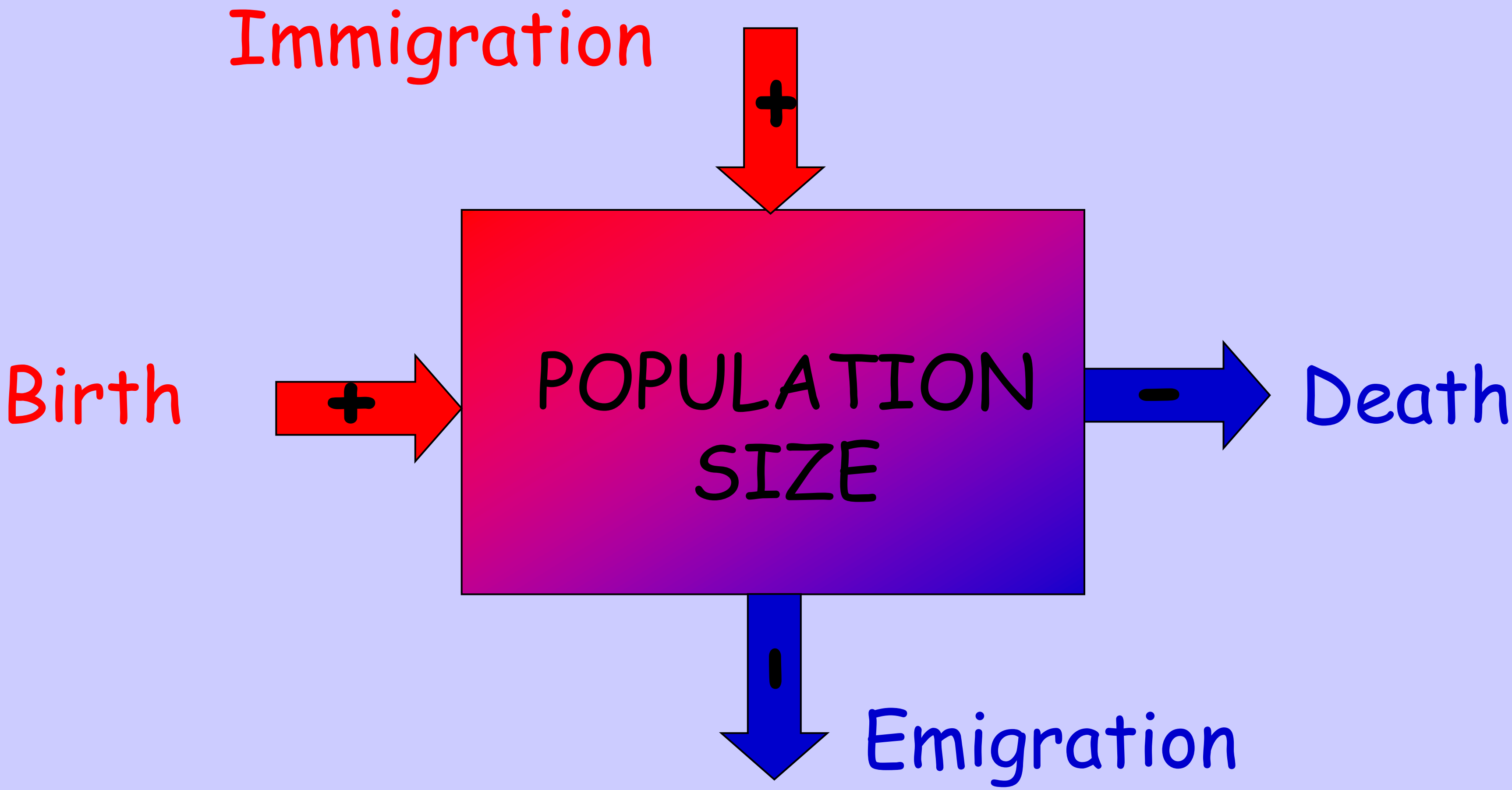
Populations

- A population is a group of individuals of the same species occupying a particular area at the same time

Population Growth

- As long as the birth rate exceeds the death rate a population will grow



- Population growth involves 3 main factors
- the **BIOTIC POTENTIAL** of the population
- **ENVIRONMENTAL RESISTANCE** of the habitat
- the **CARRYING CAPACITY** of the environment

Biotic Potential

The reproductive potential of a population under optimum environmental conditions and unlimited resources.

The maximum rate of growth of a population occurs during the exponential growth phase.

