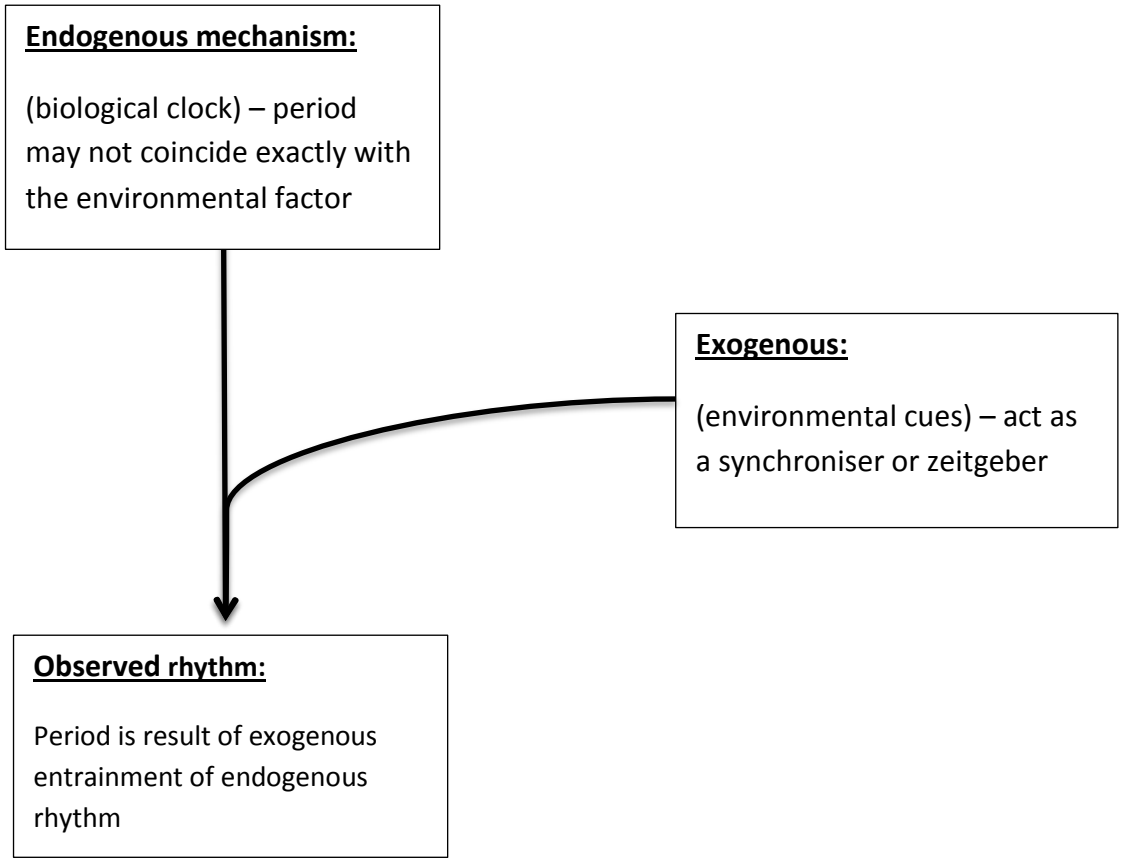
AS 91603 Timing and orientation responses

- It is important that animals are able to synchronise (match) their activities with other animals and their environment, e.g. bats in caves need to be able to predict when it is dark before they come out of the cave to feed as they are nocturnal, or Godwits need to be able to eat lots of food in preparation for migration.
- These responses are made up of a number of factors:



- The existence of **endogenous mechanisms** (biological clocks) have been found by bring organisms into the lab and keeping them under constant conditions (light, temperature, humidity etc. - any factor that could act as a synchroniser or **zeitgeber**). If they kept behaving in a cyclic fashion, under these conditions, then some sort of endogenous mechanism was working.
- The **period** of the biological clock could be worked out by measuring the time from the start of activity to the start of the next activity.
- This process of observing them in constant conditions results in the organism being **free running**.
- From these tests it is found that biological clocks have a slightly different period to their geophysical cycles and are therefore called circa meaning “about”.
    - Circadian (about a day / 24hours)
    - Circatidal (about 12.5 hours)
    - Circalunar (about 29.5 days)
    - Circannual (about 365 days)

Examples of circadian rhythms

- Nectar being released at certain times of the day when the plants pollinators are active
- Dropping of leaves at night due to changes of water pressure in their cells
- Flowers moving to follow the sun
- Humans sleep wake pattern

Examples of circamonthly

- Planting calendar used by many cultures to grow plants, based on the phases of the moon and tides
- Human menstrual cycle
- The release of sperm and eggs by some algae

Examples of circatidal

- Many organism that live in areas where tidal action is observed have a circatidal rhythm e.g. Fiddler crabs are active during low tide because this is when they feed. At high tide they go into their burrows and are less active

Examples of cirannual

- Flowering in many plants (long day etc.)
- Loss of leaves (abscission)
- Growth patterns in trees
- Hibernation in animals
- Migration

