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## Ecology

### Overview

Ecology is the study of the relationship of living organism with each other and their nonliving environment. The study of ecology lays a foundation for understanding agriculture, forestry, fisheries, conservation, impact of human activities on ecosystem and how to remedy these impacts.

General objectives

By the end of the topic, the learner should be able to

- (i) Describe the relationships of organisms with each other and their nonliving environment.
- (ii) Explain the impact of human on ecosystem and the need for conservation

### 1. Components of the environment

#### Specific objectives

The learner should be able to

- (i) Describe the abiotic components, (air, water, Soil) and biotic components (living things)
- (ii) State abiotic factors (light, temperature, humidity, atmospheric pressure, rain fall, edaphic facts) and biotic factors (competition, predation, and biological association)
- (iii) Explain how the components and environment factors influence the distribution of abundance of organism in an ecosystem.

#### Concepts in ecology.

##### Biosphere

The earth is the only planet on which life is believed to exist.

The part of the earth and its atmosphere inhabited by living organism is called ecosphere / biosphere. The biosphere is subdivided into large areas with different environment conditions called biomes. Large the biome is subdivided into terrestrial biome and aquatic biome.

##### Terrestrial biomes

The two most important environment variables for life on land are rainfalls and temperature. Basing on these facts the terrestrial biome is further subdivided into;

### **a. Tropical rain forests**

These are formed whenever, it's hot [24-28<sup>0</sup>C ] and wet throughout the year. The vegetation of a tropical rain forest has a distinctive structure, with very tall tree which project above the rest of the forest canopy, beneath these emergent is a second layer of large tree which, together with emergent make up a continuous canopy. A third tree layer is made up of smaller tree which complete their cycle without ever reaching the canopy. Still nearer the ground are young trees, palms vine and herbs. By the time sunlight reaches the forest floor, most of it has already been intercepted so that it's dark with relatively sparse vegetation. Many organisms live in the canopy. The leaves of the tree are tough and impossible for most animals to digest. The most successful leaf-eater in central and tropical south America are sloths.



#### **Adaption of the sloth to feed on leaves**

- It eats a large amount of leaves to enable it extract as much food contents as possible.
- has long gut that allows enough time for digestion to complete
- contain mutualistic bacteria that digest cellulose
- Because of low energy content of leaves and necessity to conserve energy; the sloth.
  - \* is a slow-moving animal which rely on camouflage for protection
  - \*its temperature fluctuates, falling several degrees Celsius at night.

The soils of tropic rain forest are generally poor probably because decomposition occurs very quickly and any other available nutrient are rapidly taken up by plant or leached.

### **b. Temperate deciduous forest.**

The north temperate zone lies between tropical of Cancer and arctic cycle. The southern temperate zone lies between tropical of Capricorn and Antarctic cycle. In these two zones is where the temperate deciduous forest likely to be found, dominated by oak, hazel, beech

The major problem in this biome is that half of the year is winter when the temperature is too low for life. To survive in this condition, organisms have developed the following adaptations.

- a. loss of leaves by the trees in winter to reduce on water loss by guttation.
- b. small animals hibernate
- c. birds migrate to tropics during winter
- d. some animals have accumulated a lot of fat to prevent heat loss in winter
- e. some have short life cycle in of 3-6 months and survive in dormant stage in winter

### **Desert**

For example, Sahara Desert in Northern Africa is characteristic by scarce irregular rainfall and sandy soil. To survive in the desert organisms have developed the following adaptations.

- i. Small plants and animals have got very short life cycle; For instance, plants may germinate, mature, flower in a few weeks following occasional rainfall and then survive in form of seeds during the long dry spell.
- ii. To overcome shortage of water, the camel; use metabolic water and its body is very resistant to dehydration; certain frogs can survive for years without water by burying themselves deep into the sand. When it rains they dig themselves out, mate and lay their eggs in shallow puddle. Here the tadpole grows very quickly, metamorphosing into adults before the puddle disappears.
- iii. The camel has got broad feet not to sink in sand.
- iv. Some plants such as cactus store water in their fleshy stems.

### **Tundra**

It occurs in northern Canada and Asia. It is characterized by long winter and very short growing season. For this reason, it contains no trees neither small mammals but plants with very short life cycle and bigger animals with a lot of fat deposits e.g., Reindeer

### **Aquatic biomes**

Most important variables that affect organisms which live in water are

- Salinity
- nutrient availability
- depth of water
- how permanent is the water body
- tide strength

### **Salinity**

Aquatic organisms have got a problem of osmoregulation at different salinities. Consequently, organisms are only adapted differently to this problem in fresh water and marine water. And those that can survive in fresh water cannot survive in marine water and vice versa

### **Nutrient availability**

The most important nutrients in water are the nitrates and phosphate. Lakes with low phosphate and nitrate (oligotrophic) contain more species than lakes with high levels of nitrates and phosphates (eutrophic lakes)

In eutrophic lakes, the high levels of nitrates and phosphate promote high growth rates of algae and other photosynthetic organisms. This in turn supports a large number of aerobic bacteria which decompose the dead photosynthetic organisms. However, the aerobic bacteria take up more oxygen from water thus oxygen concentration may fall below that, can support life of big organisms.

### **Depth of water**

Shallow water may not be able to support big animals like whales. Small ponds may dry up which has a profound effect on organism that can only survive in water.

### Tide strength

Distribution of organism on the shores is affected tide strength; very strong tides, it prevents the growth of plant near the lake and big animals in water.

### Factor that affect distribution of organism on land.

### Abiotic factors

#### 1. Soil

It provides vital link between the biotic (living) and Abiotic (nonliving components) of the terrestrial ecosystem.

The term soil is applied to a layer of material overlying the rocks of earth crust. A suitable nutrient content and structure essential for successful growth and production in ecosystem.

#### (a) Components

Soil contains mainly

Component	Percentage of the soil
mineral salt (inorganic particle)	50 -60%
Organic matter	Up to 10%
Air	15 -25%
water	25 -35%

#### (i) Inorganic particles.

They are usually classified by the average size of particular shown below

Particle diameter ( $\mu\text{m}$ )	Particular name
<2	clay
2 - 20	silt
20 -200	fine sand
200- 2000	coarse sand
2 – 20 mm	gravel

Soil that contains a mixture of sand, clay, silt. Loams soil a mixture sand and clay soil in equal proportional with humus is the best soil for plant growth.

Physical properties of sand, clay soils are summarized below.

Properties	sand	clay
Texture	coarse	fine
Structure	light	heavily
Aeration	good	poor
Drainage	fast	slow
Water retention	poor	good
Nutrients	poor	good

### **(ii) Air and water**

Water and air occupy the same space therefore the soil that contain more air will contain less water and vice versa. Aeration is the term used to describe the amount of air in the soil. Drainage is the ability of water to go through the soil. Oxygen is particularly required for respiration of micro organism and plant roots; decomposition of organic matter, germination of seed, root hair formation and growth and water absorption.

Soil water is important

- As a source of water and dissolved mineral salt in plant.
- Promotes seed germination
- Excess water (water logging) slows down water absorption (by lowering the respiration of plant roots since it displaced air from the soil) and decay.
- Water softens soil for easy root penetration

### **(iii) Organic matter**

Dead organic matter is derived from soil organisms and from organism that live above the soil surface. Fungi and bacteria in the soil decompose organic materials to humus. Humus improves the water retention in the soil and therefore the soils containing humus will resist leaching.

### **(iv) Soil organism.**

The soil organism range in size from bacteria and protoctist to fungi, Nematode, insect, worms and a few mammals such as screw:

Role of soil organism

- (i) Microorganisms such as bacteria and fungi.
  - Promote germination by breaking seed coats
  - Fix nitrogen in the soil
  - Decompose and recycle or organic matter
- (ii) Macro organism such as rodent, termite and worms.
  - Turn the soil and improve aeration and drainage
  - Promote decay by breaking big pieces into small pieces
  - When they die they decay and add humus to the soil

### **(v) Dissolved minerals**

The nature of dissolved minerals in the soil depend on the parent rock, organism growing in and above the soil and whether aerobic conditions prevail chalk soil for example are high in calcium carbonate. However, are low in phosphate, nitrogen and iron, again as is the case with oligohophic lakes, species diversity is high. When soils are water logged, ions capable of existing in either oxidized or reduced state are found in their reduced form.  $\text{Fe}^{2+}$  for instance occurs instead of  $\text{Fe}^{3+}$  some plants are very sensitive to  $\text{Fe}^{2+}$ , so the vegetation found on waterlogged soil differs from vegetation in well drain condition

- (b) **Soil pH** is the acidity or alkalinity of the soil. It usually lies between 3 and 8.  
**Effect of soil pH**

- Acidic soil with pH of less than 4.5 reduce the availability of nitrogen and phosphorus to plant on the other hand,
- the concentration of toxic  $Al^{3+}$  ions increase as the pH falls. These two factors enable a few plants to grow in acid bogs. Those that do are often carnivorous and this supplies them with extra nutrients.
- Affect the activity of microorganism which may increase or reduce the rate of decay and nutrient recycling

### (c) Soil Structure

This is the arrangement of soil particles, it refers to the looseness or compactness of the soil particle.

Its effects are

- Drainage for loose soil is faster than that of compact soil
- Erosion for loose soil is faster
- Aeration is higher in loose soil

### (d) Soil temperature.

- High soil temperature increases the rate germination, decay, absorption of water

## 2. Climate

Climate refers to the predictable long-term pattern of rainfall, temperature and light. Weather is more short term. It may be cold, windy and wet one day and warm, calm and dry the next.

### (a) Water

In general, water is necessary for life. For terrestrial organism annual rain fall is the most important variable. However, it's predictability and pH are also important organism living in dry places usually have specialized mechanism to reduce water loss.

For aquatic organism, the temperature, salinity, oxygen saturation and nutrient content of the water are vital. In addition, the wave action limits the distribution of many aquatic species. In river the rate of current flow is important. It is noticeable that free- floating aquatic plants are absent from most streams and rivers but wide spread in lakes and ponds

### Temperature.

Few organisms can grow if the ambient temperature falls outside the range  $0 - 40^{\circ}C$  though, remarkably, some thermophilus [heat – loving] bacteria can complete their entire life cycle at temperature in excess of  $100^{\circ}C$ .

### Light

Light is need for photosynthesis in plant and vision in animals. Light can vary in its wavelength, intensity and daily duration and these can affect the quality of life.

Effects of light on living organism

- Photosynthesis in plant
- Photoperiodic behavior in plants i.e. influence flowering in plants
- Phototropism
- Phototaxis
- Vision in animals

- f. Migration of animals
- g. Reproduction

### **Air.**

One of the most important component of air is oxygen and few organism can live without it. CO<sub>2</sub> is a reagent in photosynthesis

### **Relative humidity**

This the measure of the amount of water vapor in air. When it's low organism lose water through evaporation and therefore face the risk of dehydration, on the other hand, If it's very hot and humid, a low rate of evaporation may be harmful as evaporation serves to remove heat from an organism and so cool it down.

### **Wind.**

- Occasional stormy wind can flatten trees that are 100 years old.
- Continuous strong wind can prevent trees from becoming established.
- Wind serves a useful function in the pollination and seed dispersal in plant
- Migratory birds may use winds to minimize.

### **Fire**

Fire can only burn if organic matter has accumulated. Now days fire is often the result of human carelessness. Natural fires are caused by lightning strike or more rarely by volcanoes

### **Ecological effect of fire**

- kill slow animals & plants
- some animal migrates
- encourage soil erosion & leaching
- release poisonous gases
- encourages regeneration in some grasses e.g. Cymbopogon
- destroys or chase away vectors, pests and parasites, e.g. tsetse flies
- accelerates nitrogen recycling of plastic waste.
- Enable vision of distant are for prey and predator.
- Allow growth of fire resistant species which are often not palatable.
- Destroys humus

### **Topography**

By topography is meant the altitude, slope and aspects of a place. As one climbs a mountain, many features of the physical environment change. It may be cold, wetter and windier. The air gets thinner so that oxygen and carbon dioxide become scarcer and more ultraviolet light penetrate. Slope is important because it reduce the chance of becoming waterlogged on very steep slope, soil cannot form, so plant cannot establish themselves.

The aspect of a place is of most important to sessile (immobile) organism. In the northern hemisphere, south facing slope receive more light and heat energy than north- facing one. The reverse is the case in south hemisphere. This influences the distribution of plant in the wild.

## **Population and niche concept**

### **Population.**

A population is group of individuals of the same species in a defined area. The number of individual in a population is called the population size e.g. all Tilapia living in a lake, all fleas on a dog, lion (in a National park). It is important to estimate the population in a given area,

### **Importance of estimating the population size**

- i. To be able to construct food webs and chains, pyramid of numbers, biomass and energy
- ii. To understand the existing food relationship within a habitat.
- iii. To observe population changes with time/seasons so as to understand the way population affect each other at different environmental factors.
- iv. To know the population of pests in order to work out control method.
- v. For management purpose i.e. Plan for cropping programs in game and national parks.
- vi. To value and conserve biodiversity/ natural reserves/ wild life and national parks.
- vii. To understand dispersal/spread of organisms
- viii. To understand the impact of population in the environment.

### **Estimating population size.**

#### **A. Factors to be considered to select a method to be used.**

- i. Size of the organism e.g. big organisms such elephants are easily counted directly
- ii. Mode of the organism such as
  - motility; plants and sessile or slow-moving organism may be counted directly, while indirect methods may be required for fast- moving organism in large open grass land.
  - Association between organism- some methods such as capture – recapture method requires organism that associate randomly.
  - Hostility hostile organism may require special gadgets for collection and/or counting.
- iii. Size of the area under investigation. For big area, population may be estimated basing on samples
- iv. Physical and climatic factors
- v. Climatic condition
- vi. Topography
- vii. Nature of vegetation

#### **B. Method for estimate of population size of large animals living in unconcealed habitats, e.g. Antelopes, Hippopotami, lions etc.**

##### **❖ Direct counting method using a low flying aircraft.**

Basic requirements are: an aircraft, survey map of the area and a counter

### **Procedure**



The aircraft is flown on a transect section of the area of a known dimension and the animals in each transect are counted. The aircraft is then flown back along another adjacent transect and counting continues until the whole area is covered. Several counts are made and an average is determined. The estimated population in a given unit area is determined.

#### Advantage

- (i) The method gives a quick estimate of the population of animal in an area.
- (ii) It can also be done concurrently with studies on other aspect of population like feeding habits
- (iii) It reduces the risk of attack from aggressive animals
- (iv) It reduces the risk of counting the same organism more than once
- (v) There is no disturbance to the environment.

#### Disadvantage

- (i) It is sophisticated and expensive
- (ii) Aircraft may scare away some animals to be counted
- (iii) It cannot be applied to small animals in concealed habitats such as forest.
- (iv) It is greatly hampered by climate; i.e., cannot work in cloudy or mist climate.

- ❖ **Aerial photography**  
Basic requirement are aircraft and good camera

#### Procedure

Photographs are taken from a low flying aircraft usually on scale over the whole study area. They are developed and animals counted from the photographs. As in direct counting method, a population density is a given number per unit area

Advantages and disadvantages are similar to those for direct count using an aircraft

- ❖ **Drive and count**

In this method, animals are driven by a number of people into a particular spot and counted.

