Ecosystem

Previous Years' CBSE Board Questions

12.1 Ecosystem - Structure and Function

VSA (1 mark)

1. How is 'stratification' represented in a forest ecosystem?
(Delhi 2014)

LA (5 marks)

2. (a) Taking an example of a small pond, explain how the four components of an ecosystem function as a unit.

(b) Name the type of food chain that exists in a pond.
(AI 2016)

12.2 Productivity

MCQ

3. The primary productivity in an ecosystem is expressed as

(a) $gm^{-2}yr^{-1}$ (b) $gm^{-2}yr$

(c) Kcal m^{22} yr^{-1} (d) Kcal m^2.
(2023)

VSA (1 mark)

4. What does 'R' represent in the given equation for productivity in an ecosystem?

GPP-R = NPP.
(Delhi 2014C)

SA I (2 marks)

5. Write the relationship between productivity, gross primary productivity, net primary productivity and secondary productivity.
(AI 2019)

OR

How are productivity, gross productivity, net primary productivity and secondary productivity interrelated?
(Delhi 2015)

SA II (3 marks)

6. How would you differentiate between gross primary productivity from net primary productivity and secondary productivity of an ecosystem.
(2020)

OR

Describe the inter-relationship between productivity, gross primary productivity and net productivity.

(AI 2017)

7. (a) What is the primary productivity of an ecosystem and how is it expressed?

(b) Explain what does the equation given below show:

NPP = GPP-R
(2019)

8. (a) What is primary productivity? Why does it vary in different types of ecosystems?

(b) State the relation between gross and net primary productivity.
(Delhi 2014)

12.3 Decomposition

MCQ

9. Assertion (A): Decomposition process is slower if detritus is rich in lignin and cutin.

Reason (R): Decomposition is largely an oxygen-requiring process.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).

(b) Both (A) and (R) true, but (R) is not the correct explanation of (A).

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.
(2023)

SA I (2 marks)

10. How is humus formed? Mention any three characteristics of humus.
(2020)

SA II (3 marks)

11. (a) Name the type of detritus that decomposes faster. List any two factors that enhance the rate of decomposition.

(b) Write the different steps taken in humification and mineralisation during the process of decomposition.
(2019)

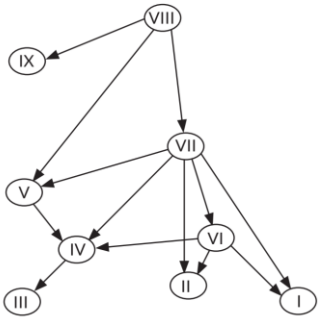
12. Why is earthworm considered a farmer's friend? Explain humification and mineralisation occurring in a decomposition cycle.
(Foreign 2015)

13. How does a detritivore differ from a decomposer? Explain with an example each. **(Delhi 2015C)**

12.4 Energy Flow

MCQ

14. In the illustration given below of a simplified food web on an island, the arrows indicate the direction of energy flow and the Roman numbers indicate species within the food web.



At which trophic level or levels does the species VIII function?

(a) 2nd and 3rd consumer (b) 1st consumer

(c) Producer (d) 3rd and 4th consumer
(2020)

VSA (1 mark)

15. "Man can be a primary as well as a secondary consumer." Justify this statement. **(Foreign 2015)**

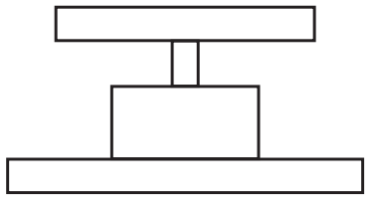
SA II (3 marks)

16. Justify the importance of decomposers in an ecosystem.
(Foreign 2015)

12.5 Ecological Pyramids

MCQ

17. Given below is a diagram of an ecological pyramid of numbers. Choose the correct food chain from the list of food chain given, that represent the given pyramid.



(a) Grass → Goat → Fox → Tiger

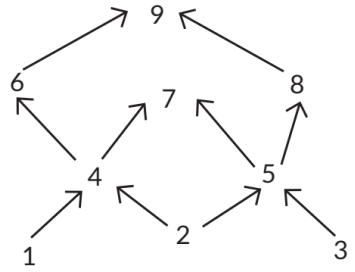
(b) Mice → Cat → Hyena → Cheetah

(c) Grass → Rabbit → Fox → Flea

(d) Grass → Insects → Sparrow → Snake
(2023)

SA I (2 marks)

18. Given below is a food web that involves nine organisms.



(a) Identify two producers and two carnivores shown in the food web.

