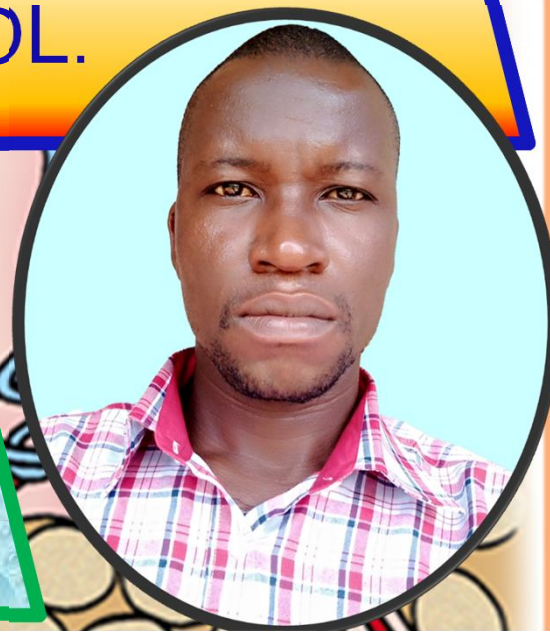
S.3 BIOLOGY

TOPIC: HOMEOSTASIS, EXCRETION AND OSMOREGULATION

SUB-TOPIC: THERMOREGULATION

(TEMPERATURE REGULATION CONTROL.



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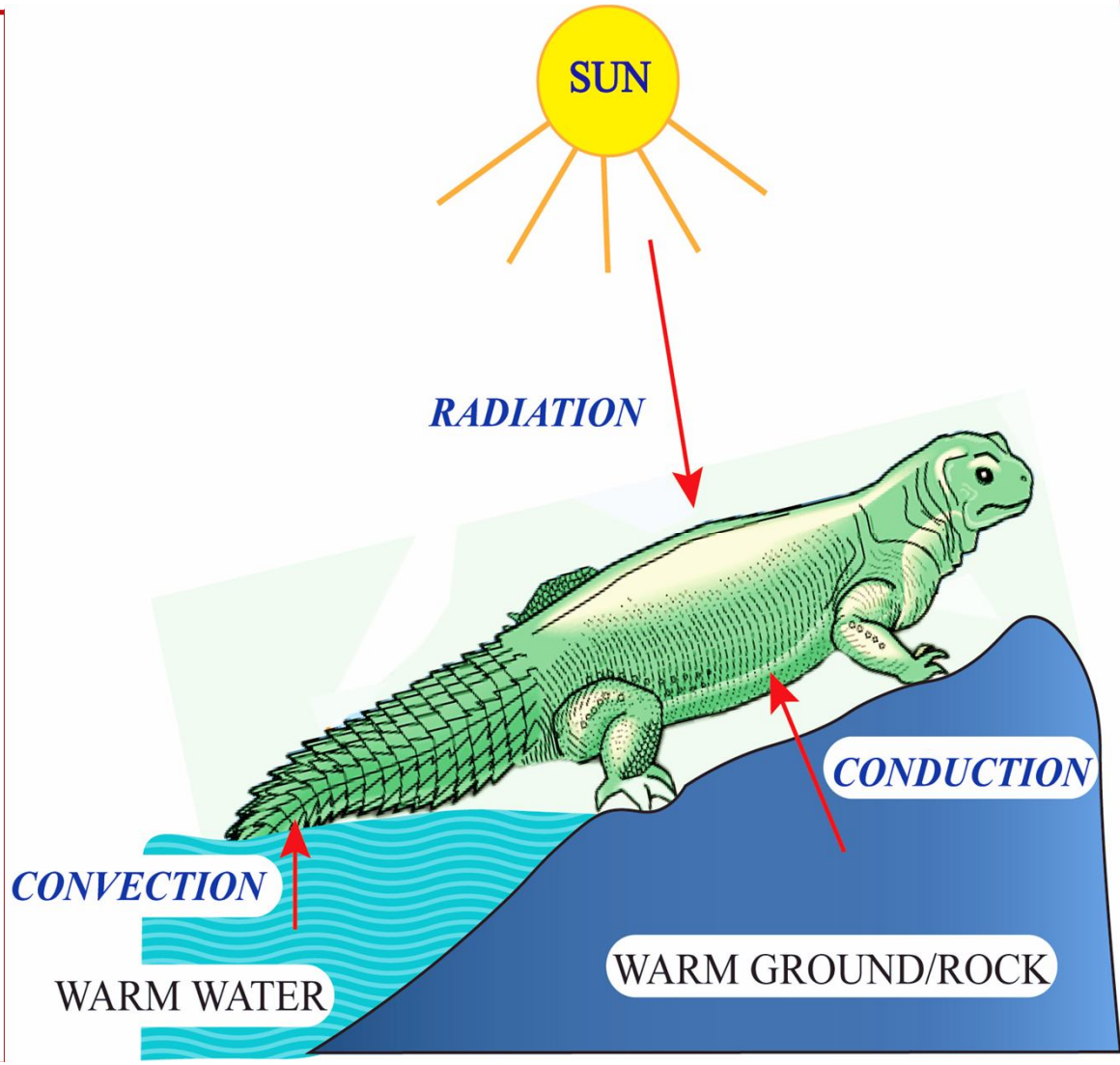
THERMOREGULATION: CONTROL OF BODY TEMPERATURE