#### Advantage

- it reduces the chances of counting animals more than once
- gives accurate results

#### Disadvantage

- it can't be used on aggressive animals
- it is tedious on fast moving animal
- it is difficult to apply on animals that do not live in herd

- ❖ **Strip census**

In this method animals are counted a long path while walking or in a vehicle. The population density of an area is determined as the number per unit area (of strips)

Advantage

It gives a quick estimate of the animal population of an animal

It is cheap

Disadvantage

- Some animals such paths and are unavailable for counting
- People of vehicle may scare away the animals
- Fast moving animals may be counted more than once

#### ❖ **Direct counting (Census)**

Large organisms that are not aggressive and are living in open habitat e.g. buffaloes, Elephants and trees in the forest are counted one by one.

Advantage

- Quick and accurate
- More than one population can be estimated at the same time
- Other aspects of an organism ecology, behavior can be taken at the same time.
- There is minimal disturbance to environment.

Disadvantage

- It may be difficult to count overcrowded acid organism, e.g. flock of weaverbird.
- Some organisms avoid being seen.
- Difficult to use on animals that concealed in their habitat.
- Bad weather may affect visibility and hence the count.
- Does not take into account the immigrants
- Tedious

### **C. Determining the population of small animals**

#### ❖ **Quadrat**

**Suitability:** plants, immobile or easily caught animals

This a small area marked out for study. A quadrat frame ( $1\text{m}^2$ ) is thrown randomly and the number of organism within a number of quadrats that represent a known fraction of the total area determined to estimate the total number in the whole area by simple proportion multiplication.

This method provides a mean of calculating three aspects distribution.

- Species density.** Number of organism per unit area; limitation. It's time consuming to count each and every individual in a quadrat
- Species frequency;** This is a measure of the probability [chance] of finding a given species with any one throw of a quadrat in a given area. The limitations are quadrat size, plant size and spatial distribution [random, uniform or clumped].

- iii. **Specie cover;** This is a measure of the proportion of the ground occupied by the species and give an estimate of the area covered by the species as a percentage of the total area. Limitation it's slow and tedious.

#### **Advantage of quadrat method**

- Accurate
- Enable the comparison of different areas and species
- It does not have to be completed over a short time
- It reduces the chances of counting same individual twice
- It is possible to estimate population of more than on species at the same time

#### **Disadvantage**

- In practice animals are not randomly distributed therefore random plots may give inconsistent results.
- Not appropriate for large area
- Not applicable in water and concealed habitat
- Time consuming to do well/tedious
- Causes some level of disturbance to the environment
- Not suitable for fast moving organism

#### **Assumptions**

- the quadrats are chosen randomly.
- The organism do not move from one quadrat to another
- The samples taken are representative of the population as whole
- The population is uniformly distributed

#### **Reliability of the quadrat method depend on**

- The population of each quadrat must be known exactly
- The area of each quadrat should be the same shape
- The quadrat size must be appropriate for the organisms being sampled.

- ❖ **Capture – recapture or mark-release methods.** Here a sample of individual is caught, counted and marked in some ways. Then these individuals are released.

After being allowed to mix with the rest of un marked population a second sample is caught and the number of marked individual noted. An estimate of population size can then be made from.

$$\text{Population size} = \frac{n_1 \times n_2}{n_m}$$

Where

$n_1$  is the number of individuals marked and released

$n_2$  is the number of individual caught in a second sample

$n_m$  is the number of marked individual caught in a second sample

#### **Precautions for capture-recapture methods**

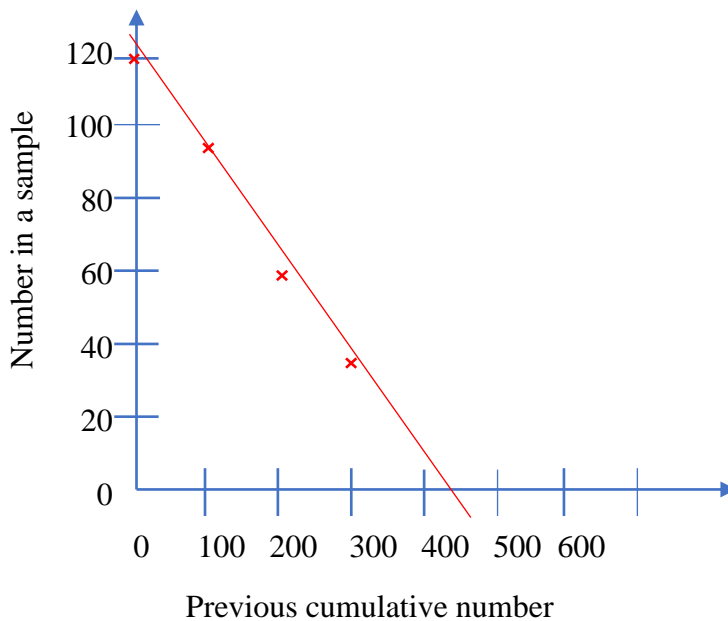
1. Organism should mix uniformly within the population.
2. Sufficient time must elapse between capture and recapture to allow uniform mixing.
3. There must be no emigration and immigration to the specified area.

4. Making does not hinder movement of organism or make the conspicuous to predators.
5. Marking should be permanent.

❖ **Removal method**

The removal method is very suitable for estimating number of small organism particularly insects, within a known area of grass land or volume of water. Using a net in some form of standard sweep; the number animals is recorded and the animal kept. This procedure is repeated a further three times and gradually reducing number recorded. A graph is plotted of number of animal captured per sample against the previous cumulative number of animal captured. By extra plotting the time of the graph to the point at which no further animal would be captured (that is the number in sample = 0) The total population may be estimated, e.g.

Sample	number in Sample	cumulative sample size
1	120	0
2	93	120
3	60	213
4	35	273



From the graph the estimated number organisms is = 425s

**Population growth and growth curves**

Populations grow and decline in characteristic ways. The size of population increase will be determined by the reproductive potential of the organism concerned and by environmental resistance. A Plot of the number of individuals against time form a growth curve. Two basic forms of growth curves can be identified by the J-shaped growth curve and the S-shaped or sigmoid growth curves.



The S- shaped or sigmoid growth describes a situation in a new environment:

- initially the population density of an organism increases slowly because there is a shortage of reproducing individual which may be widely dispersed as it adapts to new conditions and establishes itself;
- then increases rapidly, approaching an exponential growth rate. During this growth phase there are optimal environmental conditions- No environmental resistance, birth rate exceeds death rate.
- It then shows a declining rate of increase until a zero-population growth rate is achieved where the reproduction (natality) equals rate of death (mortality), The declining rate of increase reflects increasing environmental resistance, which become proportionately more important at higher population densities. In other words, as the number increase, the competition for essential resource such as food or nesting materials, increases until eventually feedback in terms of increase mortality and reproduction failure [fewer mating, stress induced abortion] reduces population growth to zero with natality and mortality in approximate equilibrium.

The J-shaped growth curve describes a situation in which, after initial establish phase (lag phase) population growth continues in an exponential form until stopped abruptly, as environmental resistance becomes suddenly effective. In very general terms the J- shaped growth form may be considered an incomplete sigmoid curve where a sudden limiting effect comes into play before the self- limiting effect within the population assume importance.

The maximum population of an organism that a particular environment can sustain is termed the **carrying capacity**. This is identified theoretically as the k-value [or upper asymptote] of the sigmoid curve

### **Factors that affect the size of the population**

The number of individuals in a population is affected by four factors; birth, deaths, immigration and emigrations. The change in the size of any population over a period of time can be summed by the equation. Change in the population size = B+I- D- E where B=birth, I= immigration, D=death and E=emigration.

### **Environmental resistance**

The form that the environmental resistance takes depends on the species in question.

Here are the main factors that limit population growth

- lack of food or water
- lack of light

- lack of oxygen
- predator and parasites
- Disease
- lack of shelter
- Accumulation of toxic waste e.g. CO<sub>2</sub> and nitrogenous waste
- stress in some case overcrowding may excess stress leading to abnormal behaviors. E.g., Female rats kept in capacity at a high population density show a breakdown in normal maternal behavior, failing to build adequate nest and abandoning their young ones.

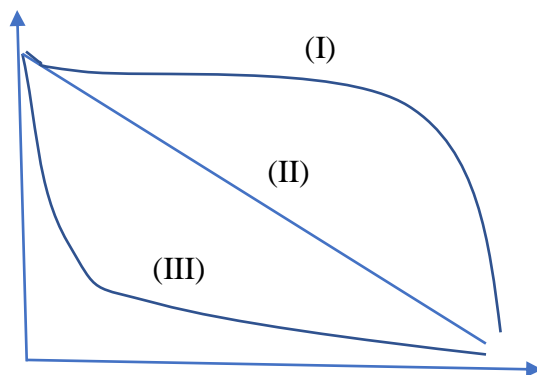
It has even been argued by some biologist that in the wild the males of some species of small mammal die prematurely as a result of excessive stress.

-Weather and catastrophes. Weather conditions and generally, may drastically reduce population. The effect is perhaps most severe for small organism, but in particularly bad winter even large species may show significant decline in population size

-Predator -prey relationship; The population of the prey is usually high when that of the predator is low. That of the predator increase with the population of the prey [which provide food]

### Survivorship curves

Ignoring for the moment immigration and emigration, birth and death are the two processes which affects population size. However, these processes depend on the age of individuals and on their sex. The crucial factor is the chance of an individual has of surviving to a given age, This can be shown by means of survivorship curve, To understand a survivorship curve, imagine a population of 100 individuals borne at the same time. The curve shows how many of them are likely to be alive at any particular age. There are three main types of survivorship curve and these are shown below;



Curve (I) is typical of organism such as ourselves that have few young ones. After an initial period of low juvenile mortality, mortality is very low until late in life

Curve (II) is found in many small birds, notice that as the vertical axis is logarithmic, the curve actually shows an exponential decline in the number of individual surviving overtime. The individuals do not die of old that is, there is no senescence.

Curve III The lower curve is typical of many plants and fish. Thousands or millions of young are produced, few of which mature into adults. The vast majority die as juveniles.

### **The niche concepts**

In 1934 a biologist called G.F. Gause published a book called the struggle for existence. In it he included the results of careful experiments he had carried out on two species of paramecium, a unicellular ciliate. Gause found that he could easily keep paramecium caudatum and p. Aurelia. in separate containers in his laboratory. However, when he tried to keep the two species in the same container, P. caudatum always died out, after a few days. Gause's results were put into a general statement called the competitive **exclusion principle**.

This state that two species cannot co-exist unless there are significant differences in their ecologies. In the case of Gause's two species of paramecium, their ecologies are similar.

Nowadays Gauss's competitive exclusion principle is sometime stated as follows; 'Each species has its own unique niche'. The niche of an organism is what an organism does in its community. Niches are sometime distinguished from habitats [spatial address] because the niche of an organism describes it's the location and function [address and profession with a particular community or ecosystem. There is a notation of fundamental niche of an organism as opposed to its realized niche. The fundamental niche is the niche a species would occupy in the absence of any competitors, predator or parasite. The niche that the species actually occupies on the other hand is called it's **realized niche**.

### **Association between species**

There are many situations in which organism form close associate with one another. Such association may occur with the same species [intraspecific associate] or between different species interspecific influenced by the presence of the other.

Intraspecific association, such as communication, mating behavior, form the basis of social organization.

### **Biotic environment**

Physical environment of an organism was defined as the sum of the non-living factor that influence that organism- factor such as climate, soil and topography. The biotic environment of an organism, on the other hand, is the sum of living factor that influence the organism

Consider a female goat. Her biotic environment includes other goats with which she interacts, such as her offspring, any male which she spends her time. These individuals are all members of her species. However, her biotic environment also includes the plants on which she feeds the mites, tick, flies and other parasites that bother, and the soil organism that will decompose her body when she dies.

### **Intimate associations**

Intimate associations are found when the body of one organism called the host, acts as the habitat for another organism. The host may be habitat in or on which the organism can survive or reproduce, in which case the association is described as obligatory. If the host is not essential, the association is described as facultative. The general term used to describe intimate association

between pairs of species is **symbiosis** which loosely translated from the Greek means 'living together'. Some older books restrict the terms symbiosis to cases where the association benefits both species. However, most ecologists nowadays use symbiosis in its wider sense and divide the term into three categories distinguished by the consequence of the association to each party.

### **Parasitism;**

A parasite is an organism that lives on or in another organism from which feed. A parasite which lives on the surface of its host is called an ecto-parasite and that lives inside it's called an endo parasite. Most species, including human, harbor parasites that reduce their health and may cause death.

### **Challenges faced by a parasite**

- (i) Locating a new host
- (ii) Overcoming host rejection
- (iii) Entering a host

### **Parasitic adaptations**

Parasites show many different adaptations of overcoming these challenges, depending on whether they are ecto-parasites or endo-parasites.

1. Many endoparasites show degeneration, or even total loss of certain organs which reduces their energy and material requirements and hence a reduced burden on their host. For example, gut parasites like the tapeworms lack an alimentary canal.
2. Many parasites especially ecto-parasites have attachment devices such as sucker, hooks or anchors enabling them to cling to the host. Tapeworm has hooks and suckers to anchor on host digestive canal.
3. Some parasites have penetrative devices for gaining entrance into the host and its cells. For example, miracidium larva of the liver fluke, has a slender tip on to which open a group of glands which secrete tissue- digesting enzymes. By softening the tissue, the enzyme enables the larva to bore into the foot of a freshwater snail the intermediate host.
4. Gut parasites live in a particularly hazardous environment. They typically have protective devices which protect them from being harmed by the host's digestive processes. These devices include the possession of a thick protective cuticle, the secretion of large quantities of mucus and the production of inhibitory substances which locally inactivate the host's digestive enzymes.
5. To protect themselves from the host's immune system, some parasites such as the blood fluke, schistosoma, that cause, bilharzia, synthesizes chemicals, which switch off the host's immune system; The parasite coats itself with molecules which the host recognizes as self.



6. Parasites overcome a problem of moving from one host to another by a number of strategies, one of which is to wait until the host mates. The various organisms responsible for sexually transmitted diseases in humans spread in the same manner.
7. Many parasites employ a secondary or intermediate host which conveys the parasite from one primary host to another. Thus, the Anopheles mosquito transfers the malaria parasites from one person to another.
8. To raise the probability of success vast numbers of offspring are produced.
9. The parasites may have a dormant resistant stage in its life cycle to survive adverse conditions until a suitable host is found.
10. Some parasites are closely linked with their host that their tissues are actually interconnected. E.g., certain plant parasites such as mistletoes plug into other plants and tap off nutrients from the host's tissue.

#### Exercise

Which one of the following characteristics of a parasite is **not** a means of ensuring continuity of the species of the parasite?

- A. Degeneration of redundant body structures.
- B. Means of penetrating another organism.
- C. Protection against host enzymes.
- D. Means of dispersing offspring.

The answer is A

Degeneration of redundant body structures is an adaptation of a parasite to its mode of life, but does not directly ensure continuity of its species.

Note: Some of the adaptations of a parasite that ensure continuity of the parasite species include

- Possession of penetrative devices for gaining entrance into the host.
- Possession of protective devices which prevent the parasite from being harmed by the host's digestive processes. For example, gut parasites inhibit substances which inactivate the host's digestive enzymes.
- Having a means of dispersing its offspring. For example, employing a secondary (intermediate) host which disperses the parasite over a wide area.
- Producing a large number of offspring to increase the chance of success in getting from one host to another as is the case in a parasitic fungus and malaria (plasmodium) parasite.
- Production of chemicals which protect some parasites against the host's defense mechanisms.