(b) Is it possible to make an ecological pyramid depicting this food web? Give reason in support of your answer.
(2023)

19. Name the type of ecological pyramid that can exist as upright as well as inverted. Explain how does it happen.
(2020)

20. (a) How many primary producers do you think will be needed to support six tertiary consumers in a grassland ecosystem?

(b) Draw a grassland pyramid to substantiate your answer.
(2020)

SA II (3 marks)

21. (a) Name an ideal pyramid existing in an ecosystem. Construct it upto its three trophic levels along with their names.

(b) The sun provides 1,000,000 J of sunlight (solar energy) to an ecosystem. Write the amount of energy that is available to the first and third trophic levels. **(2020)**

22. Explain giving reasons that pyramid of energy is always upright. **(2019 C)**

23. "In a food chain, a trophic level represents a functional level, not a species". Explain. **(Delhi 2016)**

LA (5 marks)

24. (a) Construct a pyramid of biomass of grassland ecosystem. How is the pyramid of biomass in sea different from it?

(b) Name the primary producer and primary consumer in sea.

(c) What is standing crop? **(2020 C)**

25. (a) The pyramid of energy is always upright! Explain.

(b) Explain with the help of labelled diagrams, the difference between an upright pyramid of biomass and an inverted pyramid of biomass. **(AI 2019)**

26. (a) What does an ecological pyramid represent? State any two limitations that these pyramids have.

(b) Describe an inverted pyramid of biomass with the help of an example. **(2019)**

27. (a) What is a trophic level in an ecosystem? What is 'standing crop' with reference to it?

(b) Explain the role of the 'first trophic level' in an ecosystem.

(c) How is the detritus food chain connected with the grazing food chain in a natural ecosystem?

(2018)

28. (a) What is an ecological pyramid? Compare the pyramids of energy, biomass and numbers.

(b) Write any two limitations of ecological pyramids. **(NCERT Exemplar, Al 2017)**

29. "It is often said that the pyramid of energy is always upright. On the other hand, the pyramid of biomass can be both upright and inverted." Explain with the help of examples and sketches.

(AI 2015)

30. (a) With suitable examples, explain the energy flow through different trophic levels. What does each bar in this pyramid represent?

(b) Write any two limitations of ecological pyramids.
(AI 2014C)

CBSE Sample Questions

12.4 Energy Flow

MCQ

1. Which of the following food chains is the major conduit for energy flow in terrestrial and aquatic ecosystems respectively ?

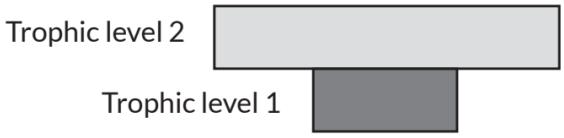
	Terrestrial ecosystem	Aquatic ecosystem
(a)	Grazing	Grazing
(b)	Detritus	Detritus
(c)	Detritus	Grazing
(d)	Grazing	Detritus

(2022-23)

12.5 Ecological Pyramids

SA I (2 marks)

2. (a) Given below is a pyramid of biomass in an ecosystem where each bar represents the standing crop available in the trophic level. With the help of an example explain the conditions where this kind of pyramid is possible in nature.



(b) Will the pyramid of energy be also of the same shape in this situation? Give reason for your response.
(2022-23)

3. (a) Draw a pyramid of numbers where a large number of insects are feeding on the leaves of a tree. What is the shape of this pyramid?

(b) Will the pyramid of energy be also of the same shape in this situation? Give reason for your response.
(2022-23)

Detailed SOLUTIONS

Previous Years' CBSE Board Questions

1. Vertical distribution of different species occupying different levels is called stratification. In a forest ecosystem, trees occupy top vertical strata or layer of a forest, shrubs occupy the second level and herbs and grasses occupy the bottom layers.

