H.1.4.10 Pyramid of Numbers

Extended Study

Use of Pyramid of Numbers

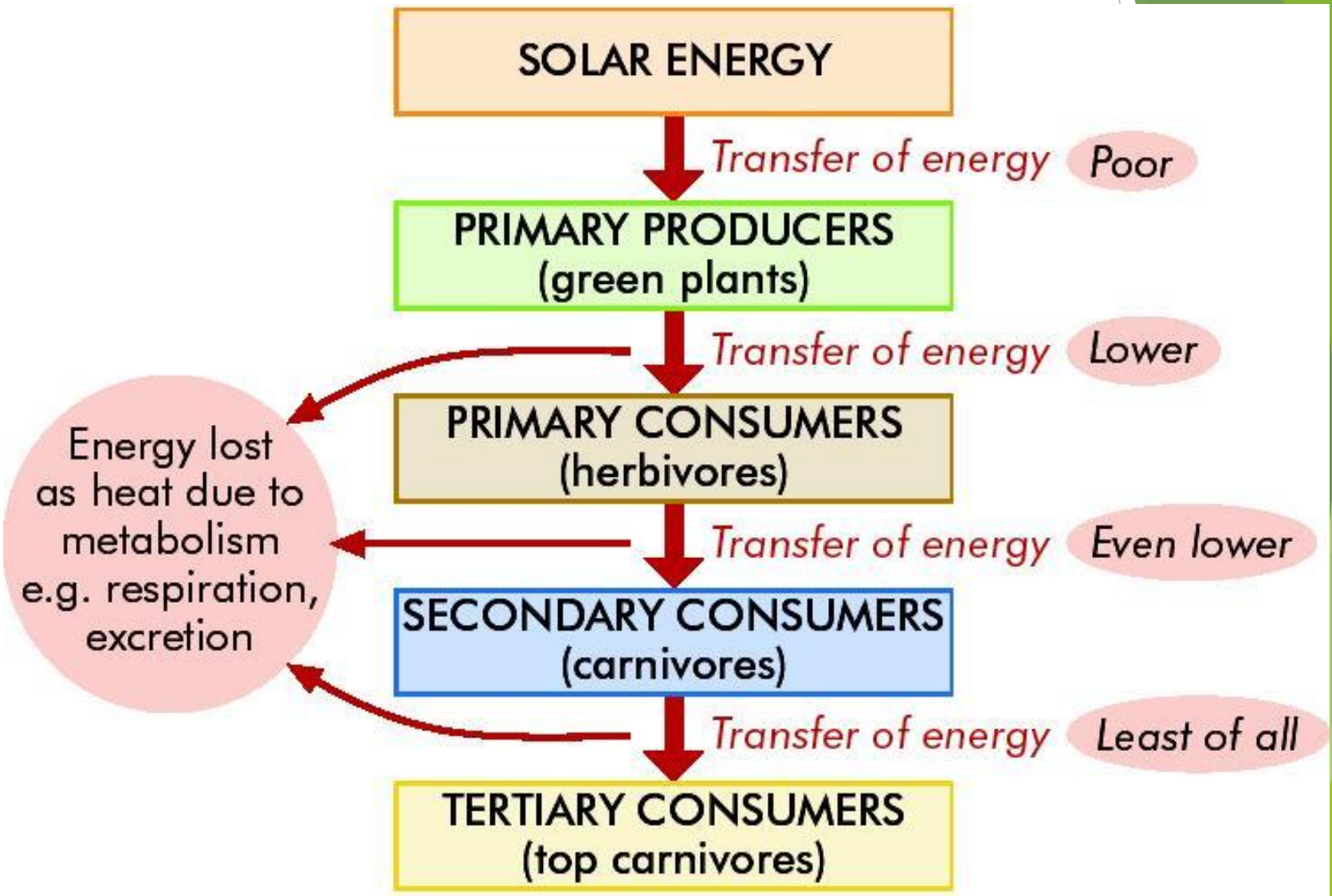
- Ecological pyramids are used to compare different communities of the ecosystem by comparing trophic levels and looking at energy structure by counting individuals at each level

Pyramid of Numbers

In general:

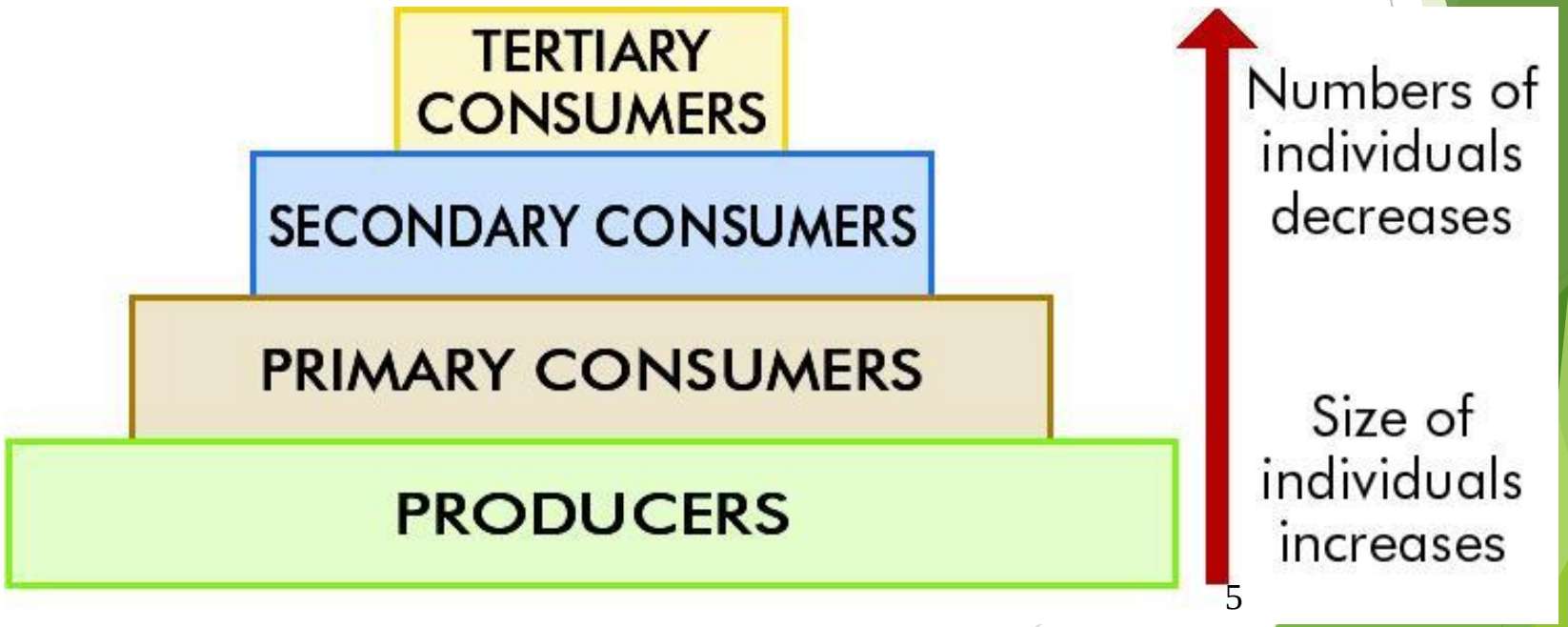
- Number of organisms declines as you go up t
- Due to large energy loss (about 90%) between each trophic level
- less energy available to organisms higher up the pyramid
- Loss of energy and body size increase as you go up the pyramid (Reason chains contain no more than 4 or 5 levels)