### **Commensalism**

This is a relationship between two organisms. One of the two organisms, the commensal benefits from the association, while the other organism usually the larger partner, neither lose nor gain.

**Mutualism;** Here the association benefit both the participant, i.e., the gain is mutual. E.g. lichen is an association between a fungus and an alga. The fungus absorbs water from atmosphere while an alga photosynthesizes for both.

### **Predation**

In this relationship in which one organism lives the other dies instantly. For example lion the predator kills the zebra (prey) instantly.

### **Communities and ecosystems**

On this planet no one can exist without another, Human depend on one another and the surroundings. Without plants animals would starve through lack of food and in the long would run out of oxygen. Without bacteria and fungi, decomposition and nutrient cycling would stop. In absence of animals, many plants would be unable to reproduce.

### **Communities**

This a sum of all living organism found in a specified. Species within a community interact with each other, sometimes these interactions benefit both species. For example. The fruit produced by the plant supply birds with food, however, the birds disperse the seeds of these fruit which benefits the plant.

### **Ecosystem**

An ecosystem is a self-sustaining unit consisting interacting organisms in area together with the non-living constituents of their environment. Example an oak wood ecosystem consists of living organisms such as trees and animals and the physical environment such as rain, the inorganic components of soil, sunlight and atmospheric oxygen and carbon dioxide.

### **Succession**

This is the change of community overtime, that is replacement of some species by other through time.

### **Primary succession**

begins with a bare rock where there is not form of organic matter. Usually the first organism (pioneer community) to colonize a bare rock is the lichen followed by mosses and ferns, big plants and animals as organic matter accumulate. It must be noted that the first organisms to colonize a bare rock must be photosynthetic.

### **Secondary succession**

Occurs when the surface in completely or largely stripped of vegetation but has already been influenced by living organism and has an organic component. For example, a cleared forest or a

previous burned or farmed area. Seeds and pores and organs of vegetative reproduction, such as rhizomes, may be present in the ground to influence the succession.

The climax community is often described as having one dominant [those with the greatest collective biomass or productivity] or several co-dominant species

### Zonation

This is the spatial distribution of species with a community according to variations of physical environment. An example of zonation is the vertical zonation that occurs on mountains with increasing altitude superficially zonation may resemble succession, but it is important to recognize the basic differences, names that with zonation the species vary in space[spatially], whereas with succession the species vary in time [temporally]

### Productivity and biomass

1. Gross primary production is the total organic material made by photosynthesis in a specified time s known as the.
2. Net productivity is amount of organic material produced by synthetic organisms actually available to the herbivores since part of gross primary production is respired or decomposed transferred to herbivore or carried downstream.

$$\text{i.e., Net primary productivity} = \left\{ \begin{array}{l} \text{Gross primary} \\ \text{productivity} \end{array} \right\} - \left\{ \begin{array}{l} \text{respired organic matter+ organic matter} \\ \text{decomposed} \end{array} \right\}$$

The percentage of the energy at one trophic level which ends up in the next trophic level is called the **trophic efficiency**. The trophic efficiency of the herbivores, for instance, equals the percentage of the net primary production that is converted to the herbivore production [i.e. to growth and reproduction of herbivores

Lindeman in 1942 proposed that succession involved increase productivity until a climax community was reached in which the maximum efficiency of energy conversion occurred.

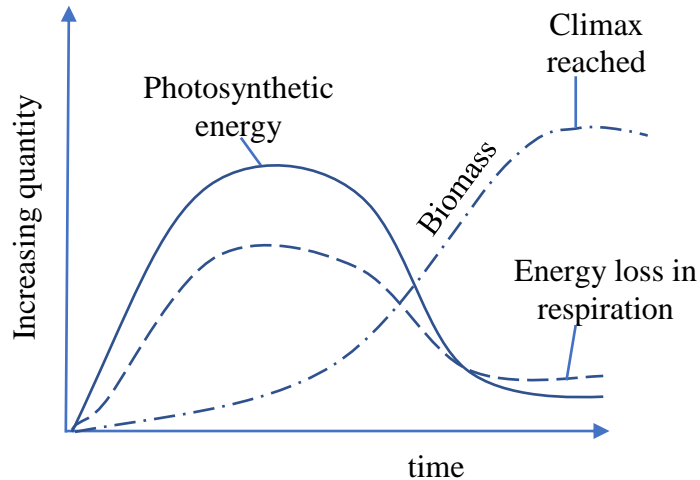
Evidence shows that the latter stages of succession do not become productive, but that there is usually a decline in the gross productivity associated with the climax community. This older forest which in turn may have lower productivity than young forest, which in turn have lower productivity than the more species- rich herb area.

Reason for decrease in production can only be speculated upon but using a forest as an example, older trees might be expected to be less productive than younger trees for several reasons. One is that the accumulation of nutrients in the increasing standing crop biomass may lead to a reduction in nutrient recycling. However, a simple reduction in vigor as the average age of the individuals in the community increases to a constant point would presumably cause a reduction in productivity.

Succession also lead to maximum accumulation of biomass. This is most obvious in the case of forest community, where the plants become larger and larger during succession, but the accumulated biomass of other climax communities is also normally greater than in the

successional stages. Changes in gross productivity, respiration and biomass during a typical succession and summarized on the graph below.

Changes in gross productivity, respiration and biomass during a typical succession



This show that in climax community these terms become more or less constant. It also shows that an upper limit of biomass is reached when total respiratory losses [R] from the system almost equal gross primary productivity [P], i.e.  $P/R = 1$

During a succession more and more of the available nutrients become locked up in the biomass of the community with a consequent decrease in nutrients in the abiotic component of the ecosystem [such as soil and water] the amount of detritus produced increases and detritus feeder take over from grazers as the main primary consumers. Appropriate changes in food webs occurs and detritus becomes the main source of nutrients

Example

Which one of the following equations shows the correct relationship between gross primary productivity (GPP) and net primary productivity (NPP) in plants?

- A.  $GPP = NPP - \text{photosynthesis.}$
- B.  $NPP = GPP - \text{photosynthesis.}$
- C.  $GPP = NPP - \text{plant respiration.}$
- D.  $NPP = GPP - \text{plant respiration}$

Answer is D

Productivity of a plant is the rate at which energy is stored in the producers in form of organic substance.

Gross primary productivity (GPP) is the rate at which chemical energy derived from the sun is stored by the plants.

Net primary productivity (NPP) is the net gain of organic material in photosynthesis after allowing for losses due to respiration

That is

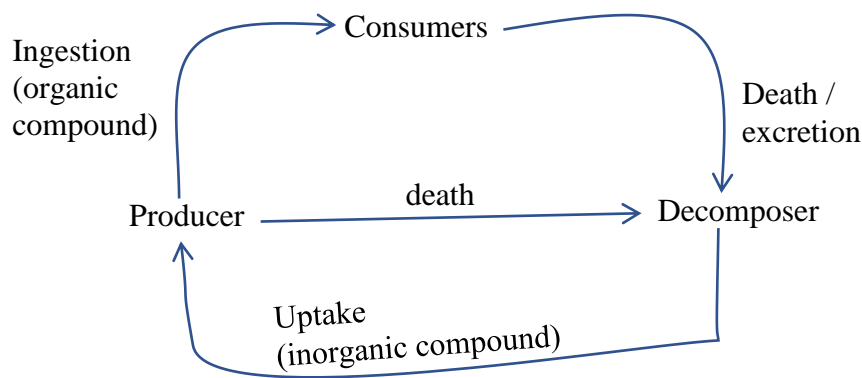
$$NPP = GPP - \text{plant respiration}$$

### **Cycling of matter and flow of energy in eco system.**

In almost all ecosystem, the organisms fall into three nutritional groups.

- producers
- Consumers
- Decomposers

These are related as follows;



Organic material synthesized by the produces are eaten and assimilated by the consumers, All the organic materials incorporated into the bodies of the consumers are eventually broken down into inorganic materials. These are then rebuilt into organic compound by the synthesis activity of the producers.

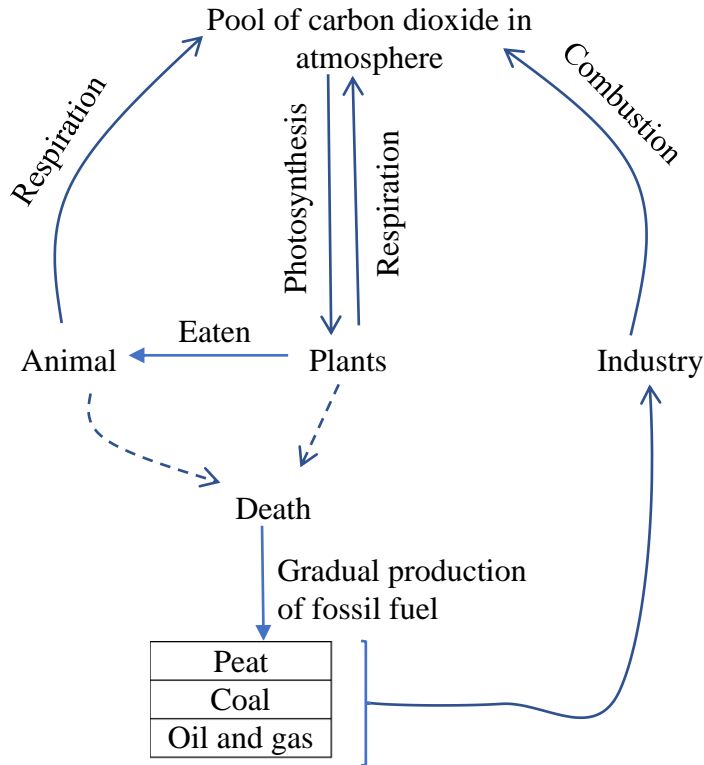
Although matter circulates repeatedly around an ecosystem, this is not the case with energy. Instead energy is continually lost from ecosystem as heat energy. The photosynthetic producers transfer some of the radiant energy of sunlight to chemical energy in plant carbohydrate. By their respiratory activities the producer, consumer, and decomposers transfer this energy to ATP, whose subsequent hydrolysis provides energy for the cells vital activities. Both in the formation

of ATP and subsequent usage, a proportion of the energy is lost from an ecosystem as heat energy. Ultimately all the energy in an ecosystem is transferred to heat energy. However, the continual trapping the energy of sunlight by green plant compensate for this loss and maintains the flow of energy.

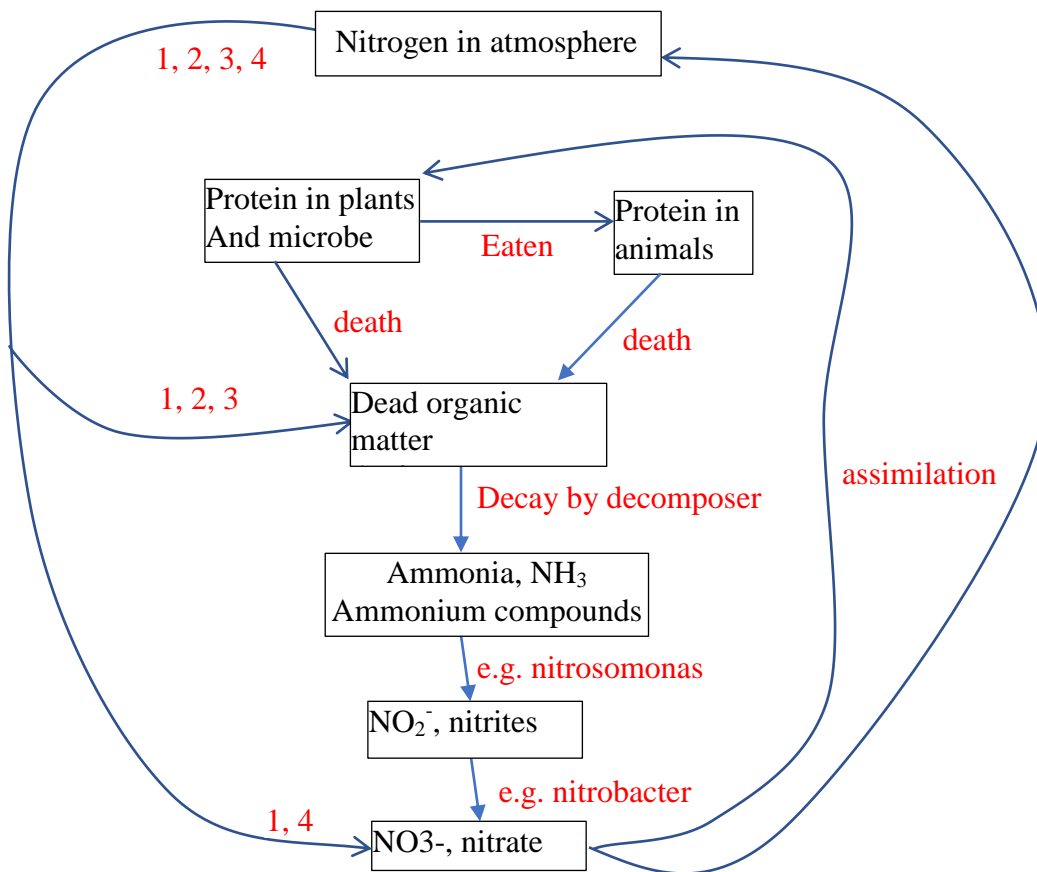
**Nutrient cycle.**

In order for organism to maintain themselves, grow and reproduce, they need supply of elements of which they are made. These they regenerate from the cycling of matter or nutrient cycle.

**Carbon cycle.**



**Nitrogen cycle**



### **Nitrogen fixation process in order of magnitude.**

1. industrial fixation e.g., Haber process
2. mutualistic blue- green bacteria e.g., Rhizobium e.g. legume
3. free- living blue- green bacteria e.g. Azobacter, clostridium
4. Action of lightning etc. on oxygen and nitrogen.
5. Manure addition
6. plant residues
7. dead animals

Ways nitrogen is lost from soil

1. Denitrification. Bacteria change nitrate in the soil to atmospheric nitrogen, which joins the atmosphere in low-aerated, water-logged soils.
2. Volatilization. Turns urea fertilizers and manures on the soil surface into gases that also join the atmosphere.
3. Leaching
4. Erosion

7. Which of the following is the correct sequence representing the action of nitrifying bacteria?

- A. Nitrites — nitrates — ammonium salts.
- B. Ammonium salts — nitrites — nitrates.
- C. Nitrites — ammonium salts — nitrates.
- D. Ammonium salts — nitrates — nitrites.

### **Energy transfer; food chains and trophic levels.**

Within the ecosystem the energy- containing organic molecules produced by autotrophic organisms are the source of food [material and energy] for heterotrophic organisms; a typical example is a plant being eaten by an animal. This animal may in turn be eaten by another animal, and in this way energy is transferred through a series of organism, each feeding on the preceding organism and providing raw materials and energy for the next organism. Such a sequence is called a food chain.

Definition

A food chain is a sequence of organisms with arrows pointing from organisms being eaten to organism that eats it.

Example of food chain

Grass → Grasshopper → chicken → man



Each stage of the food chain is known as a **trophic level**, the first trophic level being occupied by **the autotrophic organisms**, the primary producers. The organism of the second trophic level are called primary consumer, those of the third level are secondary consumer and so on. There are usually four or five trophic levels and seldom more than six because;

-There simply not enough energy in ecosystem to support more than this number of steps. As it is, top carnivores often have to roam over huge area to find enough food.