2. (a) The four components of a pond ecosystem which function as a unit are:

(i) Abiotic

(iii) Heterotrophs

(ii) Autotrophs

(iv) Decomposers

A small pond is a simple and fairly self-sustainable unit. Abiotic components include water, dissolved inorganic and organic substances and soil deposits at the bottom. Biotic components are producers, consumers and decomposers. Producers are autotrophs which include phytoplanktons, algae, submerged and floating plants.

Consumers are differentiated into herbivores (zooplanktons, larvae, tadpole and some fish), primary carnivores (water scorpions, water beetle, dragon fly larvae, Hydra and some fish), secondary carnivores (large fish, water birds, etc.). Decomposers include fungi, bacteria and flagellates.

With the help of radiant energy of the sun, autotrophs convert the inorganic materials into organic matter. Autotrophs are consumed by heterotrophs which build up their own organic matter. Organic wastes and dead organisms are acted upon by decomposers.

Minerals are released in this process. The minerals become available to autotrophs for reuse. There is cycling and recycling of matter. However, energy flow is unidirectional i.e., from autotrophs towards the higher trophic levels and

there is dissipation of energy at each trophic level which is lost as heat to the environment.

(b) Grazing food chain exists in a pond.

3. (a, c)

4. In the given equation, NPP = GPP-R, R represents respiratory losses.

5. Productivity is the rate of biomass production per unit area in unit time at any trophic level. It can be divided into : gross primary productivity and net primary productivity. Gross primary productivity (GPP) is the total organic matter synthesised by producers, in the process of photosynthesis per unit time and area while net primary productivity (NPP) is the weight of the organic matter stored by the producers in a unit area/volume per unit time. It is equal to the rate of organic matter synthesised during photosynthesis, i.e., gross primary productivity minus the rate of respiration and other losses, i.e., NPP = GPP- R.

Secondary productivity is the rate of formation of new organic matter by consumers. It depends upon the loss while transferring energy containing organic matter from the previous trophic level plus the consumption due to respiration and predation.

6. Refer to answer 5.

7. (a) Primary productivity is the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of weight (gm^{-2}) or energy ($kcal\ m^{-2}$).

(b) The given equation represents the net primary productivity (NPP) which is gross primary productivity (GPP) minus respiration losses (R).

8. (a) Primary productivity is the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. It is expressed in terms of $gm^{-2}\ yr^{-1}$ or $(kcal\ m^{-2})\ yr^{-1}$. It varies in different types of ecosystems, because it depends upon plant species of the area, their photosynthetic capacity, availability of nutrients, solar radiations, precipitation, soil type and a number of other environmental factors.

(b) Gross primary productivity (GPP) is the total organic matter synthesised by producers, in the process of photosynthesis per unit time and area. While net primary productivity (NPP) is the weight of the organic matter stored by the producers in a unit area/volume per unit time. It is equal to the rate of organic matter synthesised during photosynthesis, i.e., gross primary productivity minus the rate of respiration and other losses, i.e., NPP = GPP-R.

9. (b)

10. Humus is dark coloured, amorphous organic matter formed by decomposition of detritus. Characteristics of humus are as follows:

(i) Humus is rich in lignin and cellulose.

(ii) It is quite resistant to microbial action.

(iii) It is a reservoir of nutrients and is helpful in maintenance of soil moisture as well as aeration.

11. (a) Dead plant remains such as leaves, bark, flowers and dead remains of animals, including fecal matter are the type of detritus that decomposes faster. Warm and moist environment are the two factors that enhance the rate of decomposition.

(b) Decomposition gives rise to two products; humus and inorganic nutrients by process of humification and mineralisation respectively. During humification, a dark coloured amorphous substance called humus is formed from detritus or organic remains by the action of microbes. Humus is rich in lignin and cellulose and is highly resistant to microbial action. It undergoes decomposition at an extremely slow rate. During mineralisation inorganic substances such as CO_2, Ca^{2+}, etc. are released from humus decomposed by certain microbes. The substances released are easily available to plants.

12. Earthworms are called farmer's friend because they help in fragmentation of detritus, i.e., breakdown of complex organic matter and loosening of the soil. Humification and mineralisation occur during decomposition in the soil. Humification is the process of formation of highly resistant, dark coloured amorphous substance called humus from detritus or organic remains. Mineralisation is the release of inorganic substances, both non-mineral and minerals from organic matter.