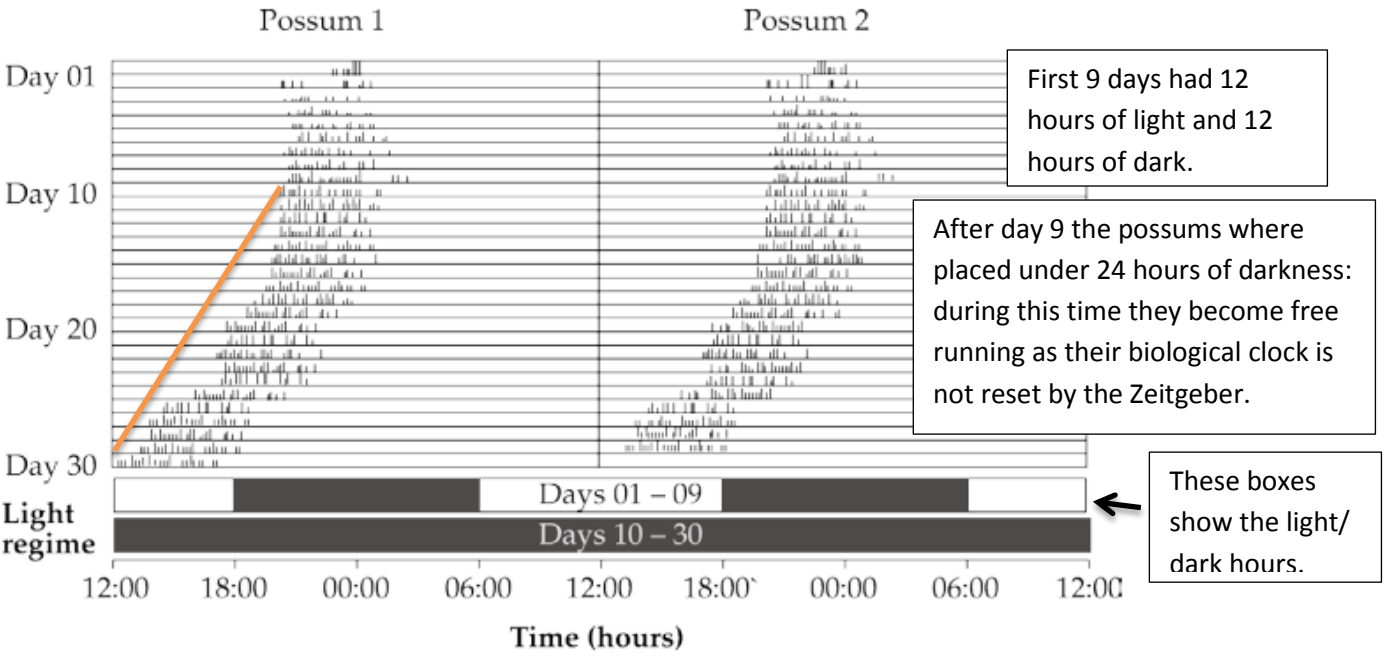
Key terms

- Exogenous = controlled by environmental stimulus
- Endogenous = biological clock/ regulated internally, no environmental stimulus needed
- Period of rhythm = time it takes to complete one cycle of activity
- Phase shift = this occurs during entrainment, it is how much the activity/ rhythm has been shifted forward or back
- Free running period = cyclic behaviour observed without external stimulus
- Entrainment = the resetting of the biological clock
- Zeitgeber = the environmental cue which resets the biological clock

Actograms

- An actogram is a special graph that shows the activity of an animal or plant during the day and over many successive days. This gives a good picture of when the organism is active at any time.
- These are used to show periods of rest and periods of activity
- Activity is shown as dark bars

- Each line on an actogram shows 24 hours
- Experiments are usually carried out that change the light cycles the organism experiences. They are shown as LD cycles, e.g. LD 12:12 means 12 hours light then 12 hours dark. Total darkness is often labelled as DD, and total light as LL.
- From actograms you can work out if the organism is nocturnal (active at night), diurnal (active during day), crepuscular (active at dawn and dusk) or arrhythmic (shows no pattern)
- You can also use actograms to work out the period of the activity
- e.g. A number of possums were taken back to the laboratory to further investigate their activity regulation. The actogram below shows the activity of two possums recorded under constant environmental conditions, using the light regime shown underneath



- This organism is nocturnal, as during days 1 to 9 it becomes active after dark.
- Its pattern is Circadian, as it's period of activity is about a day (24 hours).
- The period of this organism is slightly less than 24 hours as when it is in constant conditions (days 10 to 30) it's activity happens a little earlier each day.
- The period of activity can be calculated:
  - Draw a line from the first activity in constant conditions (day 10) to the first activity on day 30 (see above).
  - Using the scale off the bottom we can see that in 20 days it gets up 8 hours earlier 8 / 20 X 60 (this converts the answer into minutes) = 24 minutes.
    Therefore the period is 24hours – 24 minutes = 23 hours and 36 minutes.
  - If the organism is active later each day, its period of activity will be greater than 24 hours. So draw the line, but it will go \ , work out how much it has changed. But instead of 24 hours - _____ you must go 24 hours + _____. As its period is longer than 24 hours.
- Actograms can also be used to see if a rhythm is endogenous or exogenous. In the case above it is endogenous because the rhythm continues when the organism is placed in constant conditions without environmental stimulus.