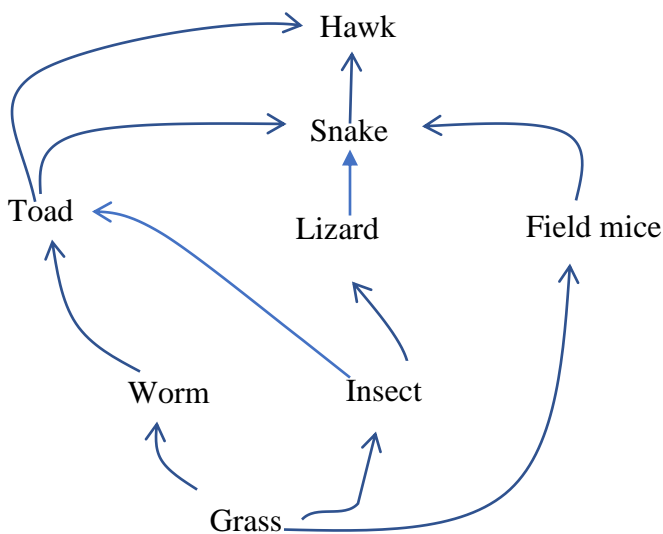
-It is difficult to imagine a species with the hunting abilities necessary to feed on eagles, loins, killer whales or any other existing top carnivores,

-The more levels in food chain the less stable it becomes.

### Food webs

Is feeding relationship showing organisms feeding on more than one organisms.

Example of a food web

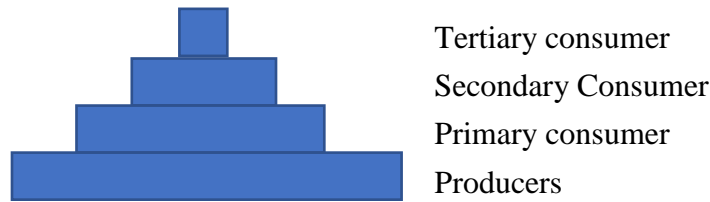


### Ecological pyramids

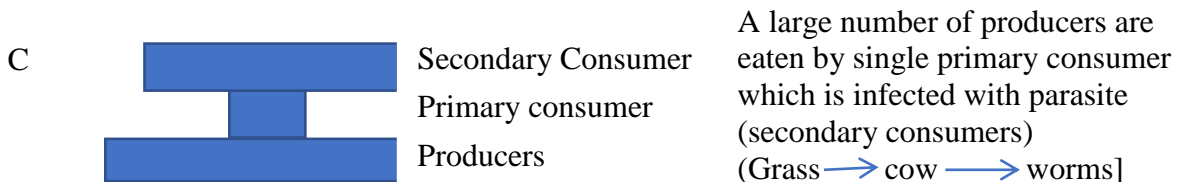
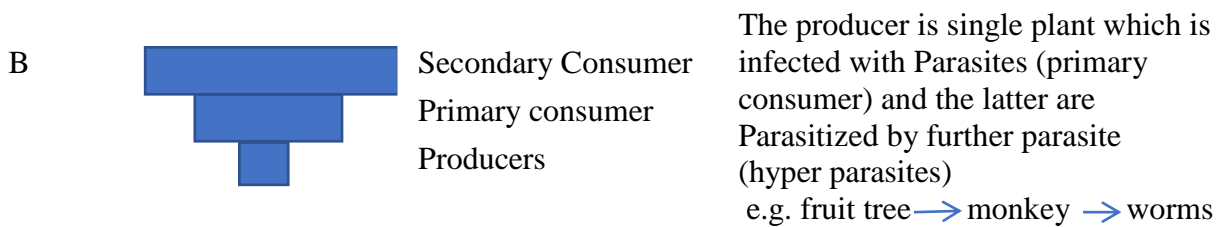
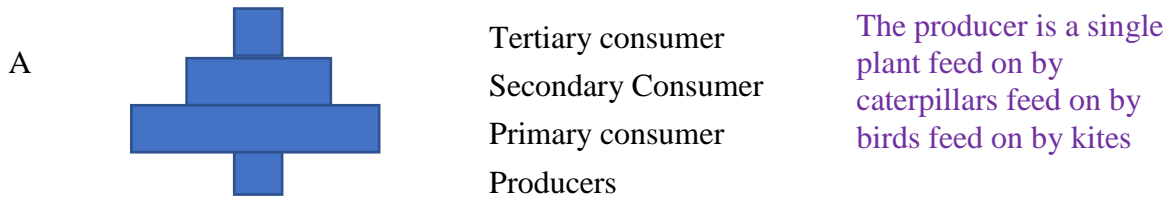
Food webs give a useful description of the feeding relationships in a community. However, they are non- quantitative. Feeding relationship and energy transfer through the biotic component of ecosystem may be quantified and shown diagrammatically as ecological pyramid. These give an apparently simple and fundamental basis for comparing different ecosystem, or even seasonal or variation of pollution induced charged with a single system.

**Pyramid of number**

These are pyramid drawn base on the number of organism in each trophical level it's based on ideology that preys are usually smaller and more numerous than their predators.



However, pyramid of numbers, despite their name, need not always be pyramidal in shape. Consider the situation where a single very large producer, such as tree, supports a large number of primary consumers. In this case an inverted pyramid of numbers result. Inverted pyramids of numbers can also result when a community contain parasites. Imagine for instance, a mammal infected with tick or fleas. These parasites are in a trophic level above the mammal, yet their numbers will be greater. Some of inverted pyramids of numbers are shown below.



**Pyramid of biomass**

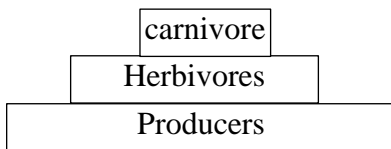
This a type of ecological pyramid base not on numbers but biomass. Here instead of counting the number of individual at each trophic level. The total mass (biomass) of organisms at each level is measured. The rectangles used in constructing the pyramid then represent the masses of organisms at each trophic level per unit area or volume. The greatest mass is usually found with the producers, but measurement of the biomass at the various trophic levels in the community

may also give an inverted pyramid. For instance, at certain times of year, the biomass of the tiny herbivorous organisms that float in lake and oceans (zooplankton) may exceed the biomass of the tiny photosynthetic organisms (phytoplankton) on which they feed. This is because biomass refers to the mass of organism present a particular moment, the so-called standing crop. **At this time of the year phytoplankton are able to support the zooplankton due to high rate of turnover than that of zooplankton.**

### **Pyramid of energy**

This is the most fundamental and ideal way of representing relationship between organisms in different trophic levels. A pyramid of energy shows the transfer or flow of energy through a community. As a result, pyramids of energy are expressed in units of energy per area per time e.g., kilojoules  $\text{m}^{-2}\text{yr}^{-1}$ . A generalized pyramid of energy is shown below.

Pyramid of energy



Consequently, the number of trophic levels in a food chain or the length of the food chain is limited by the energy wasted as it is transferred from organism, i.e. by the efficiency of energy transfer between trophic levels

Other factors are the availability of sufficient food of the preferred types and territorial space

### **Rational cropping of ecosystems**

Cropping is the removal of any organism from an ecosystem for food, whether plant or animal. Rational cropping is using the ecosystem to produce food in the most efficient way. This may mean increasing productivity of the crop and decreasing the effects of disease and predation by animals, or by using a crop which is better adapted to conditions in the ecosystem. Increasing productivity of plant crops may be achieved by adding fertilizer to the soil, and by adding water to the soil by irrigation or removing water by drainage, as necessary.

Disadvantage of carrying out these processes are that over a long period of time, the use of manmade fertilizers can lead to deterioration of the soil structure which will eventually lead to a decrease in productivity and addition of fertilizer or water is often energy-expensive. Decreasing the effects of predation, generally insects and birds in case of plant crop and disease is usually carried out by the selection of resistant genetic strains of the crop or the use of chemicals to kill the pest or disease-producing organisms. Using such chemicals must be done with care; Persistent chemicals, those not rapidly broken in ecosystem may have disastrous effects on other trophic levels and effective pesticide used too frequently may bring about outbreak of resistant strains of the pests which are more difficult to control.

## **Pollution and conservation**

Pollution is the damaging release by humans of materials and energy to environment than can be removed by the environment. The materials or energy released are called pollutants.

The pollutants may be biodegradable or non-biodegradable. Biodegradable pollutants like sewage are broken down by micro-organism to harmless substances fairly quickly, whereas non-biodegradable pollutants cannot be so readily broken down. They tend to accumulate and are therefore potentially more dangerous. Below are specific examples

### 1. Carbon dioxide

Accumulation of carbon dioxide (from burning fossil fuel, deforestation, etc.) contributes to the global warming or greenhouse effect. The greenhouse is a slow progressive increase in the average temperature of the earth over a time.

The effects of global warming

- Melting of ice on mountain tops and earth pole leading to floods
- Droughts in subtropical latitude (5-350N)

Means of reducing carbon dioxide concentration in air

- a. Using alternative source of energy other than fossil fuel such as solar electricity or nuclear energy
- b. More energy-saving measures could be introduced.
- c. Massive tree planting programs to lock up carbon dioxide in the wood
- d. Nutrient enrichment of the oceans might allow huge algal blooms which would trap carbon dioxide in organic matter.

### 2. Oil pollution

Oil pollution results in spillage from the petroleum carrying ship. When inevitable accidents happen or when oil refineries are bombed during the time of war. Oil being lighter than water, floats on sea, killing birds and other animals it may also prevent photosynthesis by blocking carbon dioxide.

Methods of treating oil pollution include

- a. Setting fire on the oil
- b. Pumping the oil back into special oil collecting ship
- c. Adding naturally occurring bacteria that can digest oil
- d. Adding special spill cleaners that are relatively nontoxic and biodegradable than previously used detergents.

### 3. Damage to ozone layer

Ozone, O<sub>3</sub>, is found at low concentration in the earth's stratosphere, 15 to 50km up. Here it protects the earth from dangerous radiations that out damage the cell genetic material leading to cancers. Ozone layer may be damaged by chlorofluorocarbons (CFCs) used as coolant in refrigerators

### 4. Pesticides

Pests are organisms which people consider a nuisance or harmful. Pesticide are substances that kill pest.

Challenges of using pesticide

- a. Non-biodegradable pesticides accumulate in plants and animals causing death
- b. Indiscriminately kill organisms including useful ones including useful ones
- c. Prolonged use may lead to resurgence of resistant strains of pest.

5. Acid rain

Acid rain is due to releases of acidic gases such as sulphur dioxide (SO<sub>2</sub>) and nitrogen dioxide (NO<sub>2</sub>) usually from unregulated industries. Low pH of acid rain is damaging to organism tissues. It causes skin corrosion, and contributes to destruction of forests in Europe and Northern America.

6. Sewage is the water-borne waste of society. It includes both domestic and industrial sewage. Domestic sewage contain human feces and urine, water used to wash these away and dirty water flows from our baths and sinks.

Industrial sewage includes the dirty water from industry, hospital and abattoirs. Agricultural sewage is not allowed to mix with domestic and industrial waste and is treated separately.

If untreated sewage or agricultural fertilizers are allowed to enter lakes or rivers, eutrophication may occur. Eutrophication is enrichment of water with nutrients such as nitrogen and phosphorus. This leads to overgrowth of algae (or algal bloom) which use up oxygen in water leading to death of fish. Death of fish lead to over multiplication of aerobic decomposers, cause further depletion of water and death of fish.

7. Radiation from radioactive substance lead to death and oor injury of people and animal by causing cancers.

### Conservation

This involves managing the earth so as to restore and maintain a balance between the requirements of human and those of other species.

There are two main reasons why we should conserve.

- a. The ethical reason is that we have a moral duty to look after the environment.
- b. The pragmatic argument says that it is to our advantage to ensure the integrity of our environment. If we preserve the tropical rain forest, the greenhouse effect will be lessened; if we conserve fish stock, we get more food from seas, etc.

### Pest control

- A good pesticide has three properties:
- It must be specific

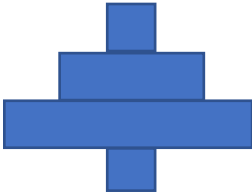
- It must remain for a short time in the environment i.e. easily transform to a non- toxic form
- It must kill the designated population only or should be specific.

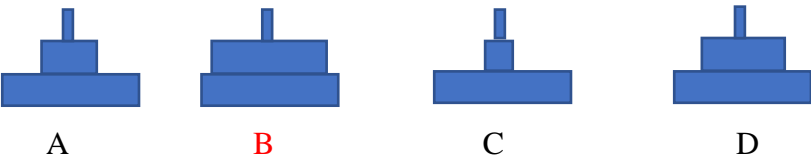
Exercise

Objective type questions		
1	2015/1/3	The number of trophic levels in a food chain is mainly determined by the <b>A. Deficiency of energy transfer between levels</b> B. Biomass of the producer C. Net productivity of ecosystem D. Species diversity of the ecosystem
2	2015/1/5	Which one of the following characteristics of a parasite is not a means of ensuring continuity of species of the parasite? <b>A. Degeneration of redundant body structures</b> B. Protection against host enzymes C. Means of penetrating other organisms D. Means of dispersing offspring
3.	2015/1/17	The biomass of consumer is always less than that of producers because A. Producers have to support consumers B. Consumers have a low productive rate <b>C. Energy is lost through body process of consumer</b> D. Consumers are small in size
4.	2015/1/25	In estimating the population of tilapia in a fish pond, 60 fish were captured, marked and released. After 2days, 50 were captured and out of which 10 were marked. The population of tilapia in the pond was <b>A. 300</b> B. 400 C. 200 D. 100
5.	2015/1/28	A good pesticide is one which A. Kills a wide range of organism B. Persist for a long time after its application C. Kills pests at different trophic levels <b>D. Easily transforms to non-toxic forms</b>
6.	2015/1/34	Which one of the following is not used to describe a population of organism? A. Density <b>B. Biodiversity</b> C. Size D. distribution
7.	2015/1/35	Mosses growing on the bark of a tree form an association with the tree is called A. mutualism B. parasitism <b>C. commensalism</b> D. predator
8.	2014/1/10	Which one of the following equation shows the correct relationship between gross primary productivity (GPP) and net productivity (NPP) in plants? A. $GPP = NPP - \text{photosynthesis}$ B. $NPP = GPP - \text{photosynthesis}$

		<p>C. <math>GPP = NPP - \text{plant respiration}</math></p> <p>D. <math>NPP = GPP - \text{plant respiration}</math></p>
9.	2014/1/26	<p>Which one of the following activities does not contribute to the greenhouse effect?</p> <p>A. Deforestation</p> <p>B. Use of SFCs</p> <p>C. Burning of fossil fuel</p> <p>D. Emission of gases from industries</p>
10.	2013/1/3	<p>Which one of the following is correct about organism in an ecosystem?</p> <p>A. Some organisms exist in isolation</p> <p>B. Every organism can be independent</p> <p>C. Each organism has a different source of food</p> <p>D. All organism interacts with each other</p>
11.	2013/1/17	<p>Which one of the following methods of estimating population has the highest chances of error?</p> <p>A. Removal method</p> <p>B. Quadrat method</p> <p>C. Capture-recapture method</p> <p>D. Direct count method</p>