13. Differences between detritivores and decomposers are as follows:

S.No.	Detritivores	Decomposers
(i)	They are animals which feed on detritus.	They are microorganisms which obtain nourishment from organic remains.
(ii)	Detritivores ingest the organic matter.	They decompose the organic matter by secreting digestive enzymes over it.
(iii)	Ecologically they cause pulverisation or fragmentation of detritus. *E.g.*, Earthworm	Ecologically they cause humification and mineralisation of organic matter. *E.g.*, *Pseudomonas*

14. (c): Species VIII represents the first trophic level, thus functions as a producer.

15. Man is an omnivore i.e., he eats both plants and their products and animals. So, when he eats plants, he is primary consumer and when he eats animals, he is secondary consumer.

16. Decomposers are microorganisms that obtain nourishment from organic remains by secreting digestive enzymes over it. They help in converting complex organic substances into inorganic substances like carbon dioxide, water and nutrients.

Decomposers act on dead animals and plants (organic matter) and return the chemical nutrients to the environment. They also make space available for new producers. Without this, all life will ultimately cease to exist. Thus, the decomposers have a crucial role in the ecosystem. The decomposers are found in the soil and at the bottom of ponds, lakes and oceans.

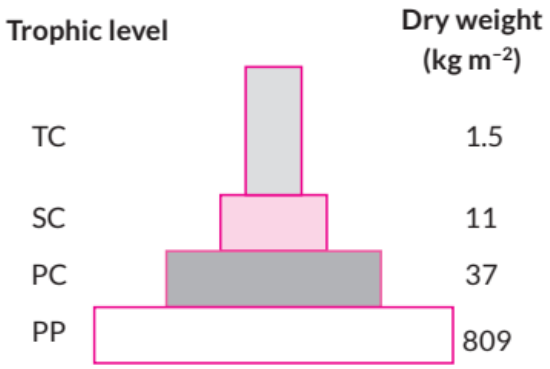
17. (c)

18. (a) In the given food web, 1, 2 and 3 are producers whereas 6, 7, 8 and 9 are consumers or carnivores.

(b) No, it is not possible to make an ecological pyramid depicting the given food web. Ecological pyramids do not accomodate a food web as it assumes a simple food chain, which almost never exists in nature. Ecological pyramids have no method of accomodating cases where a single species occupy two or more trophic levels.

19. Pyramid of biomass can exist as both upright as well as inverted. When we take grassland ecosystem in consideration, the pyramid of biomass is upright. This is because in grassland, producers are more in biomass than the herbivores, and herbivores are more in biomass than the carnivores.

The pyramid can be shown as:



When we consider the pyramid of biomass in sea, it is generally inverted because the biomass of fishes far exceeds that of phytoplankton, i.e., in sea small standing crop of phytoplankton support large standing crop of 200 planktons which in return supports larger standing crop of carnivores. It can be shown as:

20. (a) 5,842,000 primary producers are required to support 3 tertiary consumers in a grassland ecosystem (according to NCERT).

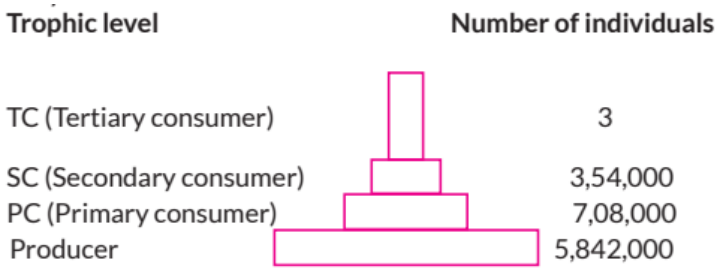
$$3 \text{ tertiary consumers} \rightarrow 5{,}842{,}000 \text{ primary producers}$$

$$6 \text{ tertiary consumers} \rightarrow \frac{5{,}842{,}000 \times 6}{3}$$

$$\rightarrow 11{,}684{,}000 \text{ primary producers}$$

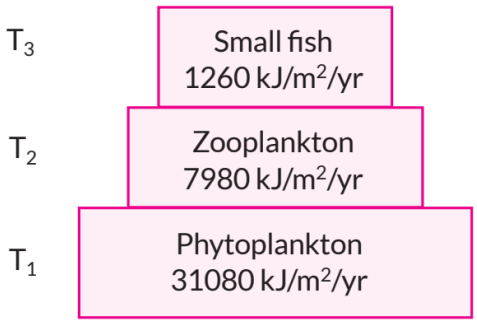
So, 11,684,000 primary producers will be required to support six tertiary consumers in a grassland ecosystem.