Environmental Resistance

The restriction by the environment on the population reaching its maximum growth rate and its biotic potential.

Abiotic factors include water, oxygen, light availability.

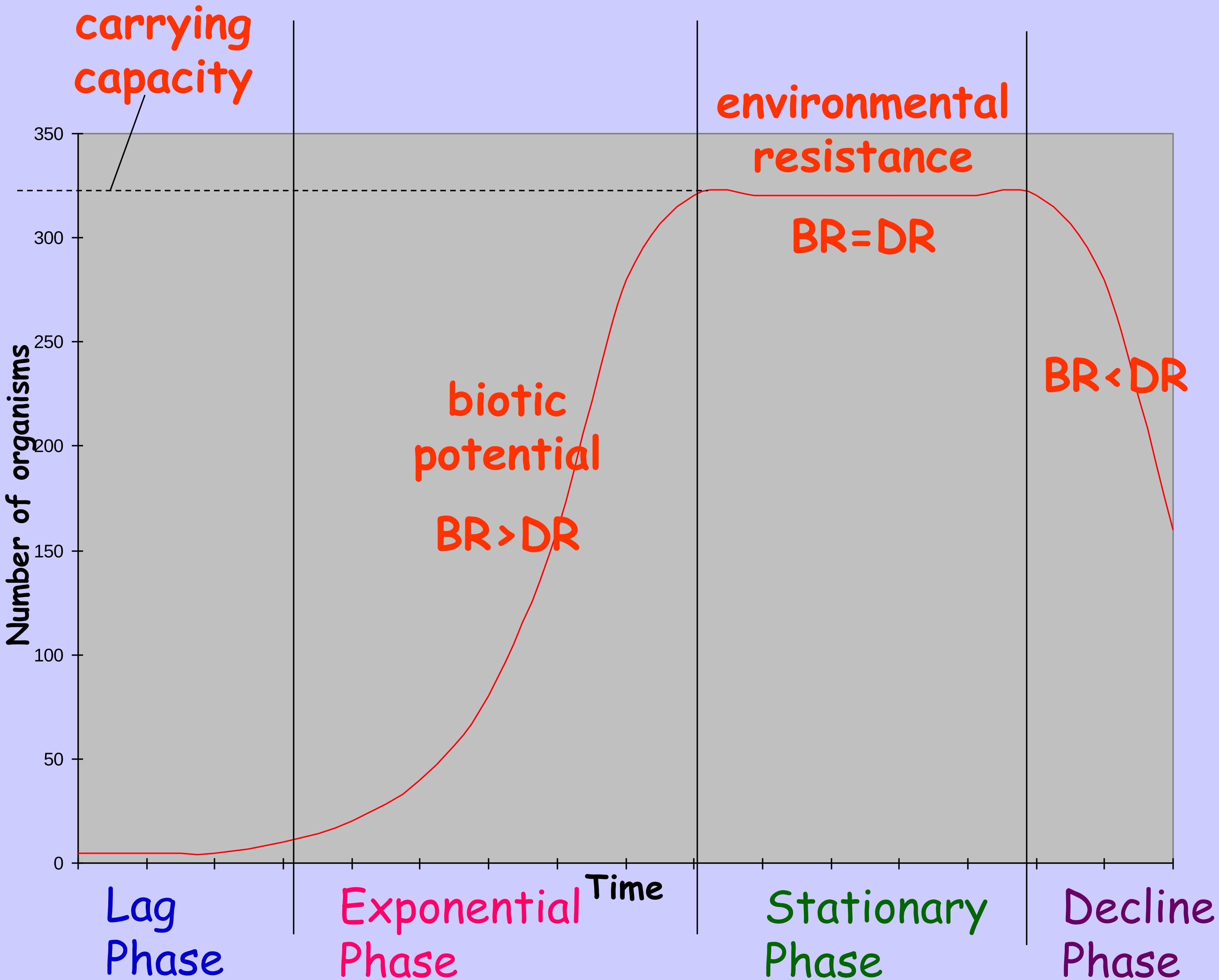
Biotic factors include nutrient shortage, accumulation of waste, competition from other organisms, predation and disease.

Carrying Capacity

- the maximum number of organisms that a population can support in an environment, and is determined by the resources available.