12	2012/1/9	<p>The figure shows a pyramid of numbers for a food chain</p>  <p>Tertiary consumer Secondary Consumer Primary consumer Producers</p> <p>The most likely mode of nutrition relationship between producer and primary consumers is</p> <p>A. Mutualistic B. Symbiotic C. Parasitic D. autotrophic</p>
13.	2013/1/23	<p>Which one of the following environmental factors has direct effect on all organisms?</p> <p>A. Light B. Humidity C. Temperature D. rainfall</p>
14.	2013/1/24	<p>Which one of the following factors reduces interspecific competition in a community?</p> <p>A. Resource partitioning B. High intraspecific competition C. Large number of species D. Similar producer-prey strategies among the species.</p>
15.	2013/1/39	<p>Which one of the following is <b>not</b> exhibited by well adapted parasite?</p> <p>A. Inflicting moderate harm to its host B. Employing an intermediate host C. Killing the host D. Using more than one host</p>
16.	2012/1/13	<p>Depletion of the ozone layer is caused by</p> <p>A. Greenhouse effect B. Release of carbon dioxide in the atmosphere C. Penetration of ultraviolet light D. Release of the chlorofluorocarbon in atmosphere</p>
17.	2012/1/17	<p>The type of succession where recolonization of an area results into a different community from the original one is known as</p> <p>A. Primary B. Dominant C. Deflected D. secondary</p>

18.	2012/1/18	Radioactive rays are particularly dangerous in nature because they A. cannot be absorbed by plant so they only affect animals B. accumulate in animals and return to the soil animals die <b>C. cause extremely high temperatures in the environment</b> D. accumulate in high concentrations at high trophic levels
19.	2012/1/33	Determining the commonest plant species in a large habitat within a short time can be best carried out using the <b>A. line transect</b> B. quadrat C. direct count D. aerial view
20.	2012/1/35	Excessive use of pesticides in the long term affect mostly <b>A. carnivore</b> B. parasites C. producers D. herbivores
21	2012/1/37	Which one of the following is true about the environment of a forest floor under a thick canopy? A. Has wide temperature fluctuations <b>B. Receives far red light</b> C. Develop dense plant growth D. Has heavy soil erosion
22	2011/1/13	 <p style="text-align: center;">A                      B                      C                      D</p> <p>In which pyramid does the primary consumer make efficient use of the producer</p>
23	2011/1/14	Which one of the following factors, has the greatest limiting influence on the population of algae at the bottom of a pond? A. Light B. Carbon dioxide <b>C. Mineral salts</b> D. oxygen
24.	2011/1/21	Which one of the following factors does not affect the distribution and abundance of organism? A. Mimicry B. Predation C. Human species D. <b>speciation</b>

25.	2011/1/36	<p>Which one of the following would be an effect of decreasing competition on a stable population?</p> <p>A. Increasing the environmental resistance thereby increasing the population</p> <p><b>B. Lowering the environmental resistance thereby increasing the population</b></p> <p>C. Lowering the environmental resistance thereby decreasing the population</p> <p>D. Increasing the environmental resistance thereby decreasing the population</p>
26.	2010/1/19	<p>Algae have much smaller biomass compared to a large producer such as trees but may have the same productivity because</p> <p>A. A lot of material and energy are locked up in the dead xylem tissue of the tree.</p> <p>B. The algae have a very high turn-over</p> <p><b>C. Algae have a high rate of reproduction</b></p> <p>D. The rate of growth and death in algae is high</p>
27.	2010/1/23	<p>Predators in top trophic levels in food chain are most severely affected by persistent pesticides because</p> <p>A. Their system are highly sensitive to chemicals</p> <p>B. They have high reproductive rates</p> <p>C. They cannot store pesticides in their tissues</p> <p><b>D. The pesticides become concentrated in their prey</b></p>
28.	2010/1/38	<p>Nitrifying bacteria convert ammonia into nitrites and nitrites into nitrates in order to</p> <p>A. Enrich the soil</p> <p><b>B. Generate energy for synthesis of organic compounds</b></p> <p>C. Maintain the nitrogen cycle</p> <p>D. Reduce the amount of nitrogen in the atmosphere</p>
29	2010/1/40	<p>Three counts of 103, 46 and 20 of plant species, were made using a quadrat of 25cm<sup>2</sup>. The density of plant per m<sup>2</sup> is</p> <p>A. 169</p> <p>B. 56.3</p> <p>C. 225</p> <p>D. 676</p> <p><b>No answer</b></p>
30.	2009/1/29	<p>Which one of the following ecological pyramid may be used to determine the productivity in an ecosystem?</p> <p><b>A. Pyramid of energy</b></p> <p>B. Pyramid of biomass</p> <p>C. Pyramid of numbers</p> <p>D. Pyramid of productivity</p>

31.	2009/1/32	Which one of the following forms of environmental hazards is attributed to application of CFCs? A. Greenhouse effect B. Acid rain <b>C. Ozone layer depletion</b> D. Eutrophication.
32.	2009/1/33	Which one of the following processes does not affect the biochemical oxygen demand? A. Ammonification B. Nitrogen fixation C. Nitrification D. <b>denitrification</b>
33.	2009/1/38	Which one of the following constitutes the most energy transfer? A. Praying mantis feeding on flies <b>B. Aphids feeding on plant sap</b> C. Cat feeding on small mammals D. Beetle larvae feeding on dung
34.	2008/1/22	Which one of the following has the greatest biomass in an ecosystem? A. Tertiary consumer <b>B. Primary producer</b> C. Secondary consumer D. Primary consumer
35.	2008/1/29	Which one of the following is not a problem that endoparasite face in their transmission? <b>A. Leaving the host</b> B. Entering the host C. Living away from the host D. Identifying the host
36.	2008/1/30	Which one of the following statement is correct about the exponential phase in the population growth? A. Death rate and birth rate are equal <b>B. Number of individuals and rate of growth increase</b> C. The number outstrip the supply of factors for support D. Slow growth of the population
37.	2008/1/35	The number of organisms in each trophic level reduces as one moves up a food chain because <b>A. Energy is lost in moving from one trophic level to another</b> B. Energy is lost from the top levels C. Organism in higher trophic levels are less productive D. Of high level of predation at the top trophic levels
38.	2007/1/2	Which of the following activities does not contribute to global warming? <b>A. Use of pesticide</b> B. Deforestation C. Burning fossil fuel D. Use of CFCs

39.	2007/1/15	<p>During which energy transfer is most energy lost in an ecosystem?</p> <p>A. <b>Producer</b> → <b>Primary consumer</b></p> <p>B. Primary consumer → secondary consumer</p> <p>C. Secondary consumers → tertiary consumer</p> <p>D. Tertiary consumer → decomposer</p>
40.	2006/1/12	<p>The bacteria which convert nitrates to nitrites during the nitrogen cycle are example of</p> <p>A. Nitrogen fixing bacteria</p> <p>B. Nitrifying bacteria</p> <p>C. Decomposing bacteria</p> <p>D. <b>Denitrifying bacteria</b></p>
41.	2006/1/24	<p>A climax community is one in which</p> <p>A. Succession</p> <p>B. A carrying capacity has been reached</p> <p>C. <b>Succession has ceased</b></p> <p>D. Death rate of organism is at its lowest</p>
42.	2006/1/29	<p>Good drainage and ploughing of soil reduces the process of</p> <p>A. Nitrification</p> <p>B. Decomposition</p> <p>C. <b>Denitrification</b></p> <p>D. Nitrogen fixation</p>
43	2006/1/36	<p>In any ecosystem, a continued input of energy is required because</p> <p>A. Matter is continually used in metabolism</p> <p>B. Biological succession occurs very slowly</p> <p>C. Of the continued increase in population in ecosystem</p> <p>D. <b>Energy is lost each time it is transferred between organisms</b></p>
44.	2005/1/12	<p>Which of the following would contribute to greenhouse effect</p> <p>. Use of nuclear power</p> <p>. <b>Use of fossil fuels</b></p> <p>. Excessive use of fertilizers</p> <p>. Accumulation of sewage in water bodies</p>
45.	2005/1/30	<p>In the energy transfer in an ecosystem, the greatest loss in energy is between</p> <p>A. <b>Primary producer and primary consumer</b></p> <p>B. Primary consumers and secondary consumers</p> <p>C. Secondary consumer and tertiary consumer</p> <p>D. Tertiary consumers and decomposers</p>
46.	2005/1/33	<p>From a bush, 120 beetles were collected and, marked and released back into</p>

		<p>the bush. A few days later 120 beetles were collected from the same place, and 30 of them carried the mark. The estimated number of beetles in the bush is</p> <p>A. 240  B. 360  <b>C. 480</b>  D. 560</p>
47.	2005/1/5	<p>Energy flow in an ecosystem refers to the energy</p> <p>A. Consumed in total, by all organisms  B. Consumed by the organism at each energy level  C. Converted from light to chemical energy by the primary producer  <b>D. Transferred from the primary producer through the various consumers.</b></p>
48.	2004/1/7	<p>Which one of the following parasites is unicellular?</p> <p>A. Taenia  <b>B. Plasmodium</b>  C. Ascaris  D. trypanosome</p>
49.	2003/1/30	<p>Which of the following ecological effects may not be caused by deforestation?</p> <p>A. Species extinction  B. Reduction in soil fertility  <b>C. Acid rain</b>  D. Flooding and land slides</p>
50.	2003/1/40	<p>Which of the following characteristics of a parasite would increase its chance of survival?</p> <p>A. Being highly specific  B. Inflicting severe effects on host  <b>C. Parasitizing more than one type of host</b>  D. Employing no vector</p>
51.	2002/1/1	<p>Which one of the following would be a characteristic of a poorly adapted parasite?</p> <p>A. Employing vectors  B. Inflicting mild harm to the host  C. Having a dormant stage during the life cycle  <b>D. Inflicting severe harm to the host</b></p>
52.	2002/1/23	<p>Which of the following methods of controlling malaria would cause least damage to the environment?</p> <p>A. Draining swamps  B. Spraying swamps and ponds  C. Spraying oil over stagnant water  <b>D. Introducing fish into the swamp and ponds</b></p>

53	2002/1/28	<p>The mycorrhiza on some plants serve to</p> <p>A. Fix nitrogen from atmosphere  B. Absorb mineral salts from the soil  <b>C. Break down humus</b>  D. Synthesize carbohydrates</p>
54	2001/1/6	<p>In which of the following situations would population growth occur?  When the number of</p> <p>A. Birth equals the number of deaths  B. Birth plus the number of immigrations is less than the number of deaths plus the number of emigration.  <b>C. Birth plus the number of immigrations is greater than the number of deaths plus the number of emigration.</b>  D. Deaths plus the number of emigration is greater than the number of births plus the number of immigration.</p>
55	2001/1/8	<p>Which of the following features are most useful to amphibians in living in aquatic habitat?</p> <p>A. Moist skin, membrane around eggs, and gills  <b>B. Membrane around eggs, gills and webbed feet</b>  C. Long hind limbs, short fore limbs and gills  D. Webbed feet, moist skin and gills</p>
56	2001/1/9	<p>Which one of the following is an intracellular parasite?</p> <p>A. Trypanosome  <b>B. Plasmodium</b>  C. Schistosome  D. Hook worm</p>
57	2001/1/10	<p>There is a limited biomass at each trophic level in a food chain because at each level, there is</p> <p>A. Reduction in the number of organisms  <b>B. Loss of energy</b>  C. Reduction in size of organisms  D. Reduction in amount of food.</p>
58	2001/1/32	<p>How many reproductive stages does malarial parasite undergo to complete the life cycle?</p> <p>A. 1  B. 2  C. 3  D. <b>4</b></p>
59	2000/1/2	<p>Which one of the following describes greenhouse effect?</p> <p>A. Depletion of the ozone layer increases atmospheric temperature.  <b>B. The earth retains the heat gained from the sun</b>  C. Increasing atmospheric carbon dioxide prevents heat loss from earth surface  D. The earth gives out carbon dioxide which prevents light rays from the sun reaching the earth.</p>

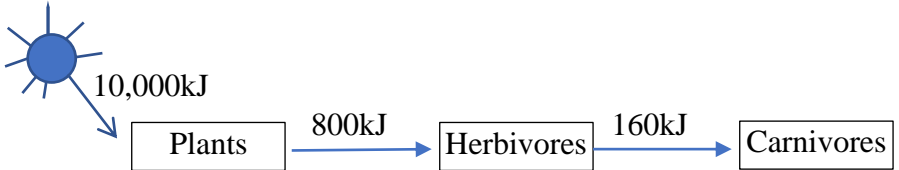
60	2000/1/3	The reproductive stage of plasmodium in the liver is represented by the A. Zygote B. Gametocyte C. Merozoite D. sporozoite
61	2000/1/26	Plant roots in association with symbiotic bacteria is an indication that A. the plant is unhealthy B. the roots have been attacked C. soil around roots lacks nitrogen D. soil around roots lack humus
62	2000/1/29	Which one of the following in not a component of environmental stress? A. Lack of light B. Lack of shelter C. Topography D. diseases
63	1999/1/12	A dodder plant, which attaches on stems of various plants is yellow in appearance. This indicates that the plant A. lacks roots B. lacks certain minerals C. is parasitic D. lacks supporting tissues
64	1999/1/32	Which one of the following is not a structural component of ecosystem? A. Green plants B. Decomposers C. Predators D. Solar system
65	1998/1/16	The existence of ring worm on human skin is an example of A. Parasitism B. Mutualism C. Commensalism D. symbiosis
66	1998/1/21	What is meant by ecological niche? A. Conditions in which the organism lives B. Specific localities with particular set of conditions C. Geographic region, cutting across continents D. Precise place of an organism and what it does there
67	1998/1/32	Which of the following best describes how pesticides have become dangerous today? The pesticide A. Persist in the soil and make it infertile B. Harden the soil C. Pass through food chains in more concentrated forms D. Cause eutrophication in water and kill fish.



