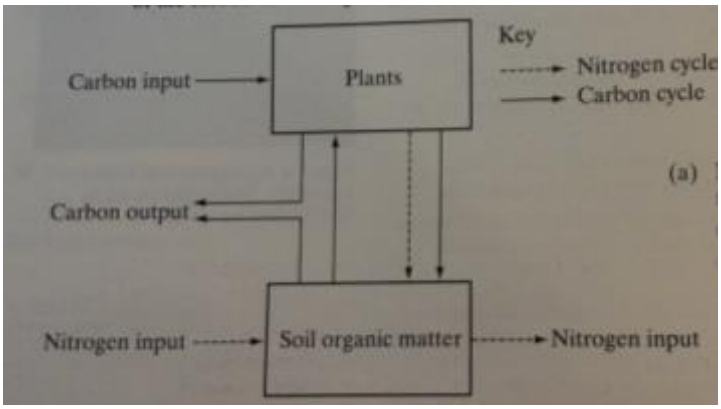
CHARLIE COOPER

NUTRIENT CYCLES – CHAPTER 6 END OF TOPIC QUESTIONS

1. **Arctic tundra is an ecosystem found in very cold climates. Figure 1 shows some parts of the carbon and nitrogen cycles in arctic tundra.**



(a) NAME THE PROCESS REPRESENTED BY:

(i) Carbon output - respiration.

(ii) Nitrogen input - Nitrogen fixation

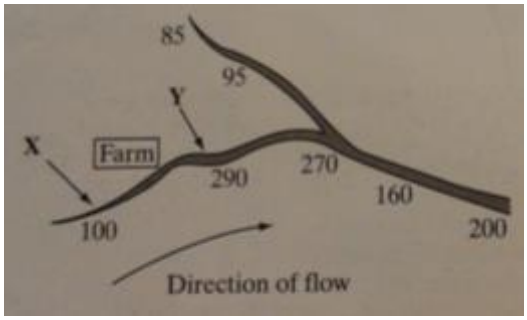
(b) An increase in temperature causes an increase in carbon input. Explain why.

An increase in temperature will increase the rate of photosynthesis as the enzymes used in the light-independent stage of photosynthesis will work faster.

(c) The nitrogen compounds in the organic matter in soil are converted to nitrates. Explain how nitrogen output can occur from these nitrates.

During denitrification, anaerobic denitrifying bacteria will convert the soil nitrates into nitrogen gas.

2. **Figure 2 shows a river system in an area of farmland. The numbers show the nitrate concentration in parts per million in water samples taken at various locations along the river. Concentrations above 250ppm encourage eutrophication in the river.**



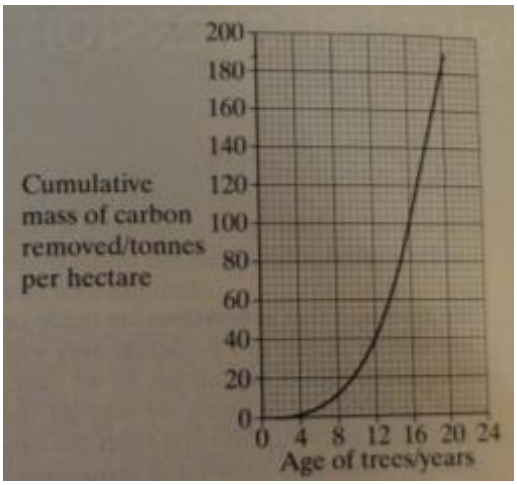
(a) Explain how farming practices might be responsible for the change in nitrate concentration in the water between point X and point Y.

In the farm, the crop will be removed from the soil so the nitrates are not returned and therefore are added by the use of natural or artificial fertilisers which causes leaching of nitrates into the river, increasing its overall nitrate concentration.

(b) Describe the effect the nitrate concentration may have in the river at point Y.

The concentration is above 250ppm, so eutrophication is likely. Nitrates from the farm will leach into the river and, due to the direction of flow, end up flowing towards point Y. The nitrate concentration will build up and will no longer be a limiting factor for plant and algal growth, which will rapidly grow. The upper layers of water will become densely populated with algae and this layer will absorb light, preventing it from reaching lower depths and so light becomes a limiting factor for the plants at lower depths. These plants will eventually die. The lack of dead plants will no longer be a limiting factor for the growth of saprobiotic bacteria, and so they too will increase in number. These bacteria need oxygen to respire, creating an increased demand for oxygen, and so oxygen levels will then decrease, leading to more organisms dying and thus more nitrates being released from the decaying organisms. There is then less competition for anaerobic organisms which increase and further decompose dead material releasing some toxic wastes and eventually making the water putrid.