(b) Following is the pyramid of numbers for grassland ecosystem:

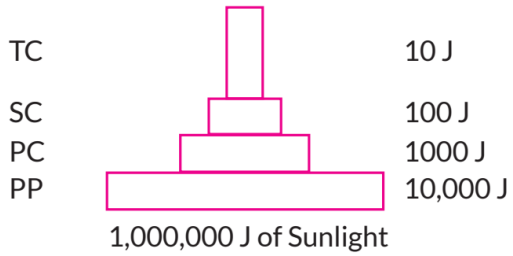


Only three top-carnivores are supported in an ecosystem based on production of nearly 6 million plants.

21. (a) Pyramid of energy is more accurate than the pyramid of biomass and pyramid of number and is considered to be an ideal pyramid existing in an ecosystem. Pyramid of energy in a fish pond is as follows:



(b) In the given ideal pyramid of energy, it can be observed that primary producers convert only 1% of the energy in the sunlight available to them into NPP:



Primary producers convert only 1% of the energy in the sunlight available to them in NPP and only 10% of energy passes from one trophic level to another and remaining 90% is lost as heat.

Hence, 10,000 - of energy is available to the first trophic level and 100 J of energy is available to the third trophic level.

22. (a) The pyramid of energy is always upright in shape as there is always a gradual decrease in the energy content at successive trophic levels from producers to various consumers. This is because some energy is used at each trophic level for various metabolic activities and some energy is lost as heat, so only 10% of the energy is available to the next trophic level (Lindeman's 10% law).

23. In a food chain, each trophic level represents a functional level and not a species because:

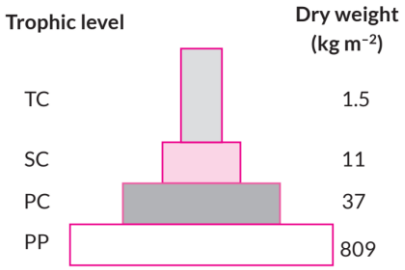
(i) At a particular time, a trophic level is never occupied by a single species.

(ii) At a particular time, all organisms of a trophic level are considered together for calculating biomass, number and energy.

(iii) A particular species may occupy more than one trophic level, e.g., omnivorous species may occupy more than one trophic level in the same ecosystem at the same time.

(iv) If we consider few species then no generalisation can be made for studying ecosystem.

24. (a) Pyramid of biomass of grassland ecosystem is as follows:



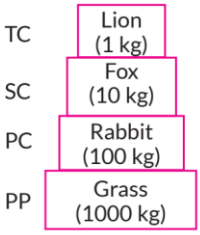
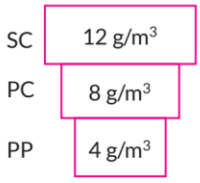
The pyramid of biomass of grassland ecosystem is upright, i.e., producers are more in biomass than the herbivores, and herbivores are more in biomass than the carnivores. While, the pyramid of biomass in sea is generally inverted because the biomass of fishes far exceeds that of phytoplankton.

(b) Phytoplankton represents primary producer while zooplankton represents primary consumer in sea ecosystem.

(c) Standing crop represents a certain mass of living material at a particular time in each trophic level.

25. (a) Refer to answer 22.

(b) Pyramid of biomass is a graphic representation of biomass present sequence-wise per unit area of different trophic levels with producers at the base and top carnivores at the apex. Pyramid of biomass may be upright or inverted.

S.No.	Upright pyramid of biomass	Inverted pyramid of biomass
(i)	The biomass of producers is more than that of consumers.	The biomass of producers is less than that of consumers.
(ii)	Pyramid of biomass in grassland ecosystem is always upright. 	Pyramid of biomass in aquatic ecosystem is always inverted. 