Energy transfer through an ecosystem



Normal Pyramid of Numbers

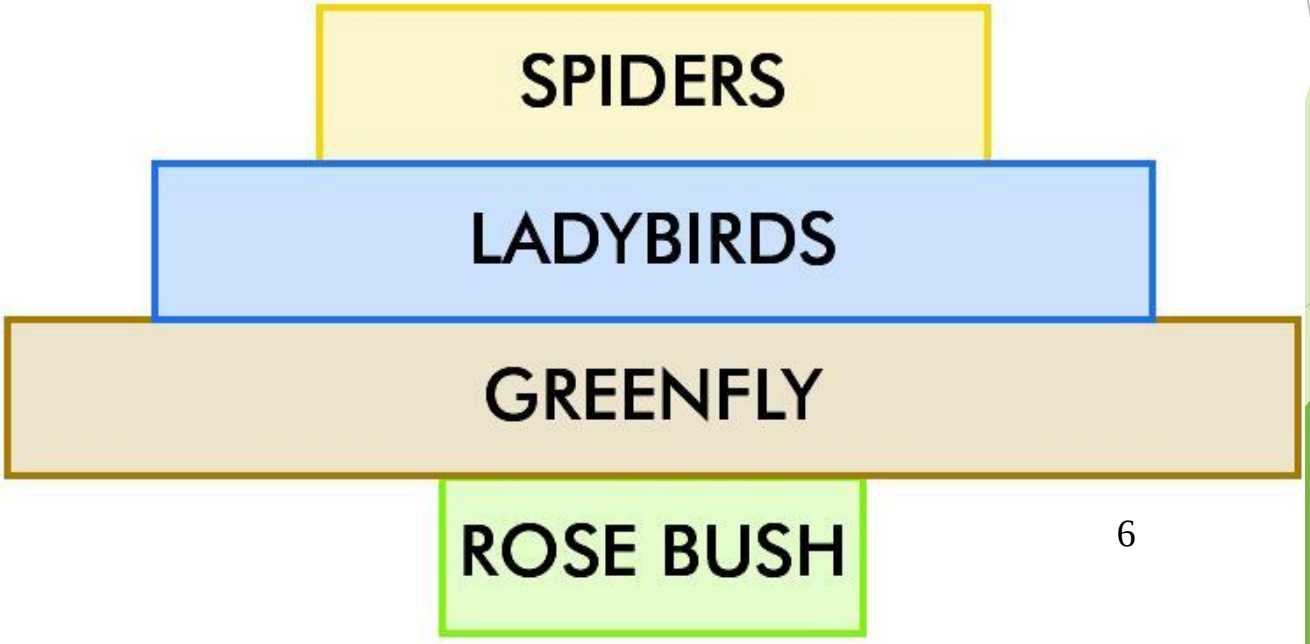
A reminder of what a pyramid of numbers looks like



Limitations of use

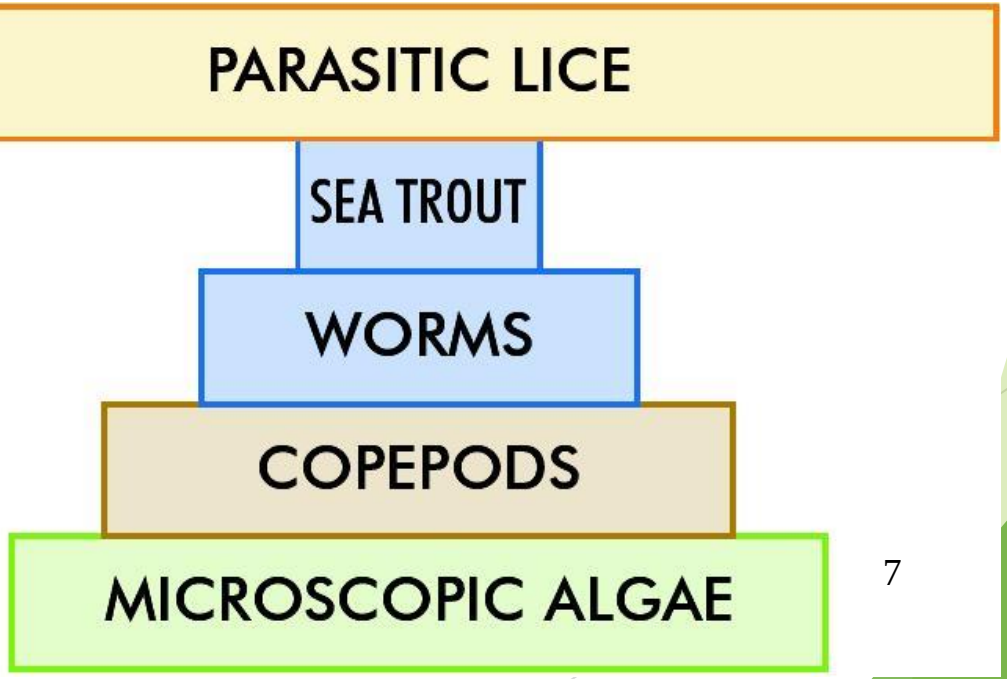
The size of organisms is not considered in a pyramid of numbers.

e.g. one rose bush can support thousands of greenfly.



