

# Biology: ECOSYSTEMS

## Assignment 2 – Due 16 July 2021

Read the following and complete the questions

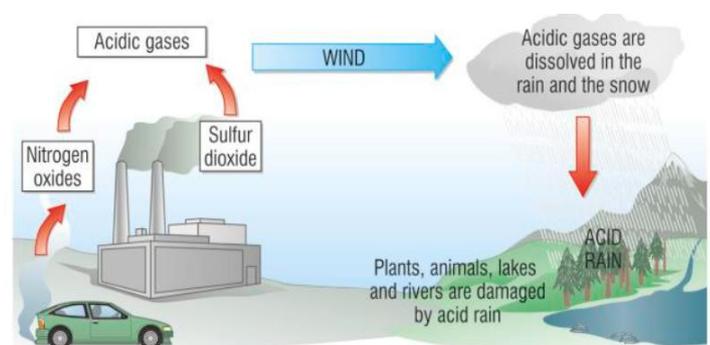
### Biodiversity and ecosystems

Biodiversity is a measure of all the different organisms on Earth or within a particular ecosystem. A high biodiversity helps ensure a stable ecosystem which in turn enables the long term survival of populations, this is because it reduces the dependence of one species on another for food shelter or maintenance of the physical environment. However many human activities have a negative effect on biodiversity, causing it to fall. Over the past 200 years the human population has grown rapidly because we do not have any natural predators and technological advances have enabled us to find new ways to produce food, avoid disease and produce resources. As the human population increases we are using more land for building, quarrying and farming. This destroys habitats and reduces the amount of land available for other organisms to live on, furthermore as our population grows so does the amount of waste we produce. If this waste is not properly handled and disposed of it causes pollution.

There are many different ways the land can become polluted; soil can become contaminated by untreated human sewage containing chemicals and gut parasites; if landfill sites are not carefully managed toxic chemicals can spread into nearby soil, landfill sites also take up space which means less space for natural habitats; modern farming often involves the use of chemicals such as herbicides and pesticides and fertilizers which can enter the soil and be absorbed by plants. These plants are eaten by primary consumers which are in turn eaten by secondary consumers, going up the food chain the concentration of the chemicals within the organism will increase and can reach toxic levels in the higher trophic levels, which is known as bioaccumulation.

Rivers and seas are also affected by water pollution, fertilisers and untreated sewage are very high in nitrate ions. If nitrate ions enter the soil they can be washed out into rivers and streams where they build up. The high level of nitrates causes algae on the water's surface to grow rapidly which prevents sunlight from reaching the water below which causes other aquatic plants to die as they cannot absorb enough light to photosynthesise. The dead plants undergo decay, the decomposers in the water use oxygen to respire which lowers the waters oxygen concentration, as a result other organisms in the water die as they don't have access to enough oxygen to respire this is called eutrophication.

Air can be polluted by poisonous gases produced by burning fossil fuels, one of these is sulphur dioxide. When sulphur dioxide enters the air it dissolves in water vapour in the clouds and leads to acid rain. Acid rain can damage the leaves of trees and damage plant roots when it soaks into the soil. If it falls into rivers and streams it makes the water acidic which can harm aquatic plants and animals. Many countries have taken steps to reduce pollution released into the air. However air pollution can travel great distances



**Figure 1** Air pollution in one location can cause serious pollution and acid rain somewhere else entirely, including other countries.

so countries which have not taken any steps to reduce air pollution may still cause acidic rain to fall in countries that have.

