OCR (A) Biology A-level

Topic 6.3: Ecosystems

Notes

An **ecosystem** includes all the organisms living in a particular area known as the **community** as well as all the non-living elements of that particular environment.

The **distribution** and **abundance** of organisms in a **habitat** is controlled by both **biotic** (living) factors e.g. predators andpathogens and **abiotic** (non-living factors) such as light levels and temperature. Each species has a particular role in its habitat called its **niche** which consists of its biotic and abiotic interactions with the environment.

Succession

Succession is the change of one community of organisms into the other. **Primary succession** occurs when area previously devoid of life is colonised by communities of organisms for instance after the **eruption of a volcano** which lead to formation of a rock surface. The area is first colonised by the **pioneer species** such as lichens which are adapted to survive in such harsh conditions. As organisms die, they are decomposed by microorganisms thus adding **humus**, this in turn leads to **formation of soil** which makes the environment more suitable for more complex organisms. Over time, the soil becomes richer in **minerals** thus enabling larger plants such as shrubs to survive. Eventually, a **climax community** is established which is the final seral stage of succession, a **self-sustaining and stable** community of organisms. **Secondary succession** occurs in a previously colonised area in which an existing community has been cleared. This type of succession can occur after events such as **forest fires**. As a soil layer is already present, succession begins at a later stage.

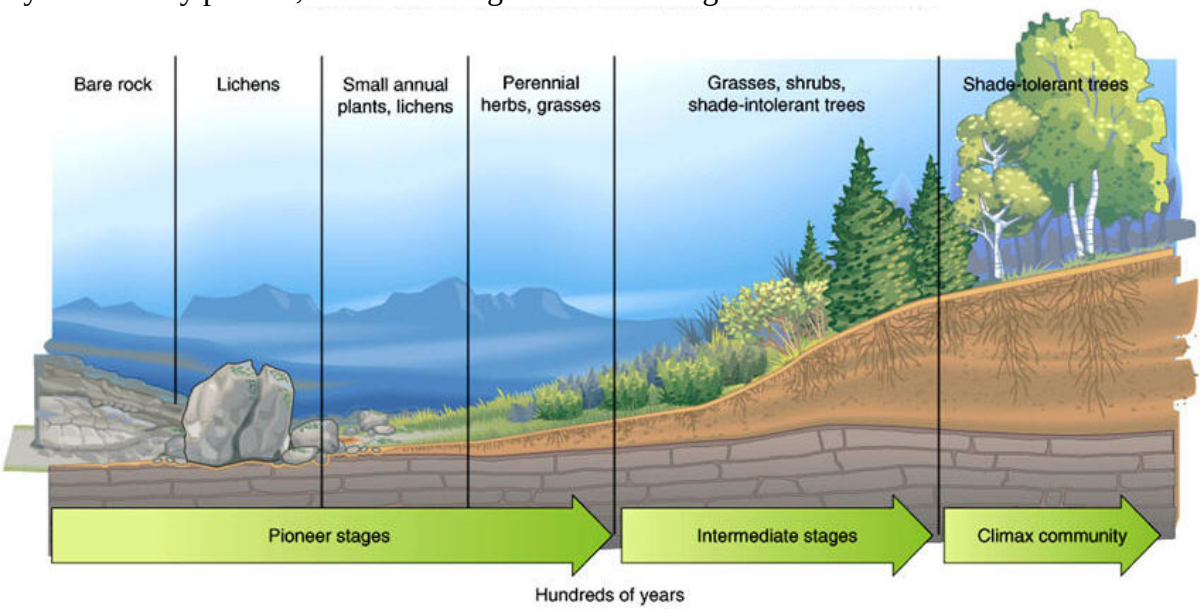

Figure 1 Yellowstone National Park

Biomass

In any ecosystem, plants synthesise organic compounds from either **atmospheric or aquatic carbon dioxide**. Most of the sugars synthesized by plants are used by the plant as respiratory substrates whereas the remaining sugars are used for synthesis of biological molecules which form the biomass of plants.

The biomass can be measured in terms of mass of carbon or dry mass of tissue per given area per given time. The chemical energy stored in dry biomass can be estimated using calorimetry.

- **Net primary productivity (NPP) –** the rate at which energy is transferred into the organic molecules that make up new plant biomass, that is the chemical energy store in plant biomass after respiratory losses to the environment have been taken into account

- **Gross primary productivity (GPP) –** the rate at which energy is incorporated into organic molecule in the plants in photosynthesis, that is the chemical energy store in plant biomass, in a given area or volume, in a given time

- Therefore: **NPP = GPP – R**

- The net primary production is available for plant growth and reproduction as well as to other trophic levels in the ecosystem such as decomposers and herbivores

- The net production of consumers (N) such as animals can be calculated by: **N= I – (F+R)** where I represents the chemical energy store in ingested food, F represents the chemical energy lost to the environment in faeces and urine and R represents the respiratory losses to the environment.