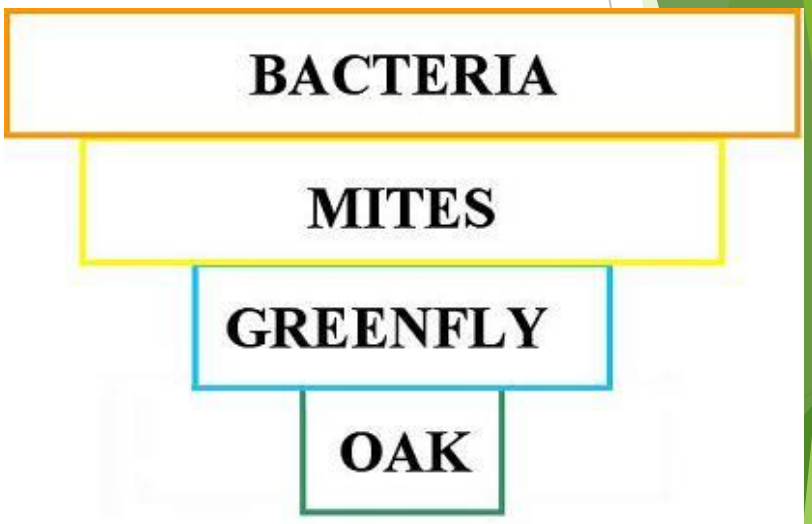
A distorted Pyramid of Numbers

A similar problem arises with parasites – numerous parasites on one host – resulting in a distorted pyramid

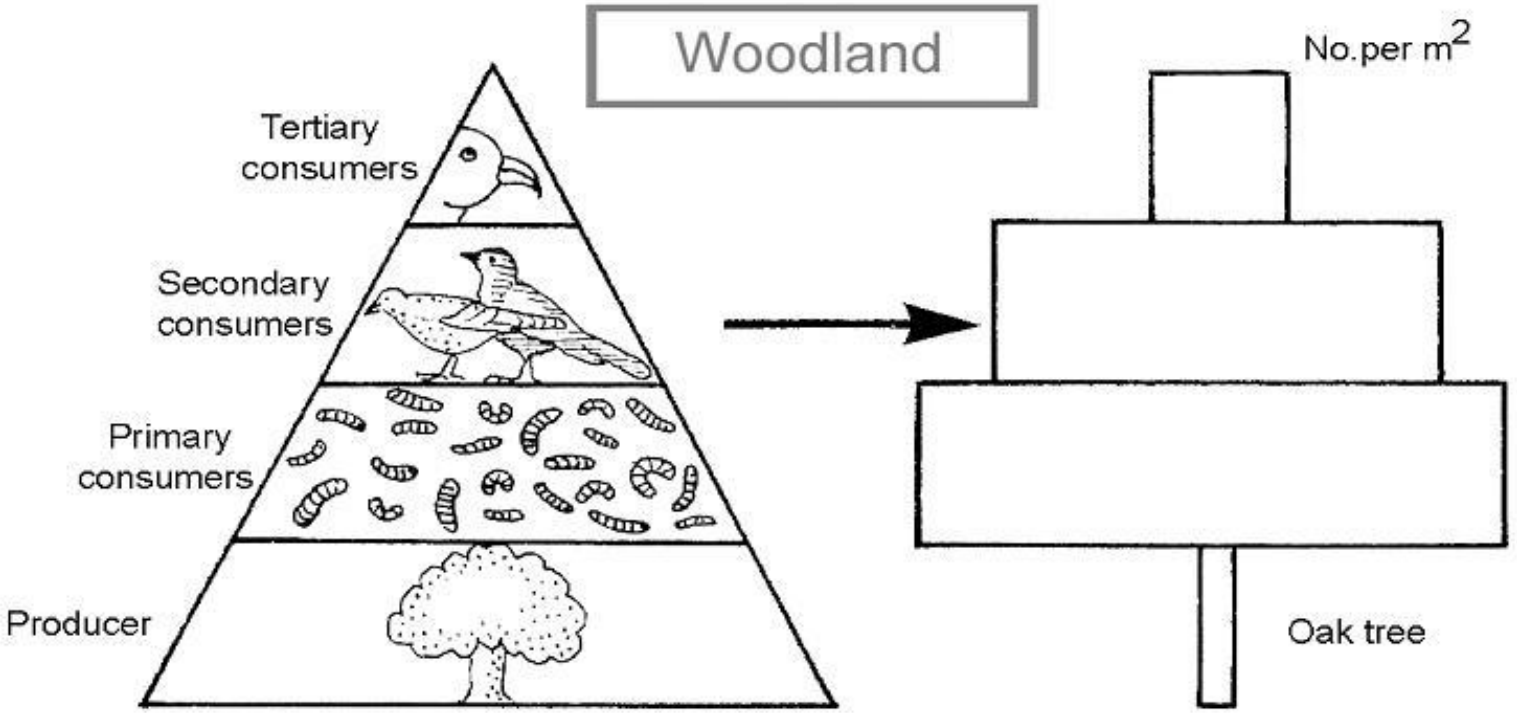


An inverted Pyramid of Numbers

When organism size is not considered very unusual pyramid shapes are likely to occur.