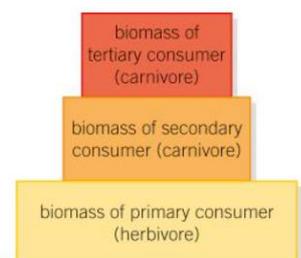
Many forests are under threat of deforestation, especially tropical rain forests. Trees may be removed for building or to graze cattle and grow crops to provide more food for the growing human population. Whilst trees are alive they act as carbon stores absorbing carbon dioxide from the atmosphere and locking it up within their tissues. When trees are cut down and left to decompose this carbon is released into atmosphere as carbon dioxide, often the trees are burned and this also releases carbon dioxide into the atmosphere. Fewer trees means the rate at which carbon dioxide is removed from the atmosphere by photosynthesis is reduced, less carbon can be locked away in the years to come. Deforestation has significant consequences on the environment, the release of carbon dioxide contributes to global warming, as it is a type of greenhouse gas, it also causes a reduction in biodiversity as organisms which previously relied on the trees for resources may no longer be able to survive.

Peat bogs are also under threat from human activities. Peat form over thousands of years from plant material that has not fully decayed and is a huge store of carbon on Earth. However, peat is being removed by humans to be used as compost which reduces the habitat available for plants, animals and microorganisms that live in peat bogs. Peat is also burned as fuel releasing carbon dioxide into the atmosphere, as a result the carbon store is being lost faster than new peat can be formed. Efforts have been made to conserve peat bogs but there is a conflict; some people still want to use peat as a cheap form of compost which improves plant growth which and in turn improves food production, others want to protect the habitat to maintain its biodiversity and to decrease carbon dioxide emissions.

The release of greenhouse gases into the atmosphere such a carbon dioxide and methane is a major contributor to global warming. Global warming has many biological consequences for the Earth. Rising sea levels could cause a loss of habitat if low-lying areas are flooded, whilst changes to temperature and rainfall patterns could affect the distribution of species and the migration patterns of animals.

Many human activities have resulted in a reduction of biodiversity, however we have started to take steps to prevent this from happening. There are many projects in place that aim to increase or maintain biodiversity, including: breeding programs for endangered species; protection and regeneration of rare habitats such as coral reefs, mangroves and heathland; reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop; recycling resources rather than dumping waste in landfill; the introduction of laws to reduce deforestation and reduce carbon dioxide emissions by some governments. However much more needs to be done to ensure that biodiversity will be protected in the future.

We can number each position in a food chain as a trophic level. The first trophic level are producers such as plants and algae which make their own food using energy from sunlight, the second trophic level contains the herbivore primary consumers that eat producers, the third trophic level is the carnivorous secondary consumers which eat the primary consumers and the forth trophic level is the tertiary consumers which eat other carnivores. The carnivores in level 4 are referred to as Apex carnivores as they themselves have no predators. Decomposers break



**Figure 2** Pyramid of biomass, the pattern moving up through the trophic levels will always be the same.

down dead plant and animal matter from all trophic levels, they secrete digestive enzymes on to the decaying organism and then absorb the small food molecules into their cells by diffusion. Between each trophic level energy is always lost.

One way to quantify energy transfer through a food chain is by drawing a pyramid of biomass. The first trophic level is always placed at the bottom of the pyramid and the bars of biomass get smaller with each trophic level. This shows how energy is lost at each stage of the food chain. The transfer of energy from the sun to the producers has a very low efficiency, only about 1% of energy transferred by light is used in photosynthesis. About 10% of energy from the first trophic level is then transferred to the second trophic level and of this energy only 10% is transferred to the third trophic level and so on. This explains why food chains are usually a maximum of only four trophic levels as there is soon not enough energy left to support another trophic level. Between each trophic level biomass is lost because not all of the material eaten is digested and used for growth, some of the lost biomass is egested as faeces, some is excreted as waste materials for example the carbon dioxide in exhaled air and the urea in urine and a large amount of glucose is respired for life processes. This means only a small amount is used for growth to increase an organism's biomass, it is only energy in this biomass that is available to the next trophic level.

Food security is having enough food containing all the required nutrients to feed the entire population. Several factors can affect food security, new pests and pathogens can damage crops and kill farm animals reducing the amount of food made. Environmental changes such as drought or flooding can affect crops preventing them being sown or harvested. There is increasing evidence to suggest that global climate change is causing an increase in these environmental changes. Changing diets in develop countries means that scarce food resources are shipped around the world to meet consumer demand, this can deprive local food supplies causing prices to increase so much that some people can no longer afford it. In some countries the birth rate is increasing rapidly, this causes a continual rise in the human population which puts pressure on the amount of food which needs to be produced to provide enough for each individual.

