ENERGY IN ECOSYSTEMS

Video Support Notes

Following many requests, these notes have been printed on
A4 size sheets for easy photocopying

Produced by Video Education Australasia
Commissioning Editor Christine Henderson

Teacher notes by Simon Garner

TELEPHONE 1 866 727 0840, FAX 1 866 727 0839

www.veavideo.com

Duration 25 mins

ENERGY IN ECOSYSTEMS

Brief Summary

The input of energy is required to sustain any ecosystem on Earth. This usually comes from the Sun, and involves the fixing of energy by autotrophs and then the transfer into usable chemical energy, or ATP.
This program looks at the vital role of energy transfers within ecosystems and how living organisms use the energy available to them.
Firstly, ecosystems and their components are identified, with biotic and abiotic elements defined.
In terms of biotic elements, living organisms are classified as autotrophs or heterotrophs, and then as producers, consumers and decomposers. Various types of abiotic factors in an ecosystem include temperature, salinity, light, acidity, and water.
Food chains and food webs, and the availability of energy to the various trophic levels are also explained using simple examples, both terrestrial and aquatic.
The two laws of thermodynamics are introduced as the basis of the study of energy in ecosystems – that energy is not created or destroyed, but transferred from one form to another; and that there is always some loss of energy as heat in any energy conversion.
The proportional breakdown of energy use by a living organism remains about the same, regardless of the organism concerned – 60 per cent is lost in heat, 30 per cent is used for daily activities, growth and repair, and 10 per cent is stored as biomass. This stored component is then available to other consumers, as we move up the trophic levels, so roughly 10 per cent of energy from one trophic level is available to the next one up.
Also introduced are the concepts of aerobic and anaerobic respiration, and metabolism.
The program then looks at the three types of pyramid that can be used to represent different quantities in an ecosystem – the number pyramid; the biomass pyramid; and the energy pyramid.
Variations in the shape of pyramids are also examined, with examples given as to how this can occur in certain ecosystems.
The concept of niche is defined, with various factors that make up an organism's niche, and its relation to energy flow. Cost/benefit for organisms is also covered, as are niche overlap, the breadth of an organism's niche, and competition within a niche.
The role of other organisms and their wastes within a niche is explored, and other aspects, including the fact that no two organisms can occupy exactly the same niche; that the same organism can occupy very different niches depending on the ecosystem; and that different organisms living within close range of one another in an ecosystem can occupy markedly different niches.
Finally, a rocky shore is used as an example of how different abiotic factors can impact on one ecosystem, resulting in a broad diversity of living organisms within it.

Further Areas to Consider

The program covers a range of basics in the study of an ecosystem. These could easily be applied to different ecosystems which are not covered in the video – eg. rainforests, alpine ecosystems, desert ecosystems, etc. Similarly, organisms within any chosen ecosystem could be studied in terms of their niche. Examples of unusual niches could be introduced – eg. those of: the dung beetle; deep-sea marine life; swamp-dwelling organisms; amphibious (marine) iguanas on the Galapagos Islands.

Early on in the program, the two laws of thermodynamics are introduced as being the bases for any study of energy flow, and these also could be explored at more length in terms of biological applications – eg. a look at the energy use of one particular mammal species – its typical patterns of movement, feeding, and sleeping within a particular time frame; and growth during its juvenile stage of life (ie at what rate it stores biomass in its developing stages).

Those ecosystems used as examples in the program could also be further developed. The video touches briefly on a range of ecosystems – forest, grassland, freshwater and saltwater aquatic, but there is wide scope for more intensive studies of these environments.

Some Useful Websites

Ecosystems and Energy Flow

http://jimswan.com/111/niches/niches_and_biodiversity.htm
(also click on trophic link)

http://www.gullivermedia.com.au/eco.html
(a range of Australian ecosystems)

http://www.amonline.net.au/factsheets/

http://www.marietta.edu/~biol/102/ecosystem.html

http://www.biology.ualberta.ca/courses.hp/bio366/general-energy-flow.htm

Food Chains and Food Webs

http://www.geocities.com/Heartland/Ranch/2200/foodchains.htm

http://www.alienexplorer.com/ecology/topic4.html
(material of a more basic level)

http://www.arcytech.org/java/population/facts_foodchain.html

http://www.ultranet.com/~jkimball/BiologyPages/F/FoodChains.html

http://www.geog.ouc.bc.ca/physgeog/contents/9o.html

Niche

http://www.szgdocent.org/ff/f-divrs.htm
(also click home at bottom of page for some good links)

http://www.teaching-biomed.man.ac.uk/student_projects/2000/mnqe6jdh/ecosystem.html

http://fastplants.cals.wisc.edu/pdfs/nichekit.pdf
(activity-based – could be modified to suit)

