that."

3 Biosphere

The biosphere is the part of the Earth's systems where **living** things are found. It includes **all** the living parts of the Earth — plants, animals, birds, fungi, insects, bacteria etc.



4 Hydrosphere

The hydrosphere includes all of the **water** on Earth. It may be in **liquid** form (e.g. in lakes and rivers), **solid** form (ice stored in the cryosphere) or **gas** form (e.g. water vapour stored in the atmosphere). It can also be **saline** (salty) or **fresh**.



5 Atmosphere

The atmosphere is the layer of **gas** between the **Earth's surface** and **space**, held in place by **gravity**.

- 3) These subsystems are all **interlinked** (connected together) by the cycles and processes that keep the Earth system as a whole running as **normal** (e.g. the water cycle and carbon cycle).
- 4) **Matter** (e.g. water and carbon) and **energy** **move between** the subsystems — the output of one cycle is the input of the next, then the output of that cycle is the input of the next, and so on...
- 5) Because of the way that matter and energy move from one subsystem to the next, the Earth system is said to be a **cascading system**.
- 6) **Changes** that occur in one subsystem can **affect** what happens in the **others**.

See pages 4-5 for how water moves through the subsystems and pages 10-11 for how carbon moves through the subsystems.

Practice Questions

- Q1 What is meant by the term 'store' in a system?
- Q2 What is meant by the term 'boundary' in a system?
- Q3 What does it mean when a system is said to be in 'dynamic equilibrium'?
- Q4 What is 'negative feedback'?
- Q5 Name the five subsystems of the Earth.

Exam Questions

- Q1 Outline the differences between open and closed systems. [4 marks]
- Q2 Explain how positive feedback can alter a natural system. [4 marks]

And lastly, there's the examosphere...

...which is where knowing about all those other -spheres might come in useful. Not to be confused with the examofear, which is that feeling you get as you walk into the exam hall if you haven't revised as well as you could have. Luckily, you have a book in your hands right now (put that comic down and pick this book up) that can help avoid that. You just have get on with it.