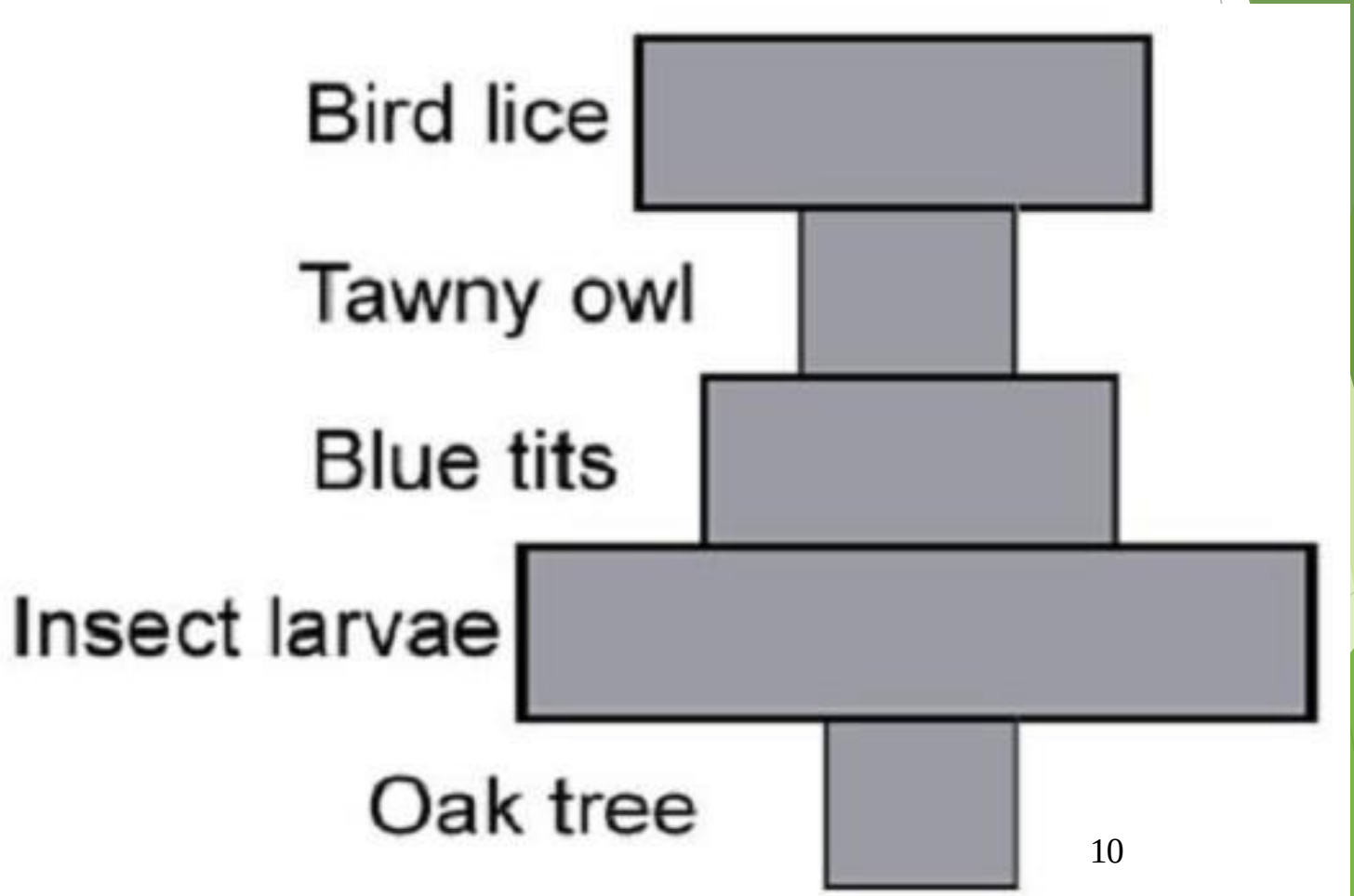


Another example



Food pyramid--Unusual shape

Last example



H.1.4.11 Ecological Relationships

Factors that control Population

1. Competition
2. Predation
3. Parasitism
4. Symbiosis

These factors help maintain *population* numbers and bring about a 'balance of nature'

Population

Def: Population-A group of individuals of the same species living together in a habitat.

They live in populations for the following reasons:

- Their habitat provides food and shelter
- Individuals are safer in a group
- The availability of a mate for breeding purposes

Competition

Def-Competition-When organisms of the same or different species 'fight' for necessary resources that are in short supply.

Intra-specific competition:

Between members of the **same species** i.e. within a species

Inter-specific competition:

Between members of **different species**

Competition for resources

Plants

compete for light, water, minerals and space

Animals

compete for food, water, shelter, territory and mates

Two types of competition

1. Contest Competition

involves an active physical confrontation between two organisms – one wins

Example

two dogs fighting over a bone

One may have stronger muscles and sharper teeth and so win the bone

Two types of competition

2. **Scramble Competition**

This is where each organism tries to acquire as much of the resource as possible e.g.

an ivy plant and a hawthorn tree may compete for light.

The ivy uses adventitious roots to grip the hawthorn and climb higher.

adventitious roots

adventitious root: root that does not develop from the radicle

e.g. (a) climbing roots of ivy,

(b) roots of cuttings that arise from a node.

Scramble competition in action

Competition & Population Size

- Restricts population size
- Survival of the fittest
- Is a driving force behind evolution i.e. **adaptive techniques** (sharp teeth of carnivores or climbing abilities in ivy)

How do animals survive competition?

They adapt to their environment by:

- Changing their feeding habits
- Camouflage
- Producing protective coats
- Moving away from over-populated areas
- Reproductive strategies e.g. Kangaroo can carry up to three offspring
    1. Joey
    2. New born baby (2.5 cm long)
    3. Fertilized Egg sitting in tubes to go to womb

How do plants survive competition?

e.g. weeds (i.e. plants growing in a place where they are not wanted)

These compete with other plants for water, minerals and light and will survive because:

- They produce large numbers of seeds
- Seeds germinate quickly, even in poor soil
- Plants thrive even in poorer soil conditions

Adaptive Techniques

Adaptive techniques are adaptations which have evolved (developed) in response to the need to survive competition

e.g.1 sharp teeth of carnivores

e.g.2 climbing abilities in ivy

Learning check

- How do animals and plants survive competition?

Animals

- Feeding habits
- Camouflage
- Protective coats
- Move away from over-populated areas
- Reproductive strategies

Plants

- Produce large numbers of seeds
- Seeds germinate quickly
- Plants thrive even in poorer soil conditions

Adaptation-a inheritable trait that helps an organism survive

- Types of adaptation
- 1-structural- giraffes have long neck
- 2-competitive-fihting for a mate
- 3-behavioural-Male birds like peacocks perform mating dances!!!

Predation

predation: the act, of some animals (predators), of capturing and killing other animals for food.

predator: animal that hunts, captures and kills other animals (prey) for food.

Predators have evolved adaptive techniques to survive, e.g. wolf has keen hearing and eyesight, strong muscles, sharp teeth, camouflage and hunts in packs.

Positive Effects of Predation

1. Stabilises the community
2. Predators control the number of herbivores and so prevent overgrazing
3. Predators eliminate the less well adapted (weaker) prey

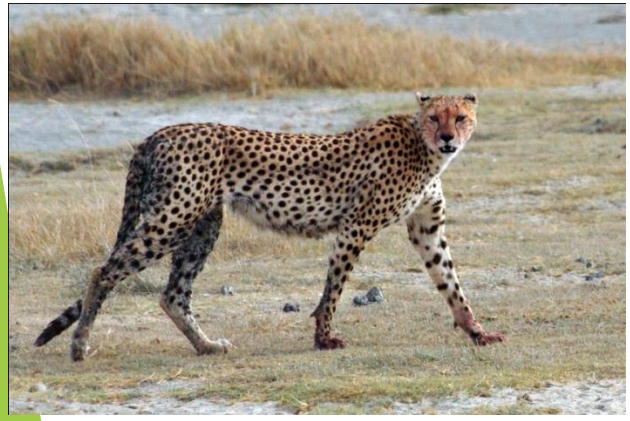
Adaptations of Predators

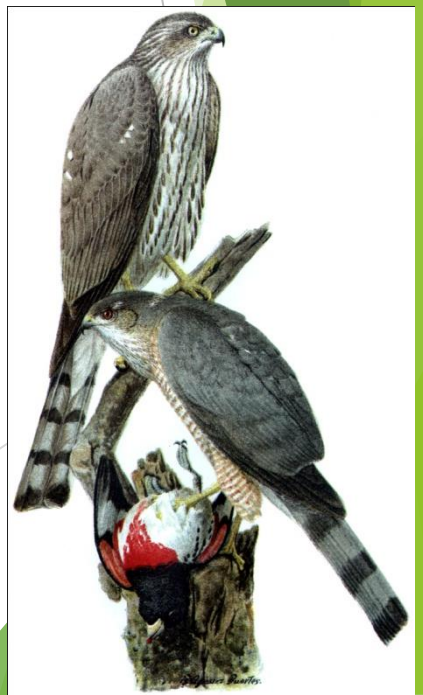
- Keen senses and sharp teeth
- Catch easiest prey – old and sick (less energy used)
- Change diet to suit prey available e.g. foxes
- Live and hunt in packs
- Migrate to where prey is plentiful
- Camouflage