Growth curves

- Plotting the number of organisms in a population over time will produce a distinctive growth pattern
- This shows there are 4 stages
- The curve can be used to calculate the carrying capacity of the population


carrying capacity
environmental resistance
BR=DR
biotic potential
BR>DR
BR<DR
Number of organisms
350
300
250
200
150
100
50
0
Time
Lag Phase
Exponential Phase
Stationary Phase
Decline Phase

•Lag Phase

the rate of growth starts very slowly. Nutrient assimilation is taking place. Individuals adjust to new conditions, and need to activate genes to make the appropriate enzymes to metabolise the new substrate.

•Exponential Phase

Growth rate is at a maximum and the population increases exponentially by doubling. There is no restriction on growth, as resources are abundant and there is little waste.

•Stationary Phase

Growth rate slow due to limiting food supplies and the accumulation of waste products and toxins which restrict growth. Fewer new individuals are produced. There is intraspecific competition and Birth rate = Death rate.

- **Decline Phase**

death rate exceeds birth rate and the population declines, sometimes very rapidly. This is due to a build up of toxic waste and/or nutrient supply running out.

RESOURCES

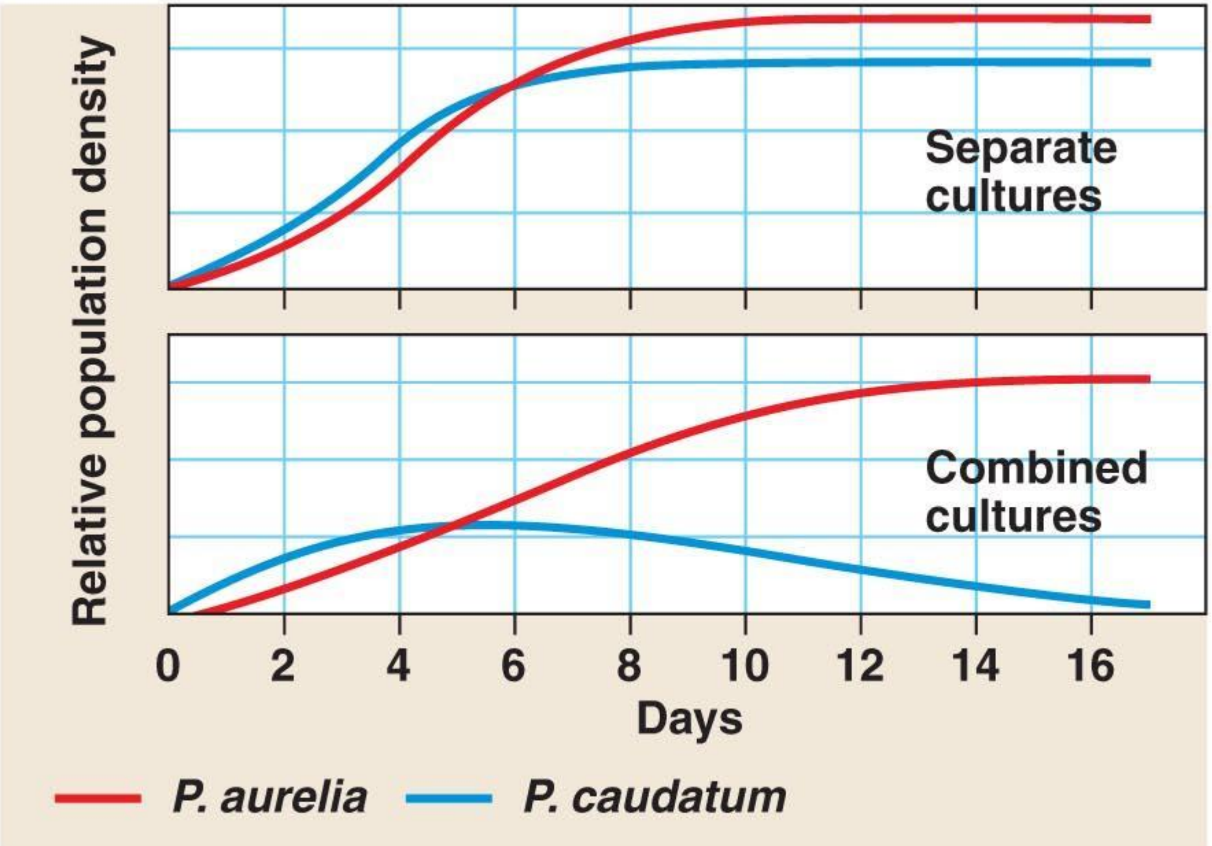
A biological resource is a substance or object required by an organism for normal growth, maintenance, and reproduction.

Non-renewable resources will be used up by a population and result in the flattening stationary and rapid fall of the decline phase.