It is vital that global solutions are found to provide sustainable methods which provide enough food to feed everyone. One solution is improve the efficiency of food production, this can be done by restricting the transfer of energy from food animals to their environment, limiting the movement of farm animals so less energy is used for muscle contraction and keeping them inside where they are protected and warm so less energy is used to maintain body temperature. Some animals are also fed high protein food to increase their growth rate. Fish stocks in the oceans are declining, so sustainable fisheries have been developed to maintain the population size of fish stocks at a level where breeding continues. Many regulations have been introduced to prevent over fishing, such as net size restrictions and fishing quotas to help conserve populations.

Modern biotechnology could provide some of the answers to modern food production and food security, a type of protein called Fusarium can be grown in large vats to produce mycoprotein a type of protein rich food which can be used as a meat substitute. The fungus is grown on glucose syrup in aerobic conditions and the biomass is harvested and purified and is used to make food products. Genetic modification is a technique that has enabled scientists to create crop plants that are drought, flood and pest resistant. They have also created foods which have a higher nutritional content than non-GM versions of the same crop. An example is rice which is naturally low in the nutrient vitamin A which is needed for good eye sight, people in regions of the world where rice is the main part of the diet are at an increased risk of blindness. A type of GM rice called golden rice contains large amounts of vitamin A, it is hoped that people in these areas who eat enough golden rice will avoid blindness. However, there are issues surrounding biotechnologies, for example some

GM crops are developed so they do not produce seeds, this means farmers have to return to the company each year to purchase more seed rather than using seed produced by the crop grown the year before. The seed is often expensive to buy, this raises ethical concerns of whether or not the GM crops are a practical alternative for less developed countries and whether farmers are being exploited by GM companies.

### **Questions:**

Why has the human population increased so rapidly over the past couple of hundred years?  
(3 marks)

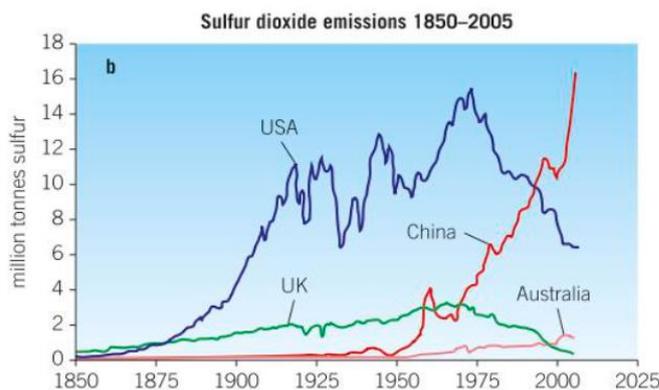
What effect is the increased population size having on the Earth? (4 marks)

Define biomass (1 mark)

What are main impacts of climate change? Give a brief explanation of each. (4 marks)

Summarise the main ways biodiversity can be maintained. (6 marks)

Discuss the implications for global biodiversity of the trends seen in the graph b below. (6 marks)



### **Research task:**

It has been hypothesised that Earth is undergoing its 6<sup>th</sup> mass extinction period. Not everyone believes this to be true, particularly those who do not believe that rapid climate change over the past century is due to anthropogenic activities.

- Research, Is Earth undergoing its 6<sup>th</sup> mass extinction period?
- Produce a 250 word response (+/- 10%), stating if you agree or disagree with the hypothesis. You will need to give reasons and examples, all of which should be referenced.
- In addition to the 250 words, please state how reliable you feel your sources were. Think about who has written them, who can edit them and if they have been peer reviewed. Wikipedia is not reliable and should not be used as reference.

Referencing can be shown as follows:

- (1) <https://www.sciencedirect.com/topics/veterinary-science-and-veterinary-medicine/fusarium-venenatum> accessed on 22/06/2021