Adaptations of Predators

Three examples of Adaptations of Predators

1. Hawks have excellent eye sight
2. Ladybirds have strong mouth parts
3. Cheetahs can run at 60 km/h





Adaptations of Prey

Three examples of Adaptations of Prey

1. Frogs are well camouflaged
2. Zebras have strips, when in a group lions can't distinguish where one ends & another begins.
3. Ladybirds contain large amounts of Formic acid so they are unpalatable to taste

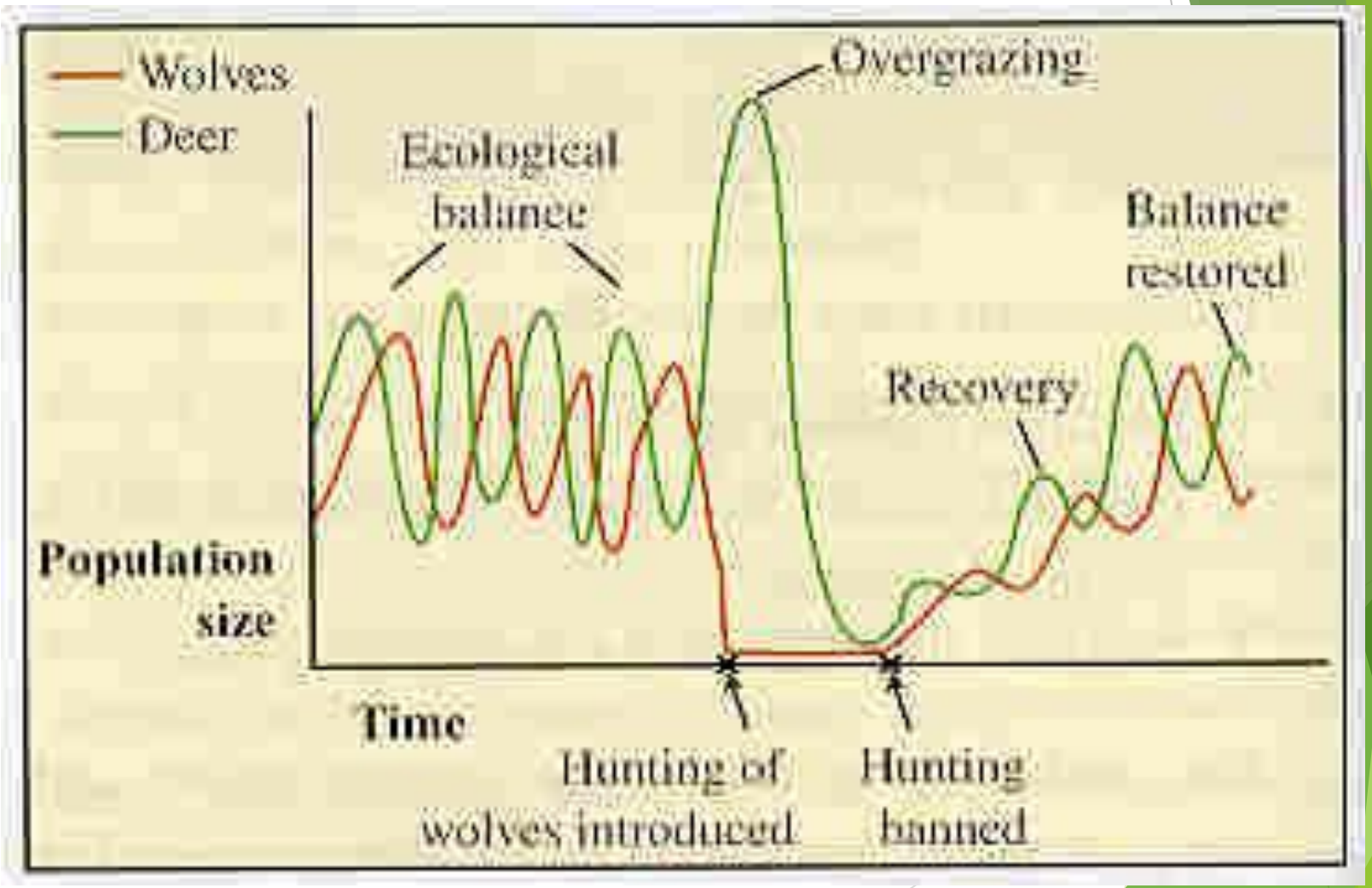
Predator / Prey relationship

The populations of wolves and deer are interconnected. Both have evolved adaptive techniques to survive e.g.

wolves – keen hearing and eyesight, strong muscles, sharp teeth, camouflage and hunt in packs.

deer – keen hearing and eyesight, quick to turn and run and camouflage to evade the wolves.

Predator / Prey relationship (Wolf / Deer in Alaska)



Notes 1 2 3 4 5 6 7 8 9

Notes on graph

1. When the deer population increased, the wolf population had more food and increased too. graph
2. As the wolf population increased, the number of deer being killed increased – graph resulting in a decline in the deer population
3. When the deer population declined, there was less food for the wolves and they declined in numbers too. graph
4. This led to an increase in the deer population. graph

Notes on graph

5. This cycle continued over years and had obviously found a natural balance to do with availability of food for both populations. graph
6. When the wolf population was drastically reduced due to hunting, the resulting explosion of the deer population led to overgrazing of the vegetation. graph
7. This produced huge mortality and emigration in the deer population with a collapse of the relationship. graph

Notes on graph

8. After the banning of hunting, a balance was slowly re-established in the two populations. graph

The populations are controlled by negative feedback, where a drop in numbers is generally self-correcting.

Over a long period of time, the deer evolve structures and behaviours to survive predation better, e.g. quicker reactions, etc.

The wolves also evolve better predation techniques to cope with the evolving prey.