Organisms which use **renewable resources** tend to remain in the stationary phase e.g. a broadleaved deciduous woodland where trees shed their leaves each year and provide food for earthworm populations.

COMPETITION

- Organisms compete with each other for the same resources such as food, light, water, space, mates
- Two types
- **Intraspecific** - within species
- **Interspecific** - between species



Paramecium aurelia

Paramecium caudatum

Paramecium competition

- When grown separately on bacteria, *P. aurelia* reaches a higher final density than *P. caudatum*.
- When grown in the same flask *P. aurelia* grows at a slightly lower rate, however *P. caudatum* is eliminated due to competition for the food resource.

The smaller *P.aurelia* is better adapted for utilising the bacterial food source.

Competitive exclusion principle

- No two species can occupy the identical ecological niche. One species always loses out as a consequence.

Which stages would be influenced by:

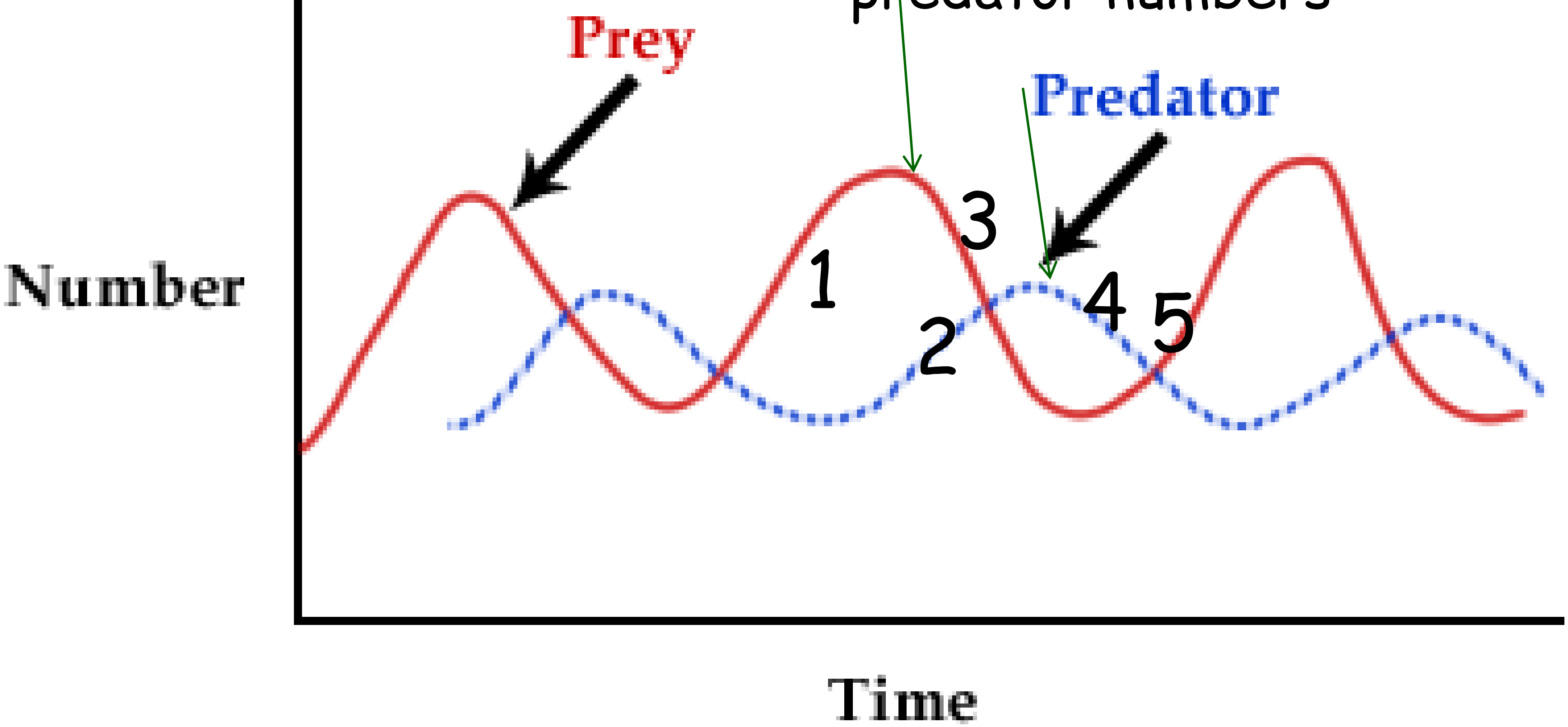
1. Competition for resources
2. Accumulation of waste
3. Availability of resources (renewable and non-renewable)