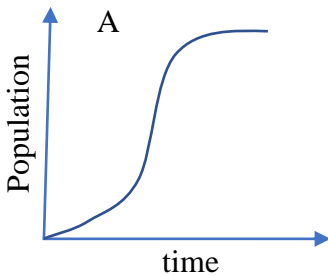
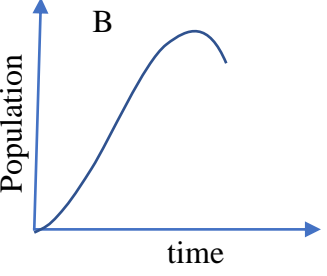
68	1997/1/21	The competitive exclusion principle attempts to explain why <b>A. A particular niche contains one species</b> B. Pioneer plants are not found in established community C. There is rarely more than five trophic levels in an ecosystem D. The diversity of a habitat increases as succession proceeds
69	1997/1/37	Insectivorous plants are most likely to be found growing in A. Soil with high organic matter contents <b>B. Soil with low nitrogen content</b> C. Soil with low pH D. Alkaline soil
70	1997/1/40	A species of beetle recently introduced to control the water hyacinth in Uganda lakes. If the beetles reduced the spread of the weed, this would be an example of A. Ecological balance <b>B. Biological control</b> C. Dominancy of species D. Successful competition
70	2014/1/7	Which of the following is the correct sequence representing the action of nitrifying bacteria? A. Nitrites → nitrates → Ammonium salts <b>B. Ammonium salts → Nitrites → nitrates</b> C. Nitrites → Ammonium salts → nitrates D. Ammonium salts → nitrates → Nitrites
71	2013/1/31	Which one of the following process does not affect the biochemical oxygen demand in an environment? A. Nitrification B. Ammonification C. Nitrogen fixation D. <b>Denitrification</b>
72	2011/1/15	A non-mutualistic role of bacteria in ruminant animals is that they A. Secrete enzymes for hydrolysis of carbohydrates B. Break down food into small fragments to ease enzyme action C. Produce bacterial proteins which is used by ruminant D. <b>Are preyed on by the ruminants</b>
73	2007/1/30	Which of the following is the main reason why insects eggs usually hatch rapidly into larvae? A. Eggs have little yolk B. Hatching is controlled by external factors C. <b>It is a way of avoiding predators</b> D. Due to excessive production of juvenile hormone
74	2006/1/29	Good drainage and ploughing of soil reduces the process of A. Nitrification B. Decomposition <b>C. Denitrification</b> D. Nitrogen fixation

75	2002/1/2	<p>Which of the following is true about a population where there is no environmental resistance? The population</p> <p><b>A. Grows exponentially</b></p> <p>B. Inflicts mild pain to the host</p> <p>C. Having a dormant stage during the life cycle</p> <p>D. Inflicting severe harm to the host</p>								
76	2001/1/19	<p>Which of the following would does not affect the pH directly?</p> <p>A. Absorption of bases by plant roots</p> <p>B. Production of carbon dioxide by plant roots</p> <p>C. Leaching</p> <p>D. Water logging</p>								
80	2001/1/26	<p>Plant roots in association with symbiotic bacteria is an indication that</p> <p>A. The plant is unhealthy</p> <p>B. The roots have been attacked</p> <p><b>C. Soil around the roots lacks nitrogen</b></p> <p>D. Soil around the roots lacks humus</p>								
81	1997/1/9	<p>Which one of the following sequence correctly represents the action of nitrifying bacteria?</p> <p><b>A. Ammonia → nitrites → nitrates</b></p> <p>B. Ammonia → nitrate → nitrites</p> <p>C. Nitrite → nitrate → ammonium</p> <p>D. Nitrite → ammonium → nitrates</p>								
82	1997/1/14	<p>Which of the methods below is most suitable for estimating the population of paramecium in a pond?</p> <p>A. Capture-recapture method</p> <p>B. Total count</p> <p>C. Removal method</p> <p>D. Random sampling</p>								
83	1996/1/10	<p>The introduction into Uganda to species of South American beetles which naturally feed on water hyacinth is an example of:</p> <p>A. Herbivory</p> <p>B. Predatory</p> <p><b>C. Biological control</b></p> <p>D. Ecological balance</p>								
84	1996/1/34	<p>The data below indicate the concentration, in parts per million, of a pesticide in the bodies of some organisms that in an area after 20years of use of pesticide.</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td>Phytoplankton</td> <td>tilapia</td> <td>zooplankton</td> <td>fish eagle</td> </tr> <tr> <td>0.04</td> <td>2.07</td> <td>0.23</td> <td>13.80</td> </tr> </table> <p>The most probable reason for the fish eagle to have the highest concentration of the pesticide is that</p> <p>A. The pesticide accumulates in the fatty tissue of fish eagle</p> <p>B. Fish eagles are at the end of food chain represented by organisms.</p> <p>C. Fish eagle take more food than other organisms</p>	Phytoplankton	tilapia	zooplankton	fish eagle	0.04	2.07	0.23	13.80
Phytoplankton	tilapia	zooplankton	fish eagle							
0.04	2.07	0.23	13.80							

		D. The elimination of pesticides is less efficient in fish eagle than in other organisms.
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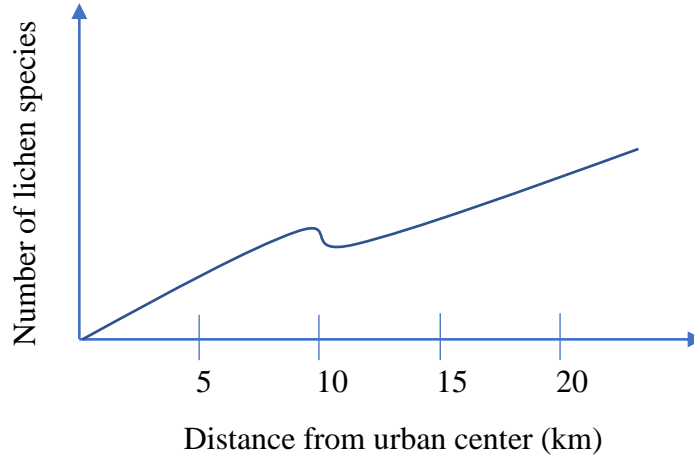
		<b>Structured questions</b>
1.	2014/1/42	<p>(a) What is parasitism? (1mark)</p> <p>.....</p> <p>.....</p> <p>(b) State <b>three physiological</b> adaptations of endo parasites. (3marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(c) Give <b>three</b> advantages of a parasitic mode of life to the parasite (3marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(d) Describe three ways of a parasite-host relationship which ensures the success of a parasite. (3marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
2.	2014/1/43	<p>The figure shows energy flow in a food chain</p>  <p>(a) (Assuming 10% of the energy received by herbivores is lost, calculate the energy retained. (03marks)</p> <p>.....</p> <p>.....</p> <p>.....</p>

		<p>.....</p> <p>(b) Explain why</p> <p>(i) Energy transfer from herbivores to carnivores is more efficient than that from producers to herbivores. (3marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(ii) The efficiency of energy transfer from herbivores to carnivores is less than 100%. (02marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(c) State the factors which limit the number of trophic levels in a food chain. (02marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
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3.	2013/1/42	<p>The below show the two forms of population growth curves of animals</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Graph A: A graph with 'Population' on the vertical axis and 'time' on the horizontal axis. The curve starts at the origin, rises steeply, and then levels off to a horizontal line, representing a sigmoidal growth curve.</p> </div> <div style="text-align: center;">  <p>Graph B: A graph with 'Population' on the vertical axis and 'time' on the horizontal axis. The curve starts at the origin, rises to a peak, and then begins to decline, representing a non-sustainable growth curve.</p> </div> </div> <p>(a) Indicate by drawing on curve A The carrying capacity of the environment (01mark)</p> <p>.....</p> <p>(b) Compare the pattern of population changes in curve A and curve B (2marks)</p> <p>.....</p> <p>.....</p>
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		<p>.....</p> <p>.....</p> <p>(c) Suggest an explanation for the population changes in curve B. (4marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(d) Suggest three biotic factors which can result into a change in carrying capacity, in an environment. (03marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
4.	2012/1/46	<p>(a) State three ecological problems which arise from accumulation of domestic waste in urban communities (03marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(b) Give two ways of reducing domestic waste (2marks)</p> <p>.....</p>

(c) The figure below shows lichen species growing along a 20Km transect from an urban Centre.



(i) Explain the trend in the lichen species with distance from urban centre (3marks)

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(ii) Suggest an explanation for the observed number of lichen species at a distance of 10km from urban center (2marks)

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5. 2010/1/45

(a) How can predation be beneficial to the prey? (02marks)

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(b) Give factors that may affect the predator prey balance in nature (4marks)

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		<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(c) Outline ways by which humans affected the predator-prey balance resulting into harmful consequences (04marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
6.	2007/1/44	<p>(a) (i) Describe how a quadrat method can be used to determine species density. (2marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(iii) state the advantages and disadvantages of the method. (2marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(b) (i) why is it important to estimate population size?</p> <p>.....</p> <p>.....</p> <p>(ii) in estimating the number of fish in a small lake, 625 fish were caught, marked and released. After one week, 920 fish were caught and of these, 150 had been marked. What was the estimated size of fish population (2 marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(iii) In using the method in b(ii) estimate the population size of fish, state two assumptions that were made (2marks)</p> <p>.....</p> <p>.....</p>



		..... .....														
7	2006/1/46	<p>The table shows the amount of DDT measured in parts per million(ppm) Found in a variety of organisms associated with a fresh water lake</p> <table border="1"> <thead> <tr> <th>Where the DDT level was measured</th> <th>Amount of DDT/ppm</th> </tr> </thead> <tbody> <tr> <td>Water</td> <td>0.0003</td> </tr> <tr> <td>Phytoplankton</td> <td>0.006</td> </tr> <tr> <td>Zooplankton</td> <td>0.004</td> </tr> <tr> <td>Herbivorous fish</td> <td>0.39</td> </tr> <tr> <td>Carnivorous fish</td> <td>1.8</td> </tr> <tr> <td>Fish-eating birds</td> <td>14.3</td> </tr> </tbody> </table> <p>(a) (i) Calculate how many times the DDT is more concentrated in carnivorous fish compared with its concentration in water (2marks)</p> <p>..... ..... .....</p> <p>(iii) What does the results show?</p> <p>..... .....</p> <p>(b) Explain why concentration of DDT changes from water to carnivorous fish. (03marks)</p> <p>..... .....</p> <p>© State two effect of DDT to organism (02marks)</p> <p>..... .....</p> <p>(c) Explain how a pest sprayed with a pesticide may flourish afterwards? (3marks)</p> <p>..... ..... ..... .....</p>	Where the DDT level was measured	Amount of DDT/ppm	Water	0.0003	Phytoplankton	0.006	Zooplankton	0.004	Herbivorous fish	0.39	Carnivorous fish	1.8	Fish-eating birds	14.3
Where the DDT level was measured	Amount of DDT/ppm															
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Zooplankton	0.004															
Herbivorous fish	0.39															
Carnivorous fish	1.8															
Fish-eating birds	14.3															

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8.	2005/1/45	<p>(a) State two human activities that increase the levels of carbon dioxide in the atmosphere. (2marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(b) What is the effect of high levels of each of the following gases in atmosphere? (7marks)</p> <p>(i) Carbon dioxide</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(ii) Sulphur dioxide</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(c) State one indicator in the environment where there is prevalence of high level of sulphur dioxide in the environment. (1mark)</p> <p>.....</p> <p>.....</p> <p>.....</p>
9.	2005/1/44	<p>(a) State the importance of the following elements in plant metabolism</p> <p>(i) Calcium (1mark)</p> <p>.....</p> <p>.....</p> <p>(ii) Magnesium (1mark)</p> <p>.....</p> <p>.....</p>

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(b) How does water logging of the soil affect its nitrate content? (3marks)

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(c) Describe three special ways of obtaining essential elements by some plants growing in soil deficient on those elements. (5marks)

(i) .....

(ii) .....

(iii) .....

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(iv) .....

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10    2002/1/44

(a) In an aquatic ecosystem which was affected by an insecticide, analysis of energy flow and concentration of the pesticide at each level in a food chain was made. The results are shown on the pyramid of biomass of the ecosystem, in figure below.

Energy flow ( $\text{kJm}^{-3}\text{yr}^{-1}$ )		Concentration of pesticide (ppm)
88	Carnivore 2	75
1603	Carnivore 1	50
14098	herbivores	10
87110	Producers	0.04

(a) What does the width of each bar of the pyramid represent? (1mark)

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(b) Explain why, from producer to secondary consumer,

(i) The level of pesticide increase (2marks)

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(ii) The flow of energy decrease? (2marks)

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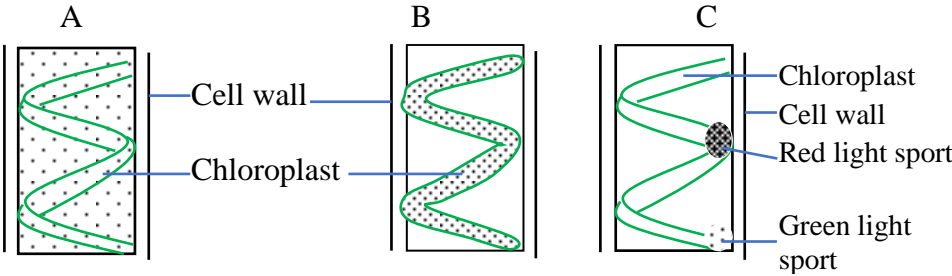
(c) From the biomass, explain how the producer can sustain the herbivores (2marks)

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(d) Give three ecological problems that may arise through the use of pesticides. (3marks)

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11 2000/1/45 One strand of spirogyra was placed on each of three microscope slides A, B and C. the spirogyra was in water contained aerobic, free-moving bacteria. The three slides were placed under conditions shown in figure below. After one hour of incubation, the results are shown below.



(a) Describe the distribution of bacteria on the three slides A, B, C. (3marks)

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(b) Explain the distribution of bacteria on each slide (7marks)

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12	1997/1/45	<p>The table shows the concentration of organism chloride in different organism inhabiting a pond. Study the table and answer the question that follow.</p> <table border="1" data-bbox="418 1255 1393 1444"> <thead> <tr> <th data-bbox="418 1255 678 1329">organism</th> <th data-bbox="678 1255 865 1329">Planktons</th> <th data-bbox="865 1255 1011 1329">Large fish</th> <th data-bbox="1011 1255 1203 1329">Fish eagle</th> <th data-bbox="1203 1255 1393 1329">Small fish</th> </tr> </thead> <tbody> <tr> <td data-bbox="418 1329 678 1444">Concentration of organic chloride (ppm)</td> <td data-bbox="678 1329 865 1444">0.04</td> <td data-bbox="865 1329 1011 1444">0.5</td> <td data-bbox="1011 1329 1203 1444">25</td> <td data-bbox="1203 1329 1393 1444">40</td> </tr> </tbody> </table> <p>(a) Comment on the data given in table above</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(b) Using the information given in the table, construct a possible food chain in the pond.</p> <p>.....</p>	organism	Planktons	Large fish	Fish eagle	Small fish	Concentration of organic chloride (ppm)	0.04	0.5	25	40
organism	Planktons	Large fish	Fish eagle	Small fish								
Concentration of organic chloride (ppm)	0.04	0.5	25	40								

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(c) Explain the high concentration of chlorine in the fish eagle

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(d) Suggest the properties you would recommend for a suitable chemical to use in water purification

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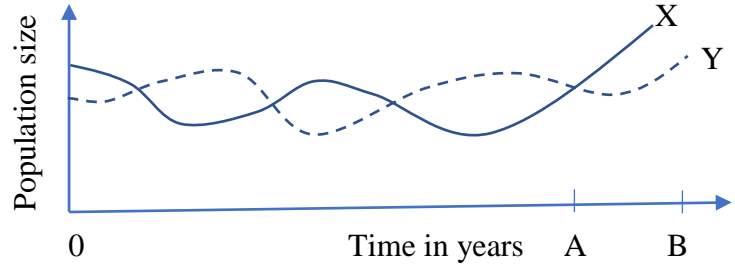
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13. 2012/1/41

The figure shows changes in the size of a population of a producer and the consumer in a lake over time.