In Summary

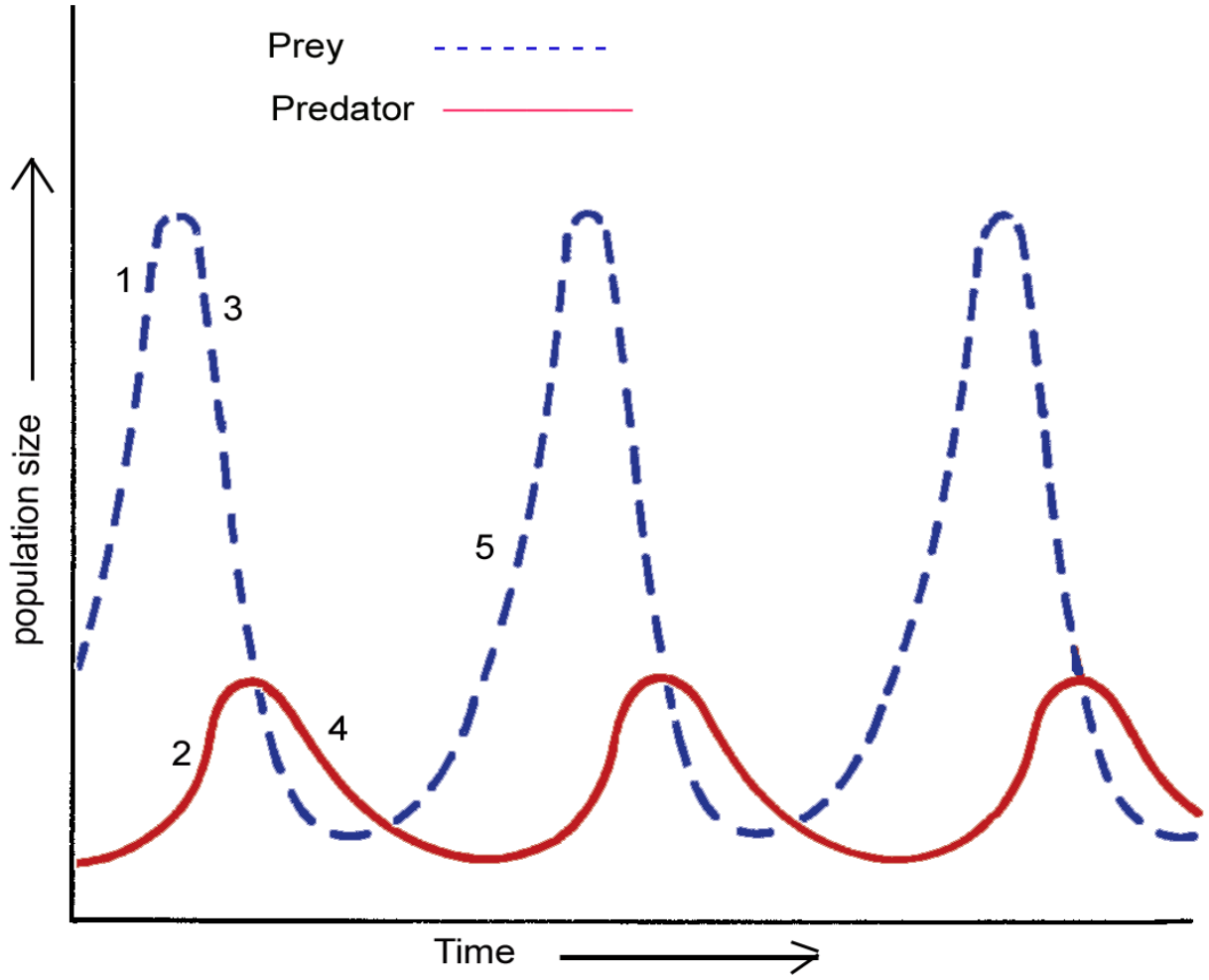
Predator/Prey relationships

- As Prey INCREASES Predators INCREASE .
- As there are more predators the prey will DECREASE and then

therefore predators DECREASE

- Eventually numbers of prey will increase, starting the cycle once more.

Alternative graph of predator / prey relationship



Symbiosis

Symbiosis ('living together') - where two organisms of different species have a close, specific relationship with each other where at least one of them benefits.

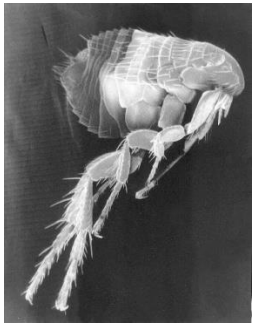
Parasitism is a form of symbiosis

Examples of Symbiosis

- Gut Friendly bacteria produce VIT K
- While bacteria get shelter we get vitamins

- A lichen is composed of an alga and a fungus intertwined.

  The alga obtains support and a mineral supply from the fungus; the fungus obtains food from the alga.



3 types of symbiosis

1)Parasitism

Def: Parasitism- When one organism (the *parasite*) benefits from another (the *host)* and does harm to it

e.g. fleas **on** a dog (*ectoparasites*),

liverfluke **in** cattle/sheep (*endoparasites*).

Parasites do harm to their hosts but usually do not kill them too quickly.