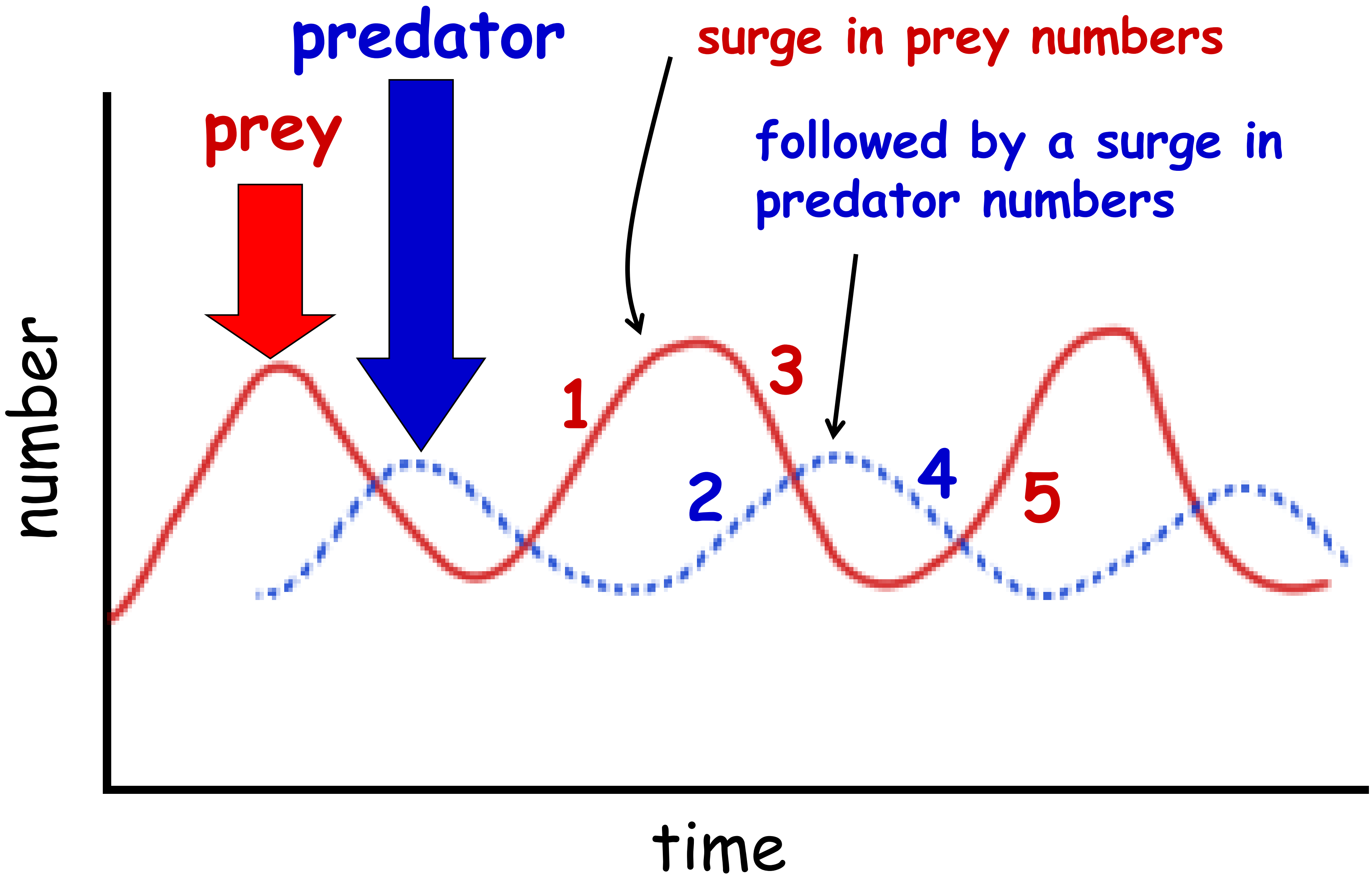
Answers

1. Stationary
2. Stationary and decline
3. Stationary and decline

PREDATOR-PREY INTERACTIONS

surge in prey numbers followed by a surge in predator numbers




predator
prey
surge in prey numbers
followed by a surge in predator numbers
1
2
3
4
5
number
time

1. The prey has plenty of food. They survive to breed and numbers increase.
2. The increase in prey numbers mean that there is more food for the predator. So more predators survive to breed and their numbers increase.
3. As there are now more predators, the rate of predation rises and the number of prey goes down.