- (a) State which curve represents the
  - (i) Producer ..... ( ½ mark)
  - (ii) Consumer ..... ( ½ mark)
- (b) Explain the interaction between the two population before point A (5marks)

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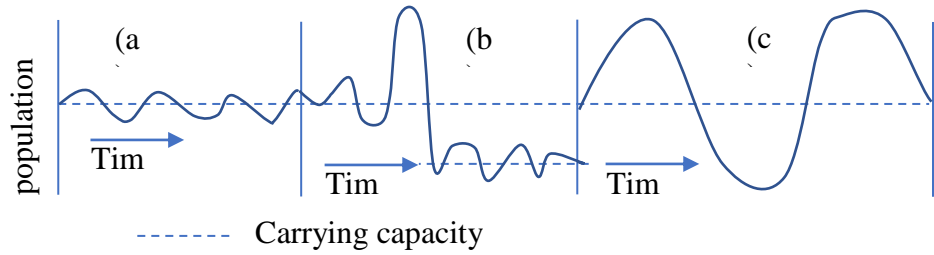
- (c) Suggest how human activities could result in the interactions of the population between points A and B (4marks)

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14 2009/1/45

The figure shows population growth curves partten (a), (b) and (c) that occur naturally



Describe and suggest reasons for thr observed pattern of each population growth curve

(a) (3marks)

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(b) (4marks)

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(c) (3marks)

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15. 2004/1/41

(a) What is meant by **eutrophication**? (2marks)

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(b) State two human activities that may encourage eutrophication (2marks)

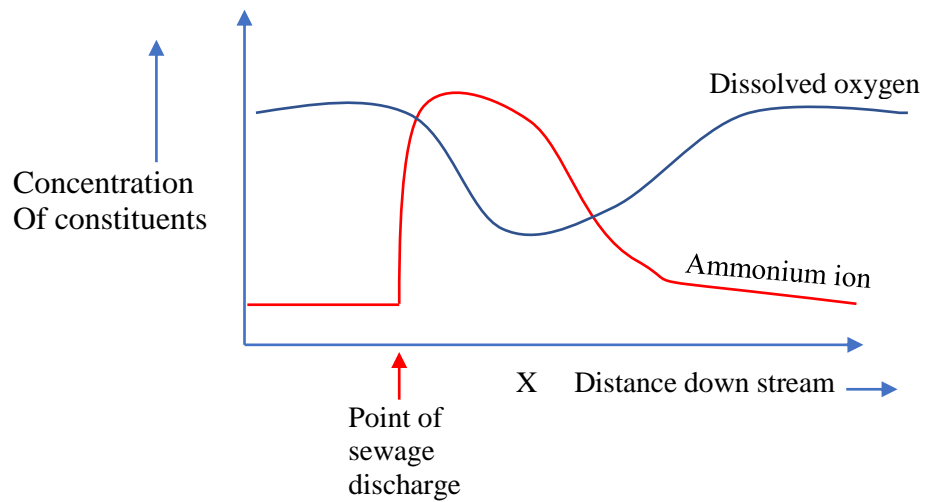
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		<p>.....</p> <p>.....</p> <p>.....</p> <p>(c) What is the effects of eutrophication? (04marka)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(d) Effects of eutrophication are more sevee in water bodies where thermal polution occurs. Explain. (2marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
16.	2003/1/44	<p>(a) What do you understand by <b>biological control</b>? (2marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(b) What consideration must be made before application of a biological pest control method? (2marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(c) (i) state <b>two</b> ways in which chemical pest control method can upset ecosystem(2marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>(ii) Suggest <b>two</b> reasons why pests eventually flourish after a period of pesticide application. (2marks)</p> <p>.....</p> <p>.....</p>



(d) Suggest three characteristics of a good pesticide (3marks)

17. 2001/1/45 The graph below shows the effect of sewage discharge on some chemical constituents of a river at increasing distance down stream from the point of sewage discharge



(a) Give explanation for the variation in concentration of ammonium ions and dissolved oxygen, down stream from the point of sewage discharge

(i) Ammonium ion (3marks)

ii) dissolved oxygen (3marks)

		<p>.....</p> <p>.....</p> <p>.....</p> <p>(b) Describe the effect of sewage on the ecosystem at distance X down stream.(4marks)</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
18		

		<b>Assay questions</b>
1.	2015/2/6	(a) What is a food chain? (2marks) (b) Explain how energy flows through an ecosystem? (08marks) (c) How does temperature influence the distribution of organism? (8marks)
3.	2013/1/3	(a) What is ecological impact of each of the following human activities? (i) Use of pesticide (6marks) (ii) Use of artificial fertilizers (4marks) (iii) Over fishing (5marks) (b) Describe advantages of biological pest control over pesticides in an ecosystem. (5marks)
4.	2013/1/5	(a) Describe the relationship between organisms in the lichen. (06marks) (b) Compare mutualism and parasitism. (7marks) (c) Explain how termite are able to feed on wood. (07marks)
5.	2012/2/5	(a) Explain how ferns are better adapted for terrestrial life than mosses (08marks) (b) How does temperature influence the following processes in plant? (i) Plant growth (07marks) (ii) Plant distribution (05mark)
6.	2011/2/6	(a) Outline the causes of nutrient deficiency in soil (4marks) (b) Explain how plants have overcome the problems of nitrogen and phosphorous deficiencies in soils they grow in. (16marks)
7.	2009/2/6	(a) What is meant by (i) Biotic potential? (3marks) (ii) Primary productivity? (2marks) (b) Discuss the factors which influence the size of the population in ecosystem (12marks) (c) Suggest reasons why human populations are not naturally regulated by negative feedback mechanisms (3marks)
8.	2006/2/1	Figure 1, 2, 3 shows the immigration and extinction of species on different categories of virgin islands.  Figure 1 shows the rate of immigration of new species on a island nearby the sore and one that is far from the shore.  Figure 2 shows the rate of extinction of species on a large island and on small island Figure 3 shows the rate of immigration and extinction of species on the island. Study the information and use it to answer the questions that follow.

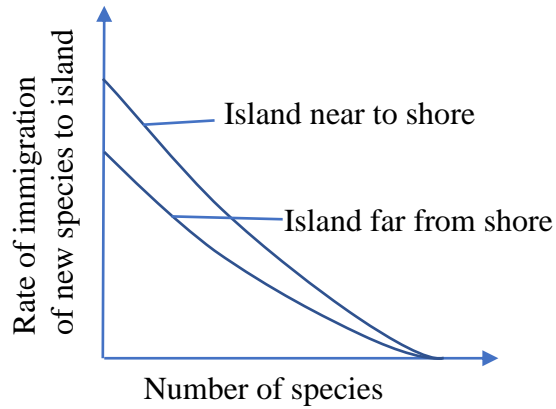


Figure 1

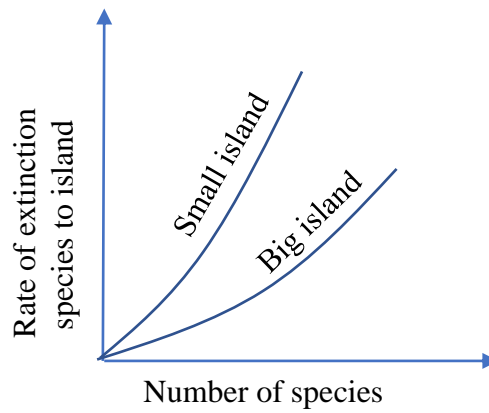


Figure 2

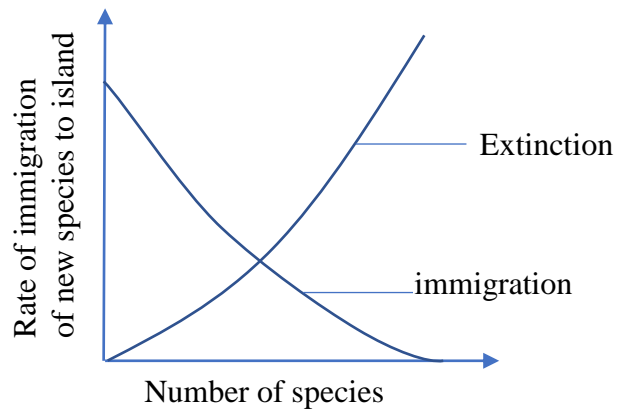


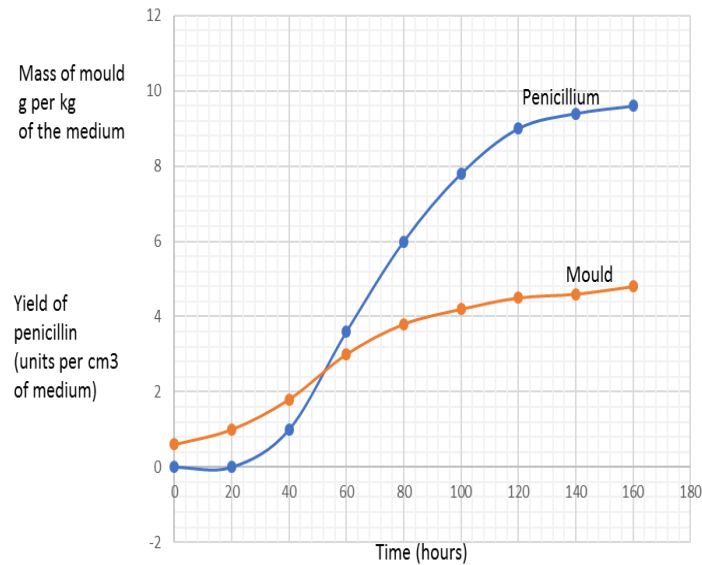
Figure 3

- (a) Explain the rate of
- (i) Immigration of new species on an island that is near to the shore and one that is far from the shore (figure 1) (10marks)
  - (ii) Extinction of species on a small island and on a large island (figure

		<p>2) (09marks)</p> <p>(iii) Immigration and extinction of species on an island (figure 3 (7marks)</p> <p>(b) From figure 1, 2, 3 what conclusions can you draw about what determines the number of species on an island? (05marks)</p> <p>(c) Describe how factors other than those depicted in information provided, may affect the immigration of new species on an island. (4marks)</p> <p>(d) Suggest the factors that would cause immigration of new species to a virgin land. (5marks)</p>
9	2004/2/6	<p>(a) What is biological pest control (2marks)</p> <p>(b) Explain the precautions to be taken in application of biological pest control (06marks)</p> <p>(c) Describe the ecological qualities of a good pesticides</p>
10	2003/2/5	<p>(a) Describe the trend of succession that would take place on a bare rock. (10marks)</p> <p>(b) Outline the flow of energy in the climax community described in (a) (10marks)</p>
11	2001/2/5	Describe the influence of biotic factors, excluding man, on the distribution of organisms in nature. (20marks)
12	2000/2/6	<p>(a)(i) Describe how plants absorb nitrates from the soil.</p> <p>(ii) Give three ways in which plants use nitrates they have absorbed.</p> <p>(c) Describe ecological effects of drainage of nitrate fertilizers into rivers and streams.</p>
13	1999/2/3	<p>(a)(i) outline the importance of population size of different organisms in a given area to an ecologist</p> <p>(ii) Differentiate between sample count and total count.</p> <p>(b) Give five factors to be considered before carrying out counting. exercise</p> <p>(c) Describe a suitable method you would use to estimate the population of</p> <p>(i) Fish e.g. tilapia</p> <p>(ii) Flying insects in a woodland.</p> <p>Give reasons for your choice</p>
14	1999/2/5	<p>(a) Describe the physiological and structural factors of the water hyacinth which enabled it to spread and persist on Lake Victoria.</p> <p>(b) Outline the ecological dangers of this weed on the water</p> <p>(c) Suggest three control methods of the water weed, and for each method point out one weakness.</p>
15	2009/2/2	<p>(a) Explain how plants living under the canopy of forest trees are able to survive (15marks)</p> <p>(b) Describe how herbaceous plants are supported of the ground (05marks)</p>
16	2004/2/1	<p>Graphs A, B and c shows results of three experiments that were carried out to study the relationship between a predator, <i>Didinium</i> and a prey Paramecium under three set of conditions.</p> <p>In the first experiment, Paramecium was introduced into a culture at point <b>P</b> and Didinium at point <b>D</b> as shown in figure1</p>

		<p>In the second experiment, Paramecium and Didinium was introduced to ether at point <b>P + D</b> at different population densities. This is shown in graph <b>B</b> of figure 1</p> <p>In the third experiment, Paramecium and Didinium were introduced together at point P +D at different densities. And after every three days as shown by the arrow in the graph in graph C of figure 1.</p> <p>Study the graphs and answer the questions that follow.</p> <p>(a) Describe the trend of the population growth of Paramecium and Didinium in graph.  (i) A (04marks)  (ii) B (03marks)  (iii) C (04marks)</p> <p>(b) Explain the interaction of the two species of organism in graph  (i) A (06marks)  (ii) B (06marks)</p> <p>(c) Compare the trend of the population growth of the two species in graph B and C. (05marks)</p> <p>(d) Supposing Paramecium and Didinium were introduced at the same time under natural environmental conditions, sketch curves to show the expected trend of population with time (5marks)</p> <p>(e) Explain the trend of the population curves of Paramecium you have drawn in (d) (5marks)</p>																											
17	2002/2/6	How are vertebrates adapted to terrestrial life (20marks)																											
18	2001/2/1	<p>Growth of two microorganisms in culture media and yield of their products was analyzed. The table shows the growth of the yeast and yield of its product ethanol.</p> <table border="1"> <thead> <tr> <th>Time (hrs)</th> <th>Mass of yeast (g per dm<sup>-3</sup> of the medium)</th> <th>Yield of ethanol (g per 100cm of the medium)</th> </tr> </thead> <tbody> <tr><td>0</td><td>1.0</td><td>0.2</td></tr> <tr><td>2</td><td>1.4</td><td>0.4</td></tr> <tr><td>4</td><td>2.4</td><td>0.6</td></tr> <tr><td>6</td><td>4.2</td><td>1.3</td></tr> <tr><td>8</td><td>5.9</td><td>2.5</td></tr> <tr><td>10</td><td>6.2</td><td>2.8</td></tr> <tr><td>12</td><td>6.1</td><td>2.6</td></tr> <tr><td>14</td><td>5.8</td><td>2.2</td></tr> </tbody> </table> <p>Graph 1 shows the growth of the ascomycete mould Penicillium and the yield of its products penicillin. Use the data to answer the questions that</p>	Time (hrs)	Mass of yeast (g per dm <sup>-3</sup> of the medium)	Yield of ethanol (g per 100cm of the medium)	0	1.0	0.2	2	1.4	0.4	4	2.4	0.6	6	4.2	1.3	8	5.9	2.5	10	6.2	2.8	12	6.1	2.6	14	5.8	2.2
Time (hrs)	Mass of yeast (g per dm <sup>-3</sup> of the medium)	Yield of ethanol (g per 100cm of the medium)																											
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4	2.4	0.6																											
6	4.2	1.3																											
8	5.9	2.5																											
10	6.2	2.8																											
12	6.1	2.6																											
14	5.8	2.2																											

follow



Graph 1

- (a) Represent the information in the table graphically (6marks)  
Use your graph and graph1, to answer question (b) –(f)
- (b) Describe the patterns of growth of the mould and yeast (6marks)
- (c) Give two differences in the growth pattern of the mould and yeast. (4marks)
- (d) Explain what is happening in the growth of yeast population during each of the following:  
(i) 0 - 2 hours  
(ii) 4 - 6 hours  
(iii) 8 - 10 hours  
(iv) 12 – 14 hours (8marks)
- (e) Describe the relationship between the  
(i) Growth of mould and yield of penicillin  
(ii) Growth of yeast and production of ethanol (4marks)
- (f) State three ways in which the pattern of accumulation of penicillin in graph 1 differs from the pattern of accumulation of ethanol on your graph. (6marks)
- (g) Ethanol is a direct product of metabolic process essential for the life of the organism. Penicillin is a product of metabolic process which is not essential to keep the organism alive.  
Suggest how the differences in the pattern of accumulation of these two

		products may be related to their differing roles in the metabolism of the producer organisms. (2marks)
		(h) State the economic importance of saccharomyces and penicillium (4marks)
18	2001/2/3	The distribution of the stomata and other leaf modification in plants are indicative of their habitats. Discuss. (20marks)

a. Which one of the following activities does not contribute to the greenhouse effect?