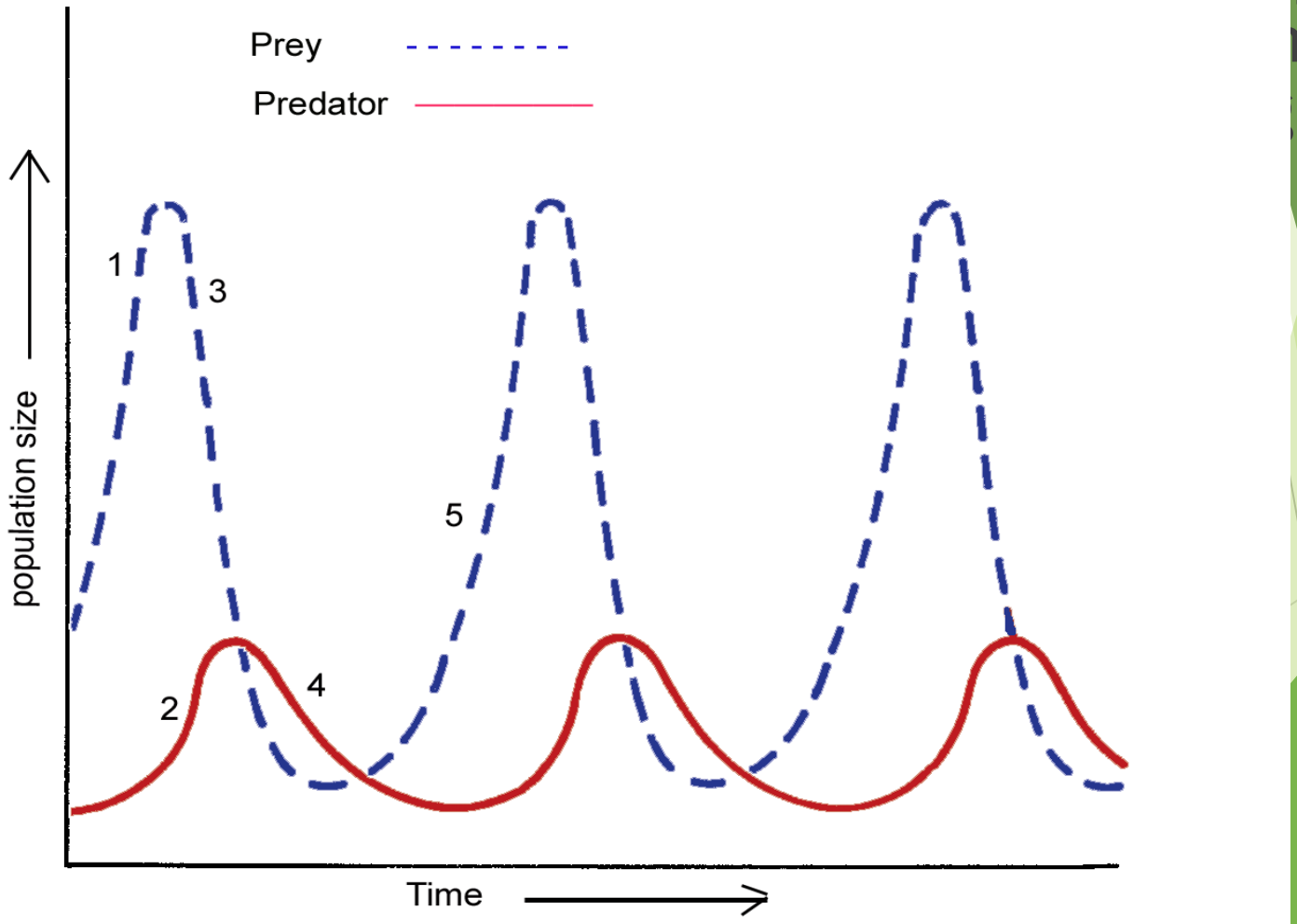
- 2. Mutualism—2 species living in close contact where both benefit

Ex Lichen (algae gain shelter and nutrients while fungus gains food)

3. Commensalism-One Species benefits while the other is neither harmed nor benefits ex- bird nesting in a tree

Learning check

- Explain what is happening
  nbered
  raph.



H.1.4.12 Population Dynamics

Factors that contribute to Predator-Prey relationships

1. **The availability and abundance of food**

   Large number of deer will increase the number of wolves.

   This will decrease the number of deer and then wolves.

   When wolves decrease deer will increase again.

Factors that contribute to Predator-Prey relationships

2. **Concealment**

   When there is less prey they can hide better, this allows population of prey to survive and increase.

3. **Movement of Prey & Predators**

   If there is not enough food the prey will move to a more abundant location;

   predator moves to area with more prey.

Population Dynamics

A ***population*** is a group of organisms of the one species.

Population density is a measurement of the numbers of a species over a stated area.

Population increases are due to increases in the birth rate and immigration.

Population decreases are due to increases in the mortality rate and emigration.

Population Dynamics

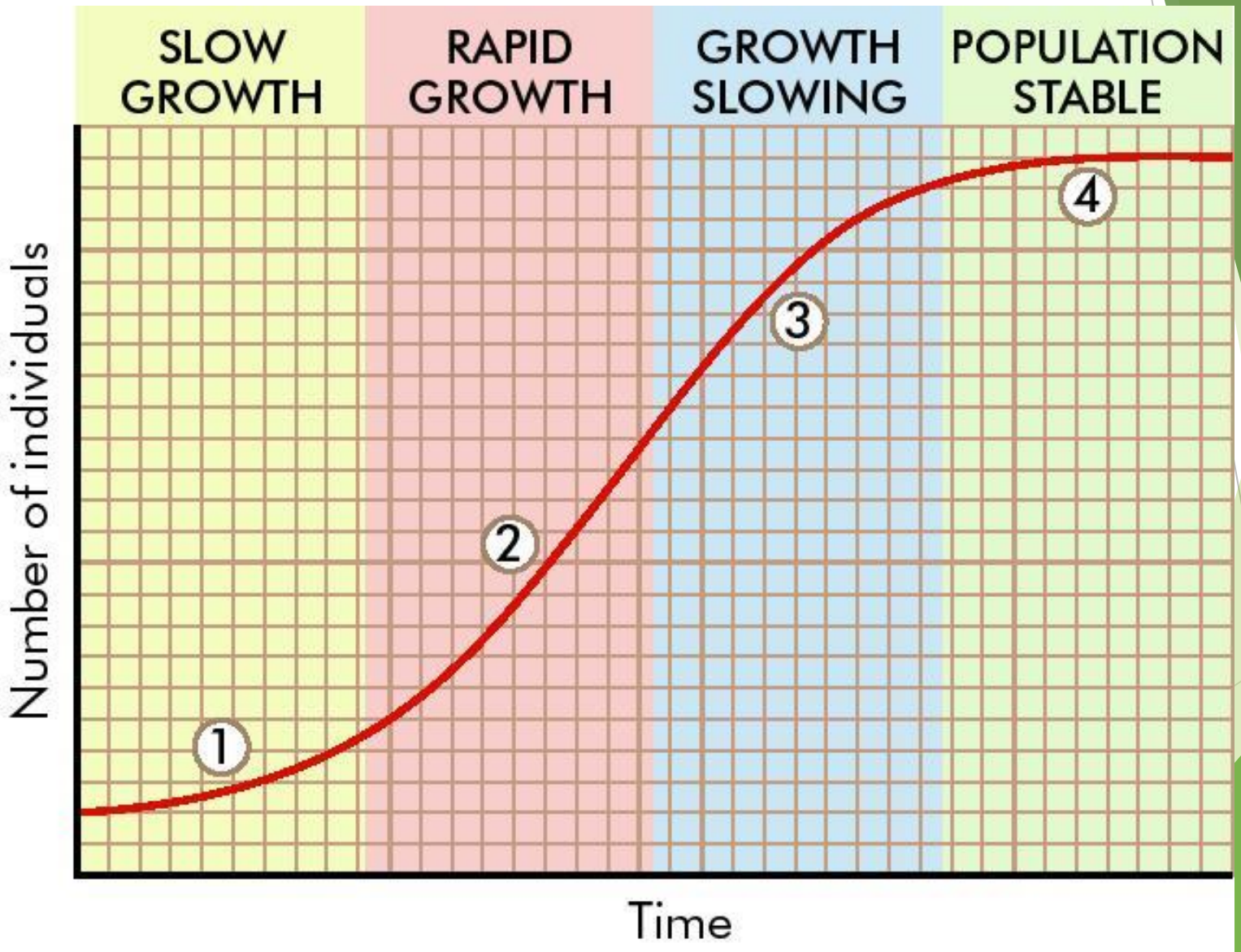
- Most population numbers tend to fluctuate in the short term, but find an overall balance in the long term where births and immigrations are equal to deaths and emigrations.
- Mortality rates are high in nature – many organisms die before they can reproduce.