4. There is now less prey for the predator to feed upon. Fewer predators survive to breed and their numbers decline.
5. With fewer predators more prey will survive to breed. Prey numbers will increase and so the cycle continues.

Describing trends in predator–prey interactions

- An **oscillating growth curve** is produced, with **alternate peaks and troughs**.
- The predator peaks and troughs **lag behind** the prey peaks and troughs. The time lag is affected by the rate and time involved in predator reproduction.
- Although lagging behind, the **length of** the predator and prey **cycles** is **usually similar**.
- **Predators numbers** are normally **significantly lower** than the prey **at equivalent points** on the cycle.

Question

- Growth curves for most predator-prey relationships have a much smoother oscillating pattern. **Why**?
- Most predators have more than one prey, consequently there is less correlation between any one prey and any one predator.

Population Dynamics

Population growth = (births – deaths) + (immigration – emigration)

In closed populations, such as a laboratory flask, migration is not a factor.

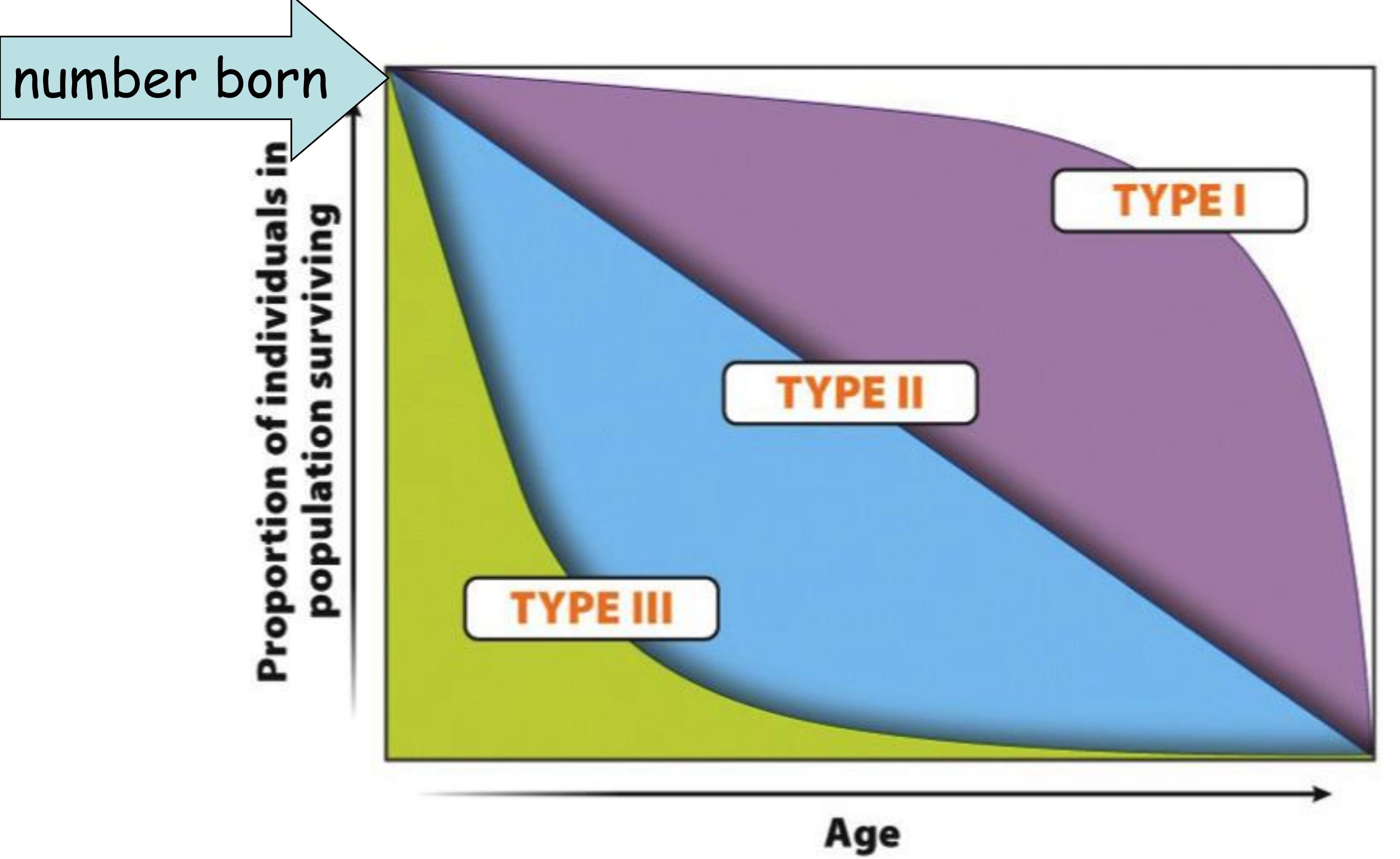
In open systems immigration of migratory species, e.g. birds in spring and summer, and a higher birth rate causes rapid increases in population size.