http://www.arts.adelaide.edu.au/Geogenvst/adams/abpop12.htm

Some Suggestions for Student Activities

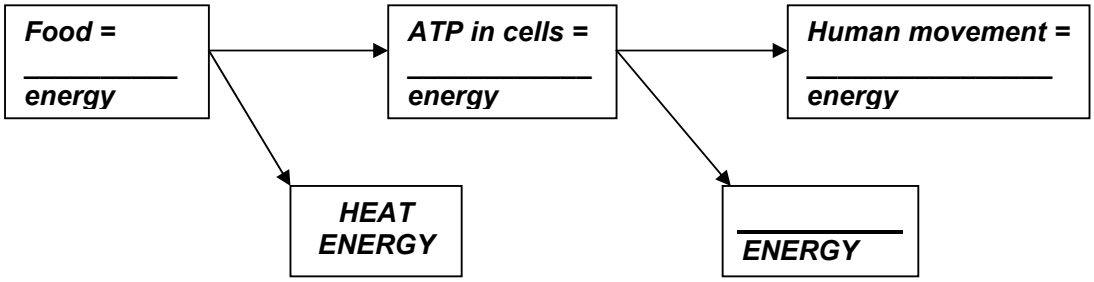
Before Viewing the Program

1. Suggest a definition for the word 'ecosystem'.

   _____

   _____

2. Complete the energy flow diagram:



Choose from the following words – (they may not all appear):
Kinetic Chemical Heat Light Gravitational

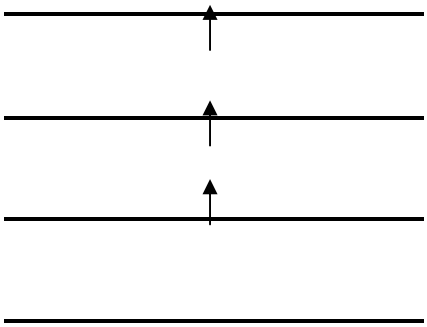
3. Consider a simplified food chain in a grassland environment. Next to each of the following organisms, state whether they are producers or consumers, and put them in their correct trophic levels.

Field mouse _____

Eagle _____

Grasses/seeds _____

Snake _____



4. What do you understand is meant by the word 'niche'?

   _____

   _____

Student Response Sheets

1. Next to each of the following fill in the appropriate percentage figure:

Solar energy reaching the Earth – 100 per cent

a) amount used for evaporating water from plants _____

b) amount used in warming the surroundings _____

c) amount reflected _____

d) amount fixed by primary producers _____

2. Summarize the First Law of Thermodynamics.

_____

_____

_____

3. Give eight examples of abiotic characteristics in an ecosystem:

a) _____ b) _____

c) _____ d) _____

e) _____ f) _____

g) _____ h) _____

4. Biotic elements within an ecosystem can be classified into producers, consumers and decomposers. Provide a brief definition of each:

Producers:

_____

_____

Consumers:

_____

_____

Decomposers:

_____

_____

5. What does ATP stand for? What is it, and why is it vital to living organisms?

_____

_____

_____

6. What is biomass? Give two examples of how it appears in living organisms.

_____

_____

_____

7. Summarize the Second Law of Thermodynamics.

_____

_____

_____

8. What percentage of energy in a living organism is:

   a) used in daily activities, growth and repair _____

   b) stored as biomass _____

   c) lost as heat _____

9. State two differences between anaerobic and aerobic respiration.

_____

_____

_____

10. Define metabolism.

_____

_____

_____

11. What three things can be represented by pyramids when studying the living organisms in an ecosystem?

_____

12. Provide two examples of where pyramids can take on unusual shapes when representing different characteristics of the living organisms in ecosystems.

_____

_____

_____

13. State eight factors that need to be taken into account when describing an organism's niche.

a) _____ b) _____

c) _____ d) _____

e) _____ f) _____

g) _____ h) _____

14. The high speeds reached by cheetahs when hunting food is an example of energy cost/benefit in an ecosystem. Explain:

_____

_____

_____

15. What is niche overlap?

_____

_____

_____

16. State three possible responses of an organism to increased competition in its niche.

a)
_____

b)
_____

c)
_____

17. What are the three zones on a rocky shore?

a)
_____

b)
_____

c)
_____

18. The broader an organism's niche, the more chance it has of survival. Why is this?

_____

_____

_____

After Viewing the Program

The concepts explored in the program could be taken individually, or collectively to apply to other ecosystems or individual species.

Some suggestions for activities are:

1. Take one particular type of ecosystem and identify the following:
   - biotic and abiotic factors
   - the presence of autotrophs and heterotrophs
   - examples of producers and different level consumers
   - examples of food chains and food webs within the ecosystem
   - approximate shapes of energy, biomass and number pyramids applicable to a food chain within that ecosystem

2. Take one particular type of organism within an ecosystem and identify the following:
   - whether it's a autotroph or heterotroph
   - whether it's a producer or consumer, and in the case of the latter, what level consumer
   - where it fits into a typical food chain or food web within that ecosystem
   - a typical niche, taking into account the eight factors covered in the video

3. Compare the characteristics of an ecosystem in number 1 above, with a similar ecosystem in another part of the world. Example – compare a desert ecosystem in Australia with one in Africa or Northern Asia; compare a South American rainforest with an Indonesian rainforest.

4. Suppose 250,000 kJ of solar energy enters an ecosystem.

   a) How many kJ would be typically fixed by the primary producers?

   b) How many kJ of the original 250,000 is available to a third level consumer?

   c) How many kJ of the original 250,000 is stored as biomass by a second level consumer?