Nitrogen cycle

Nitrogen is an essential component of metabolism as it is required for the synthesis of **proteins and nucleic acids**. Nitrogen cannot be used in the form of gas, therefore to be of any use to plants, it first needs to be **fixed** either in the form of **ammonium ions or nitrates**. The process occurs as following:

- Nitrogen is first **fixed by bacteria** such as **Rhizobium** which live in the **root nodules of leguminous plants** such as pea plants.

- The bacteria have a **mutualistic relationship** with the plant where they exchange the fixed nitrogen for glucose.

- In anaerobic conditions, which are maintained with the use of special oxygen absorbing proteins, enable **nitrogen reductase** to reduce nitrogen gas to ammonium ions

- **Ammonium ions** are subsequently released by bacteria in the putrefaction of proteins from dead organic matter.

- **Chemotrophic bacteria** (**Nitrosomonas**) oxidise ammonium ions to nitrites

- **Nitrobacter** subsequently oxidise **nitrites to nitrates** in the presence of oxygen

- Plants absorb nitrates from soil for **nucleotide synthesis**

- In anaerobic conditions, **denitrifying** bacteria convert nitrates back to oxygen gas for respiration. **Nitrogen gas and nitrous oxide** are produced in the process

Carbon Cycle

Carbon is a component of all organic molecules and as such is recycled through the environment by the processes of photosynthesis, feeding, respiration and decomposition.

Sampling

Abundance of organisms can be measured with the use of:

- **Line transect**- where a line is placed down across the habitat and species in contact with the line are recorded

- **Quadrat** – a square frame of a given size, randomly placed in the area being sampled, species inside the quadrat are identified and counted to determine the abundance

- **Belt transect** – 2 tape measures are laid out and samples are taken between the two at set intervals along the tapes

Populations and sustainability

- The limiting factors which determine the carrying capacity, that is the **maximum population size that can be supported by the environment** include: **food, water, light, oxygen, nesting sites, shelter, parasites and predators**. **Competition** between organisms takes place in a case where a particular resource is **limited supply**.

- **Predator-prey relationships** give rise to a **fluctuating population** size of predators and prey. This is because, as the predator population grows, more prey is consumed thus meaning that prey population decreases to a point where there isn't a sufficient

amount of prey to feed the predator population. As a result of that, there are fewer predators thus increasing the chance of survival of prey, thus causing the prey population to increase in size. This in turn means that the predator population can grow again, thus restarting the cycle.

- There are two types of **competition** between organisms; **interspecific** competition which is the **competition between individuals of different species** and **intraspecific competition between individuals of the same species**.

- **Conservation** serves to **maintain or increase the biodiversity within a particular habitat** by allowing a **sustainable use of the resources** whereas **preservation serves to maintain** the biodiversity **levels and the habitat intact** by **minimising the effects of human activities** on the particular habitat.

- There are many **economic, social and ethical reasons for conservation**. For instance, many species provide a source of **food and medicine**, and are important for processes such as **pollination of crops** as well as for maintaining a good **quality of water as well as tourism**. Social reasons include conservation for aesthetic reasons and recreation whereas ethical reasons include the right to survive.

The management of an ecosystem can provide resources in a sustainable way, for example:

- **Coppicing** – cutting down of trees close **to the ground to encourage new growth,** effective as **stumps have good root systems**

- **Selective felling** – the **harvesting/removal of largest, mature tree**s, as well as **diseased** ones to enable other trees to grow, trees which are removed are **replaced with seeds**

- **Pollarding** is a form of coppicing where the trees are cut higher up, to prevent **deer** from eating the new shoots

- **Efficient production** where most of the tree is used to **minimise wastage**

- A good example of the **effects of human activities on animal and plant** populations is the **Galapagos Islands**. Due to an **increase in tourism**, the **demand for resources** such as water and energy has increased dramatically in the Galapagos Islands. As a result of that, **amount of waste and pollution increased**. This has led to an increase in waste and pollution as well as **overfishing**, thus causing sea cucumbers to become threatened. Moreover, many non-native species have been introduced, which outcompete the native species. There are **several conservation projects** in the Galapagos Islands which serve to minimise those effects, such as **goat culling** to eliminate non-native species, thus in turn increasing vegetation. Moreover, the **population of giant tortoises has been depleted** as they have been **eaten by humans**. To increase the population size of giant tortoises, they are now bred in captivity.

Many ecosystems in the world need management to protect the species and habitats. This can be done in many ways including:

- Controlling number of tourists/visitors
- Involvement of local communities
- Education of local communities
- Active management of vegetation
- Control of the introduction of species