- A. Deforestation.
- B. Use of CFCs.
- C. Burning of fossil fuels.
- D. Emission of gases from industries.

The answer is B

Accumulation of carbon dioxide in the atmosphere prevents heat energy from escaping from the earth's surface. This result in accumulation of heat energy on the earth's surface, a phenomenon called greenhouse effect.

Any activity that increase carbon dioxide concentration in the atmosphere will lead to green house effect. Such activities include deforestation. burning fossil fuels and industrial emissions.

Note:

Use of chlorofluorocarbons (CFCs) causes depletion of the ozone layer and causes sun rays reaches the earth directly. This causes direct global warming but not through greenhouse effect.

42. (a) What is meant by parasitism?

- (b) State three physiological adaptations of endoparasites.
- (c) Give three advantage of parasitic mode of life to a parasite

(a) Describe three ways of parasite-host relationship which ensure the success of a parasite

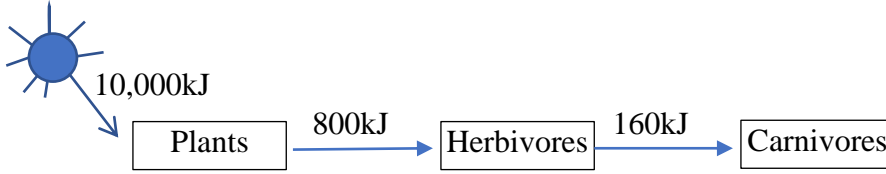


## Solution

- (a) Parasitism is a close association between two organisms of different species in which one organism (the parasite benefits while the other (the host) is harmed.
- (b) . Ability to respire adequately anaerobic conditions
- Production of digestive enzymes to aid penetration into host.
  - Chemosensitivity in order to reach the optimum location in the host's body
  - Others:
  - Production of an anticoagulant in blood feeders.
- (c) Nutrients are always readily available and so there is no loss energy in searching for food.
- They live a homeostatically regulated environment and so there is no need for osmoregulation.
  - They are usually provided with already digested food nutrients and so there's so need for digestive system.
  - Others:
  - The parasite is always accorded enough protection shelter and therefore not prone to predation
- (d) Inflicting only moderate to the host  
Inhabiting more than on host.  
Using a secondary host as a vector for transmission to the definitive host.

43. Figure 4 show energy flow in a food chain.

The figure shows energy flow in a food chain



(d) (Assuming 10% of the energy received by herbivores is lost, calculate the energy retained. (03marks)

.....  
.....  
.....

(e) Explain why

(iv) Energy transfer from herbivores to carnivores is more efficient than that from producers to herbivores. (3marks)

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.....  
.....

(v) The efficiency of energy transfer from herbivores to carnivores is less than 100%. (02marks)

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.....

(f) State the factors which limit the number of trophic levels in a food chain. (02marks)

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.....

Solution

$$\text{Energy received herbivores} = 800\text{kJ}$$

$$\text{Energy lost} = 10\% \text{ of } 800$$

$$= \frac{10}{100} \times 800$$

$$\text{Energy retained} = \text{energy received} - \text{energy lost}$$

$$= 800\text{kJ} - 80\text{kJ}$$

$$\text{Energy retained} = 720\text{kJ}$$

(b) (i) producers (plants) contain a high proportion of cellulose and sometime wood which are relatively indigestible and therefore unavailable as energy sources for most herbivores.

The herbivore transfer animal tissue to the carnivore, which is easily digestible and can therefore be utilized by the carnivore. As a result, a large percentage of energy is transferred from herbivores to carnivores than from produces to herbivores

(ii). Some energy is also in the form of excrete and egesta and it transferred to detritivores and decomposers and never reach the carnivores.

Some structure like teeth cannot be digested to release energy.

(c ) Amount of energy received by producers

Proportion of received energy that is converted into primary productivity (NPP)

Extent of energy loss at each trophic level.

3. Which one of the following is correct about organisms in an ecosystem?

- A. Some organisms exist in isolation.
- B. Every organism can be independent.
- C. All organisms interact with each other.

D. Each organism has a different source of food.

3. The answer is C

An ecosystem consists of different organism that interacts continuously interact with one another in their environment. They often compete with each other for food , shelter and available resource.

Recall:

An ecosystem is any unit of the environment composed of living and non- living components whose interactions result in a stable self-perpetuating system.

17. Which one of the following methods of estimating population has the highest chances of error?

A. Removal method.

B. Quadrat method.

C. Capture-recapture method.

D. Direct count method.

24. Which one of the following factors reduces interspecific competition in a community?

A. Resource partitioning.

B. High intraspecific competition.

C. Large number of species.

D. Similar predator-prey strategies among the species.

24. The answer is A

Interspecific competition in a community is competition which occurs among organism of different species. Resource partitioning, the allocation of a particular class of resource to a given group of species, reduces this kind of competition by ensuring that organism of a given species are entitled to particular resource, leaving other resource t the other species.

31. Which one of the following processes does **not** affect the biochemical oxygen demand in an environment?

- A. Nitrification.
- B. Ammonification.
- C. Nitrogen fixation.
- D. Denitrification.

The answer is D

Denitrification occurs in anaerobic conditions. Using nitrate as the oxidizing agent. As such, it does not affect the biological oxygen demand (BOD) in an environment.

Note:

The other processes, nitrification, ammonification, and nitrogen fixation require oxygen in order to occur and therefore directly affect the biological oxygen in an environment.

39. Which one of the following is not exhibited by a well-adapted parasite?

- A. Inflicting moderate harm to its host.
- B. employing an intermediate host.
- C. killing the host.
- D. using more than one host.

The answer is C

A well-adapted parasite never kills nor does it cause great harm to its host. However, it may

inflict moderate harm to its host

employ an intermediate host.

Use more than one host.

1. Figure 5 show two forms of population growth curve of animals.

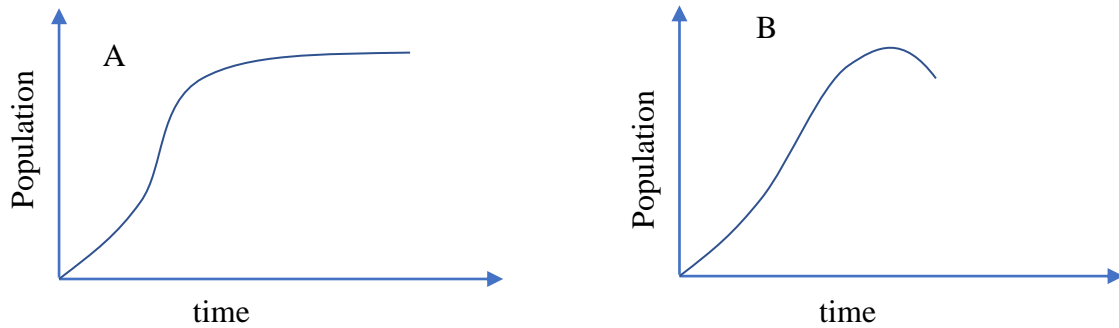
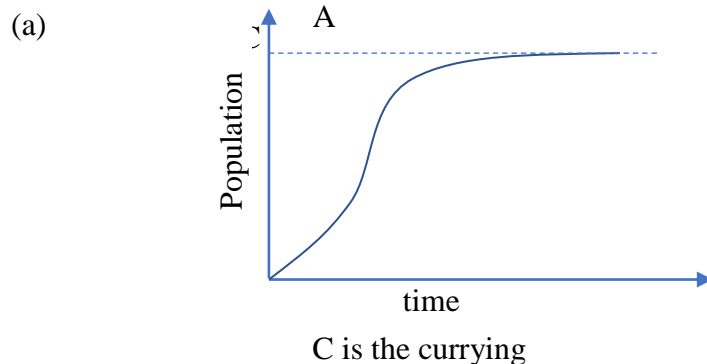


Fig. 5

- Indicate by growing on curve A the carrying capacity of the environment.
- Compare the pattern of population change in curve A and B
- Suggest an explanation for the population changes in curve B
- Suggest three biotic factors which can result into a change in carrying capacity, in an environment.

42



Note: in an examination, this should be drawn on the graph provided in the question

(b). Similarities

In the curves, population of the animals increase gradually initially, then rapidly approaching an exponential growth rate then show a declining rate of increase to a maximum.

Both population start at zero

Difference

In A, the population attains maximum and maintains it over time while in B after attaining a maximum; the population shows a gradual decline with time.

(a) Initially , the growth rate is show because

- A few animals have reached reproductive maturity.
- The animals are not yet adapted to the conditions of environment.

Later, growth rate is rapid because

- The animals are now well adapted to environment.
- There are many reproducing animals

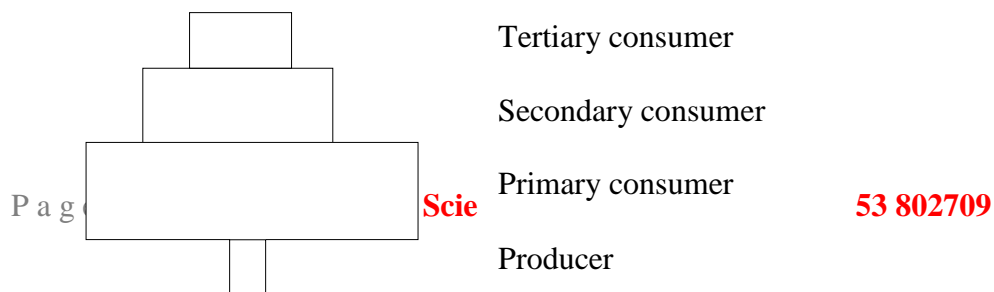
The declining rate available occur as a result of environmental stresses ssuch as:

- Competition for available resource such as food and shelter
- Accumulation of waste products
- Reproductive failure
- Predation

The decline after a maximum is a result of

- reduction in sources in the environment to support the animal population.
- Predation
- Competition
- Parasitism

9. Figure 2 shows a pyramid of numbers for a food chain.



The most likely mode of nutritional relationship between producers and primary consumers is

- A. mutualistic.
- B. symbiotic.
- C. parasitic.
- D. autotrophic.

The answer is C

The pyramid shows few producers supporting very many consumers. This is often true if the primary consumer is a parasite.

13. Depletion of the ozone layer is caused by

- A. greenhouse effect.
- B. release of carbon dioxide in the atmosphere.
- C. penetration of the ultraviolet rays.
- D. release of the chlorofluorocarbons in atmosphere.

The answer is D

Chlorofluorocarbons (CFCs) are chemical compounds which directly attack and deplete the ozone layer.

17. The type of succession where recolonisation of an area results into a different community from the original one is known as

- A. primary.
- B. dominant.
- C. deflected.
- D. secondary.



The answer is C

When an established community is destroyed and then allowed to regenerate, sometimes recolonization of the habitat leads to establishment of a climax community different from the original climax community. This usually occurs as a result of effects of human activities on the environment. The new communities are referred to as a plagioclimax and occur by a process of succession termed deflected succession.

Note:

- A succession developing on a newly emerged land (bare rock) or water is called primary succession
- A succession that develops following a fire or similar major disruption to an established community is called secondary succession.

18. Radioactive rays are particularly dangerous in nature because they

- A. cannot be absorbed by plants so they only affect animals.
- B. accumulate in animals and return to the soil when animals die.
- C. cause extremely high temperatures in the environment.
- D. accumulate in high concentrations at high trophic levels.

The answer is C

Radioactive rays often cause extremely high temperatures in the environment by giving up their high energies to materials through which they pass. This is a great disadvantage in nature.

33. Determining the commonest plant species a large habitat within a short time can best be carried out using the

- A. line transect.      B. quadrat.  
C. direct count.      D. aerial view method

33. The answer is A

A line transect involves the use of tape or string running along ground in a straight line between two designated points. Sampling is rigorously confined to species actually touching the line. This gives a quick method of identifying the commonest plant species in a large habitat.

Note:

Quadrat and direct count methods are more time consuming while aerial method is not suitable for plant species.

35. Excessive use of pesticides in the long term affects mostly

- A. carnivores.                      B. parasites.  
C. producers.                      D. herbivores

The answer is A

Pesticides have a property of bioaccumulation; a phenomenon by which the pesticides occur in increasing concentration among organisms at higher trophic levels. As a result, they affect carnivores mostly because they are at a higher trophic level than producers and herbivores.

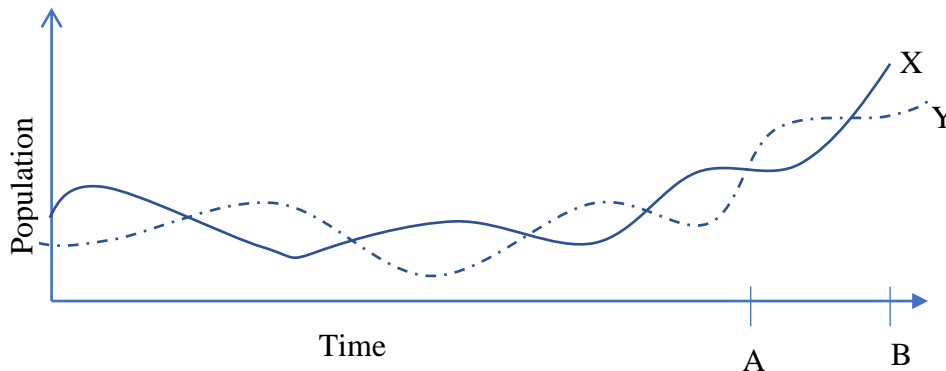
37. Which one of the following is true about the environment of a forest floor under a thick canopy?

- A. Has wide temperature fluctuations.
- B. Receives far red light.
- C. Develops dense plant growth.
- D. Has heavy soil erosion.

The answer is B

In the presence of a thick canopy, ordinary light cannot penetrate to reach the plants under the canopy. However, far red light has more energy and can therefore penetrate the canopy, therefore, it is far light that is received and utilized by the plants under the canopy.

41. Figure 6 shows changes in the size of a population of a producer and consumer in a lake over time.



- (a) State which curve represents the
  - (i) Producer
  - (ii) Consumer
- (b) Explain the interaction between the two populations before point A.
- (c) Suggest how human activities could result in the interaction of the population between points A and B

Solution:

- (a) (i) Curve X  
(ii).Curve Y

- (b) The population of consumers and producers fluctuate because consumer depends on producers for food.

When the population of consumer is high, they feed o producers at rate which is higher than the producers can reproduce. The population of the consumers increases as that of the producer decreases.

When the population of producers falls, that of the consumers also falls due to death of some consumers from starvation. This allows the population of producers to recover and the cycle continues.

- (c) Between A and B, the population of both organism increases. This may be due to:

Excessive use of fertilizers near the lake.

Dumping of untreated sewage into the lake

Deposition of detergents into the lake.

All these activities increase the nutrient content of the lake (eutrophication) thus accelerating the growth of producer which in turn support a larger population of consumers.