Seasonal Effect

- Migration has a seasonal effect on local population size, with an influx in spring and summer and numbers returning to a low, often non-existent population in autumn and winter.
- Most seasonal effect is due to temperature and food resources rather than migration. Many species reproduce in spring and summer when temperature is high and food abundant.

Survivorship Curves

- These represent the percentage of individuals surviving over a year, or a number of years.

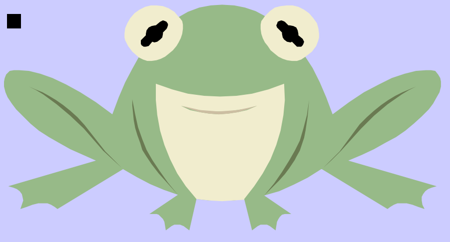


Giant tortoise	Painted bunting	Mackerel
TYPE I	**TYPE II**	**TYPE III**
High survivorship until old age, then rapidly decreasing survivorship	Survivorship decreases at a steady, regular pace	High mortality early in life, but those that survive early years live long lives

R&K Species

Most species can be divided into 2 groups based on the speed at which the population increases and the ability to remain in the stationary phase.

Each has a distinctive set of characteristics and their growth pattern gives rise to specifically shaped growth curves.



K- Selected Species

Their populations are relatively stable, with numbers remaining at or close to the carrying capacity for the species. This gives rise to an **S-shaped growth curve.**

k-species include humans and elephants, along with late succesional species such as trees.

The emphasis for these species is survival and dominance of an area.