Population Dynamics

- Deaths are usually due to predation, parasites and lack of food rather than old age.
- A high mortality rate is important to populations – why?

It protects the stock of food and eliminates the less well-adapted organisms.

Normal Population Curve



Notes

1

2

3

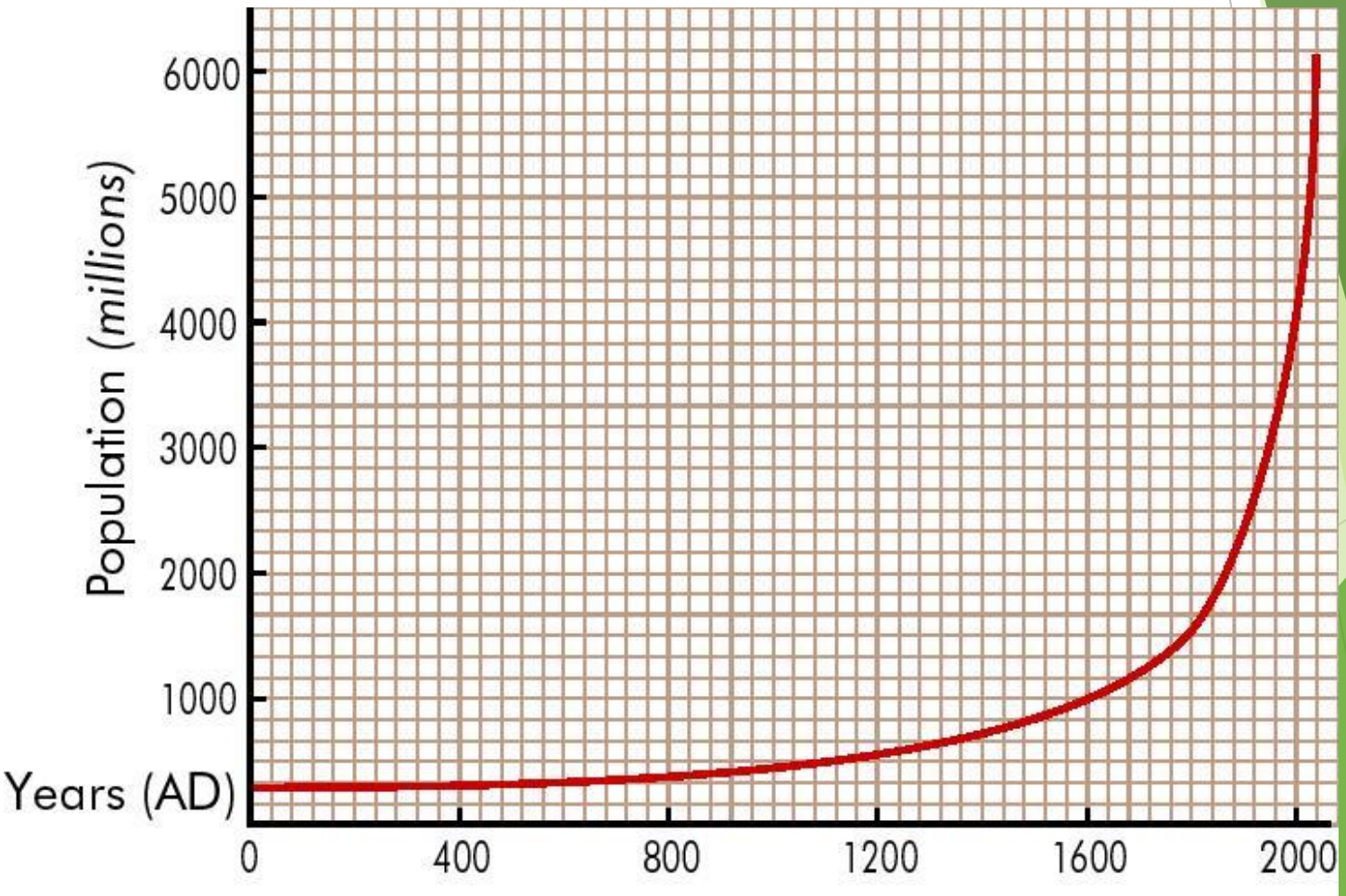
4

Notes on graph

1. Organisms arrive and then adapt to their new environment graph
2. Growth takes place rapidly due to newly-available food graph
3. Growth constraints are felt – predation, overcrowding, available food, etc. graph
4. Growth settles at a level that the environment can support.

Human Population Curve

Has not been susceptible to the normal constraints of nature and looks very different



Human population curve

Note: 1 billion = 1,000 million

Year (AD)	***Population***
400	100 million
1650	500 million
1930s	>2 billion
1970s	4 billion
2000	>6 billion

Population is now increasing by about 85 million per year = 230,000 per day = 160 per minute = 2.7 per second

Human population curve

66% of world population live in Asia. Birth rates are declining in developed countries.

The increase in the human population is not due to an increase in birth rates, but is caused by reduced death rates.

Factors affecting Human Population Numbers

- Famine
- Disease
- War
- Contraception

Famine

- A lack of food leads to malnutrition and death due to disease or starvation e.g.
- Great Irish Famine of 1845 – 47, about one million people died.
- Some countries still suffer from famine, but it is often a problem of food distribution rather than food shortages.

Back to Factors affecting Human Pop.

Disease (modern medicine led to huge population increases)

- Vaccines – reduce the incidence of diphtheria, whooping cough, tetanus, polio, meningitis, TB, etc.
- Sanitation + insecticides – have controlled malaria, yellow fever and sleeping sickness.
- Antibiotics have prevented deaths that would have been caused by bacteria.

Back to Factors affecting Human Pop.

War

- Reduces the human population.
- Effects can be temporary.
- Increased birth rates (baby booms) often follow wars.

Back to Factors affecting Human Pop.

Contraception

- Increased availability has reduced birth rates since the 1960s. Evident in *developed* countries e.g. in Western Europe and USA the average family size = 2.1.
- This is close to the level needed to ensure the pop remains constant.

The fertility rate in *developing* countries has fallen from 6.1 in 1970 to 3.5 today, due to contraception.