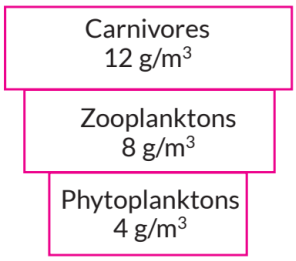
26. (a) An ecological pyramid is a graphic representation of an ecological parameter, like biomass, energy or number of individuals present in various trophic levels of a food chain with producers forming the base and top carnivores at the tip. Each trophic level represents a functional level. Therefore, it includes all the members of all the species operating at that level.

The limitations of ecological pyramids are:

(i) Ecological pyramids assume that food chains are simple. Simple food chains do not occur in nature, instead, food webs are present.

(ii) Ecological pyramids have no place for detritivores and decomposers though they play a vital role in ecosystem.

(b) In a pond ecosystem, the pyramid of biomass is generally inverted in shape. As the producers are small organisms, their biomass is least, and this value gradually shows an increase towards the apex of the pyramid, thus making the pyramid inverted in shape.

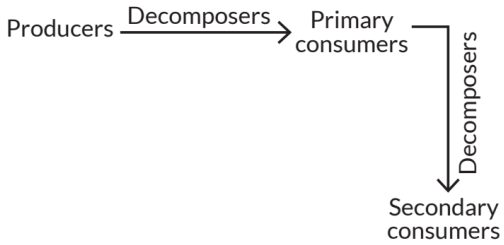


27. (a) Trophic level in an ecosystem is defined as a specific place for an organism in the natural surroundings or in a community according to its feeding relationship with other organisms. It is based on the source of that organism's nutrition or food because of which it occupies a specific position in the food chain. Standing crop is the total mass of living material at a particular trophic level at a specific time.

The standing crop is measured as the mass of living organisms or biomass or the number in a unit area. The biomass of a species is expressed in terms of fresh or dry weight and the measurement of biomass in terms of dry weight is more accurate.

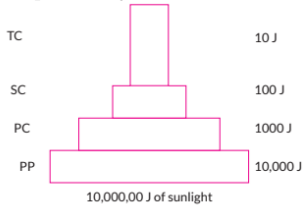
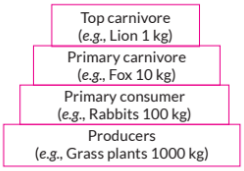
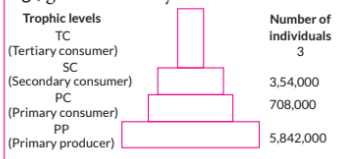
(b) Trophic level of an organism depends upon the source of food and position in a food chain. The first trophic level is occupied by the producers which synthesise organic nutrients from inorganic raw materials with the help of solar radiations (photosynthesis) not only for themselves but also for heterotrophic organisms or consumers. They have this capacity due to the presence of chlorophyll which can convert solar energy into chemical energy, e.g., phytoplanktons, plants, trees, etc.

(c) Detritus food chain is made up of decomposers which are heterotrophic organisms (mainly fungi and bacteria). They meet their energy and nutrient requirements by degrading dead organic matter or detritus. The organic matter travels through the different trophic levels and when the organisms at the highest trophic level die, dead organic matter enters the detritus food chain. They secrete digestive enzymes that break down the waste organic materials into simple inorganic materials which are released into the cycling pool. Grazing food chain (GFC) is the major conduit for energy flow. But a much larger fraction of energy flows through the detritus food chain than through the GFC. Detritus food chain may be connected with the grazing food chain at some levels : such as some of the organisms of DFC are prey to the GFC animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores.



These natural interconnection of food chains make it a food web.

28. (a) An ecological pyramid is a graphic representation of an ecological parameter, like biomass, energy or number of individuals present in various trophic levels of a food chain with producers forming the base and top carnivores at the tip. Each trophic level represents a functional level. Therefore, it includes all the members of all the species operating at that level. The comparison among the three pyramids of energy, biomass and number are given as follows:

S.No.	Pyramid of Energy	Pyramid of Biomass	Pyramid of Number
(i)	Pyramid of energy is the graphic representation of amount of energy trapped per unit time and area in different trophic levels of the food chain with producers forming the base and top carnivores the tip.	Pyramid of biomass is the graphic representation of biomass present in per unit area of different trophic levels with producers at the base and top carnivores at the tip.	Pyramid of numbers is a graphic representation of number of individual per unit area of different trophic levels with producers forming the base and top carnivores at the tip.
(ii)	It is always upright.	It is inverted or upright.	It is inverted or upright.
(iii)	*E.g.*, pond ecosystem. 	*E.g.*, grassland and forest ecosystem. 	*E.g.*, grassland ecosystem. 