3. Figure 3 shows the cumulative mass of carbon removed from the atmosphere by a pine forest in the 20 years after planting.



(a) Explain how the growth of the forest results in a decrease in the carbon content of the atmosphere.

As the forest grows there are more trees to carry out photosynthesis which takes in carbon dioxide for the light-dependant stage and fixes it into compounds in the tree.

(b) A new power station is to be built which will emit a total of 3800 tonnes of carbon over 20 years. In order to balance the carbon emissions a pine forest will be planted to remove an equivalent amount over 20 years. Use the graph to work out the smallest area of forest that would be needed.

3800/182 = 20.9 hectare's

(c) Explain how carbon-containing compounds present in the pine leaves that fall from the trees are used for growth by microorganisms that live in the soil.

During decomposition, the microorganisms will break down the leaves by secreting an enzyme which breaks down the leaves into smaller, soluble molecules that the microorganism can then absorb by diffusion. Some of these carbon compounds then will be used when the microorganism respires, and the energy from respiration will be used for its growth.

(d) Give 1 reason to explain why the rate of recycling of carbon would be greater in summer than in winter.

Photosynthesis increases in summer as there is a higher temperature which would increase the activity of the enzymes in the light-independent stage.

4. **(a) Wet moorland soils often contain low concentrations of nitrogen compounds, as a result of denitrification. Sundew is a plant which lives in wet moorlands. Its leaves have sticky hairs which can trap small insects that are then digested.**

(i) Describe the process of denitrification.

The soil becomes short of oxygen, due to the wet moorland conditions, and so there is an increase in anaerobic denitrifying bacteria. These bacteria convert nitrates in the sundew into nitrogen gas.

(ii) Explain how digestion of insects help the sundew to obtain additional nitrogen compounds.

Nitrogen is used to manufacture proteins and so, these insects contain proteins which are digested when the insects are trapped. The proteins can then be broken down into nitrogen compounds which can diffuse into the sundew plant.

(b) **Samples of plant and animal tissue were analysed to determine the proportions of the elements, carbon and nitrogen. In the plant tissue the ratio of carbon to nitrogen was 40:1. In the animal tissue the ratio was 8:1. Explain why the ratio is much higher in the plant tissue than in the animal tissue.**

Plant cells contain more starch than animal cells and starch contains plenty of carbon whereas animal cells have more protein than plant cells, and this contains nitrogen.

(c) Describe how nitrogen in compounds in a dead plant is made available for use by other plants.

Saprobiotic organisms break down the dead material, releasing ammonium ions, which can then be oxidised to form nitrates by nitrifying bacteria. Further oxidisation by the same bacteria forms nitrate ions which may be converted back to atmospheric nitrogen by the activity of denitrifying bacteria. Once in the atmosphere, it is available to be used by other plants.

5. **Two fields, A and B, were used to grow the same crop. In the previous year field A was used for grazing cattle and field B was used for the same crop. The fields were divided into plots. Different masses of fertiliser containing sodium nitrate were applied to these plots. After 6 weeks, samples of crop from each plot were collected and their mass determined. The results are shown in the table**.

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Mass of fertiliser added / kg ha^{-1}	Mass of crop / kg m^{-2}	
	Field A	Field B
0	14.5	6.4
10	16.7	9.8
20	17.4	12.9
30	17.5	16.2
40	17.5	17.1
50	17.5	17.1
60	17.5	17.1

(a) **(i) Describe the pattern shown by the data for field B.**

As the mass of fertiliser added increased, so too did the mass of crop, up until 40 kg ha-1 where an increase in fertiliser did not affect the mass of crop.

(ii) Explain the change in the mass of crop produced from field B when the mass of fertiliser added increases from 0 to 20 kg/ha.

The mass of crop increases. This is because the fertiliser provides sodium nitrate, which is required in the formation of DNA and proteins.

(iii) Explain why the mass of crop produced stays the same in both fields when more than 40kg of fertiliser is added.

Because the plants will already contain as much nitrogen as it requires and so it will no longer be a limiting factor.

(b) When no fertiliser was added, the mass of crop from field A was higher than from field B. Explain this difference.

Because natural fertiliser levels fluctuate in different fields. For example, field A may have naturally had more manure or urea.

(c) Explain 2 advantages and 1 disadvantage of an inorganic fertiliser such as sodium nitrate compared with an organic fertiliser such as manure.

ADVANTAGES: (1) it is easier to apply and gives you the precise details of the proportions of elements and nutrients

(2) it releases its nutrients quickly

DISADVANTAGES: (1) it leads to eutrophication more easily due to increased nutrient levels.