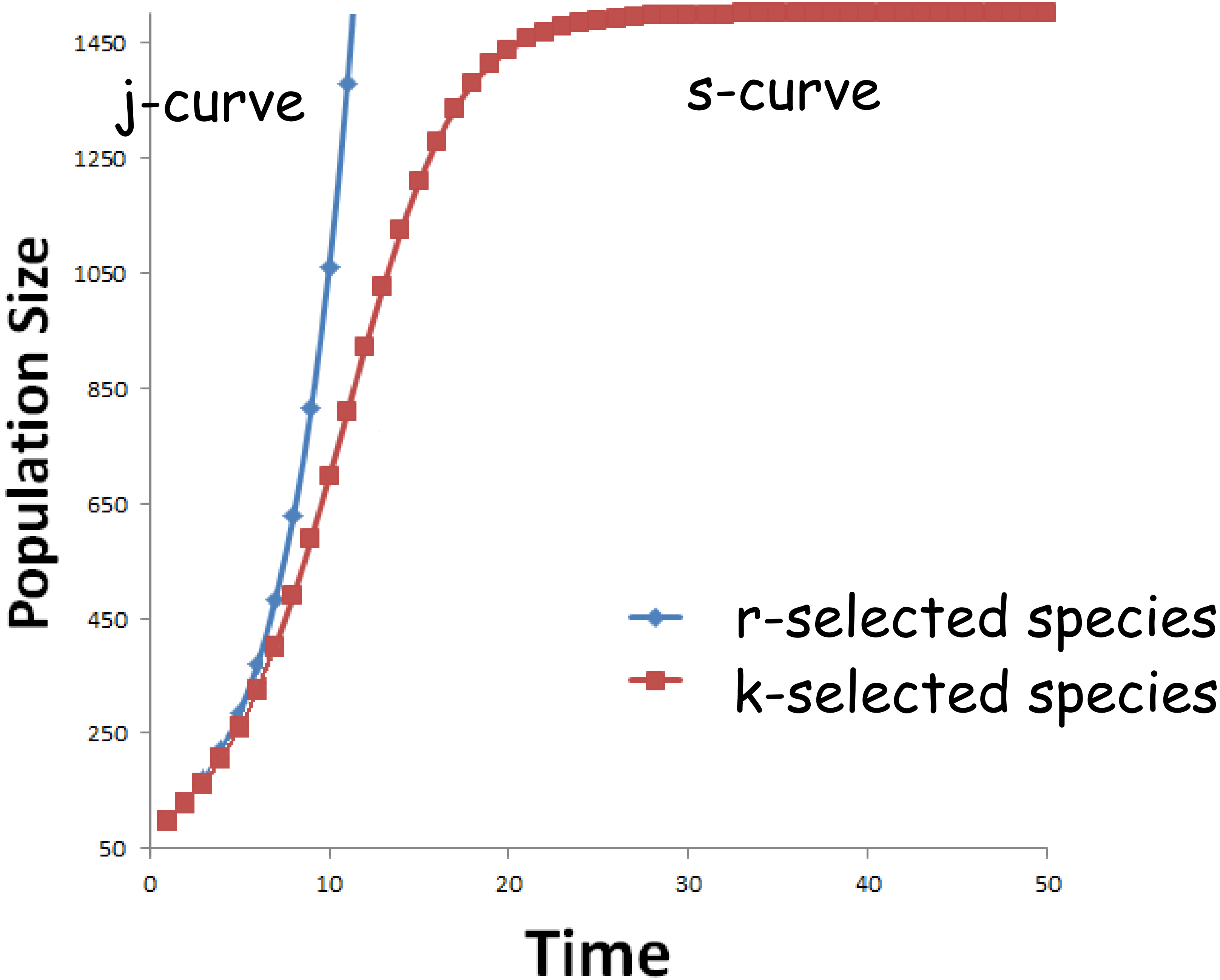
R-Selected Species

Population numbers increase very rapidly when conditions are ideal and decrease rapidly when they are less favourable. This 'boom or bust' pattern gives rise to a **J-shaped growth curve.**

r-selected species include bacteria, insect pests such as aphids and early succesional species such as pioneer plants.

The emphasis of these opportunistic species is on reproduction and colonisation of new areas.

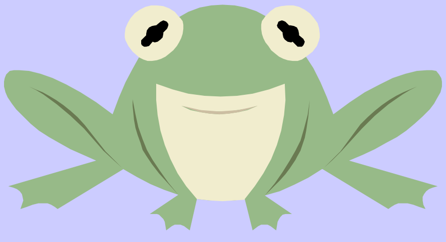
characteristic	r-selected (r-strategies)	k-selected (k-strategies)
Body size	Small	Large
Reproduction	Rapid, many offspring	Few offspring
Parental care	Little	Lot, high investment in the few young
Dispersal	Rapid, colonises new habitats	Low ability
Pop size/density	Varies	Stable
Competition	Low, unlikely to be dominant	High, may be dominant species
Specialisation	Not, adapt to changes in environment, can evolve rapidly e.g. antibiotic resistance in bacteria	Highly, less resistant to environmental change, prone to endangerment / extinction e.g. Polar bears
Habitat	Unstable, short-lived such as weeds in ploughed field	Stable, undisturbed e.g. oak trees in forest



j-curve
s-curve
Population Size
1450
1250
1050
850
650
450
250
50
0
10
20
30
40
50
Time
r-selected species
k-selected species

Also read

Froggy page 407



Population Interactions

Predator-prey +/-

Parasitism +/-

Competition -/-

Mutualism +/+

Make a table to summarise how each interaction works. Include definitions and examples for each.

BIOLOGICAL CONTROL

Practical Work

- The Haemocytometer
- Capture-recapture technique

Biological control.

- A PEST – An organism that competes with or adversely affects a population of plants or animals that are of economic importance to humans

- BIOLOGICAL CONTROL

The use of **predators**, **parasites** or **competitors** to control the numbers of pests

EXAMPLES

- Cottony cushion scale insect in California
- Attacked the citrus trees
- Found a ladybird predator in Australia
- Now controls the pest

ADVANTAGES OF BIOLOGICAL CONTROL

- After the initial expense is relatively inexpensive
- Has no detrimental effect on environment like chemicals
- Pests can become resistant to pesticides

FEATURES OF GOOD BIOLOGICAL CONTROL

- Must target pest and no other species (are specific)
- Predator must not eradicate the pest
- Predator and pest should exist in balance but at a level where the pest has no major detrimental effect

Read Froggy p413

- Take notes on problems of biological control mechanisms
- Copy out the summary table to comapre chemical and biological control mechanisms

the best control of pests

involves using a balance of

chemical and biological control mechanisms