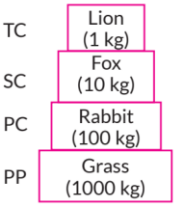
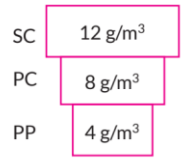
(b) The limitations of ecological pyramids are:

(i) Ecological pyramids assume that food chains are simple. Simple food chains do not occur in nature, instead, food webs are present.

(ii) Ecological pyramids have no place for detritivores and decomposers though they play a vital role in ecosystem.

29. An ecological pyramid is a graphic representation of an ecological parameter, like biomass, energy or number of individuals present in various trophic levels of a food chain with producers forming the base and top carnivores at the tip. Each trophic level represents a functional level. Therefore, it includes all the members of all the species operating at that level. The pyramid of energy is always upright in shape as there is always a gradual decrease in the energy content at successive trophic levels from producers to various consumers. This is because some energy is used at each trophic level for various metabolic activities and some energy is lost as heat, so only 10% of the energy is available to the next trophic level (Lindeman's 10% law). Pyramid of biomass is a graphic representation of

biomass present sequence-wise per unit area of different trophic levels with producers at the base and top carnivores at the apex. Pyramid of biomass may be upright or inverted.

	Upright pyramid of biomass	Inverted pyramid of biomass
(i)	The biomass of producers is more than that of consumers.	The biomass of producers is less than that of consumers.
(ii)	Pyramid of biomass in grassland ecosystem is always upright.  Fig.: Upright pyramid of biomass	Pyramid of biomass in aquatic ecosystem is always inverted.  Fig.: Inverted pyramid of biomass

30. (a) Ecosystem requires a constant input of energy. Energy flow in the ecosystem is very important as it is the basis of life. Food provides both matter and energy. Flow of energy determines the diversity of organisms. It also determines the developmental and functional status of the ecosystem. Energy flow in an ecosystem is always unidirectional or one way, i.e., solar radiations → producers → herbivores → carnivores. It cannot pass in the reverse direction as there is always decrease in the content and flow of energy with the rise in trophic level. A part of energy captured by producers (gross primary productivity) is used for maintenance (lost in respiration) and as food to herbivores.

Only 10% of the gross productivity of producers is entrapped by herbivores for their body building. Herbivores are eaten by primary carnivores. Herbivores not preyed by carnivores die a natural death and energy trapped in their body is transferred to decomposers. Only 10% of the herbivore's productivity is utilised for raising productivity of primary carnivores. The rest is consumed in ingestion, respiration, maintenance of body heat and other activities. Higher carnivores similarly are able to retain only 10% of energy present in primary carnivores.

Producer	→	Herbivore	→	Carnivore I	→	Carnivore II
1000 K cal		100 K cal		10 K cal		1 K cal

Therefore, the pyramid of energy is always upright with base representing the producers and apex occupied by top carnivores. Each bar of the pyramid represents one trophic level.

(b) Refer to answer 28 (b).

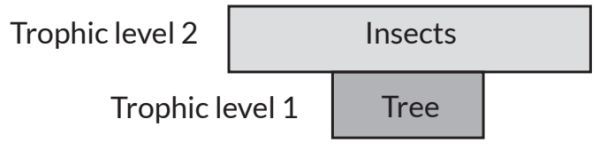
CBSE Sample Questions

1. (c) : Detritus and grazing food chain are major conduits of energy in terrestrial and aquatic ecosystem respectively.

2. (a) Inverted pyramid of biomass are seen in aquatic conditions where a small standing crop of phytoplankton supports a large standing crop of zooplankton/fish and also in terrestrial ecosystem where a large number of insects are feeding on the leaves of a tree.

(b) No, the pyramid of energy is always upright, and can never be inverted because when energy flows from one trophic level to the next trophic level, some amount of energy is always lost as heat at each step.

3. (a) Inverted pyramid because a large number of insects feed on one tree.



(b) No, the pyramid of energy is always upright, and can never be inverted because when energy flows from one trophic level to the next trophic level some amount of energy is always lost as heat at each step.