The Concept of Thermoregulation

- Thermoregulation is the process of keeping body temperature at a relatively constant level.
- Thermoregulation is important *to provide optimum temperature suitable for enzyme activity* – for normal functioning of bodily processes/metabolism.
- Organisms can gain heat by a variety of mechanisms, namely:
  1. Metabolism of food – waste heat from respiration.
  2. Absorption of solar (sun) or heat energy in the following ways:
     - ✓ Heat reflected from hot objects (e.g. sun) as rays/waves – by radiation.
     - ✓ Heat convected from the warm object through fluids– by convection.
     - ✓ Heat conducted from the ground (or hot object) – by conduction.

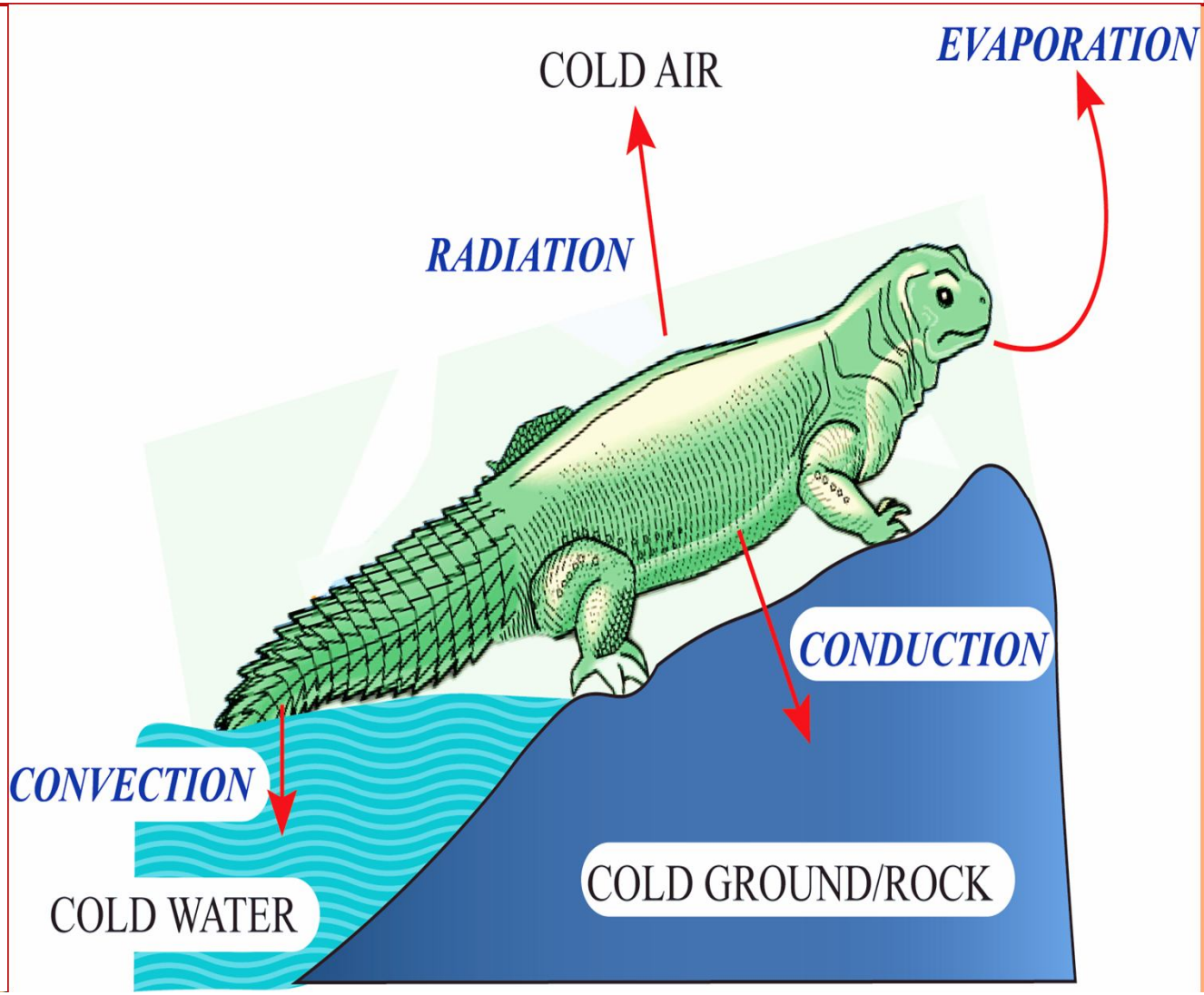


THERMOREGULATION: CONTROL OF BODY TEMPERATURE

The Concept of Thermoregulation

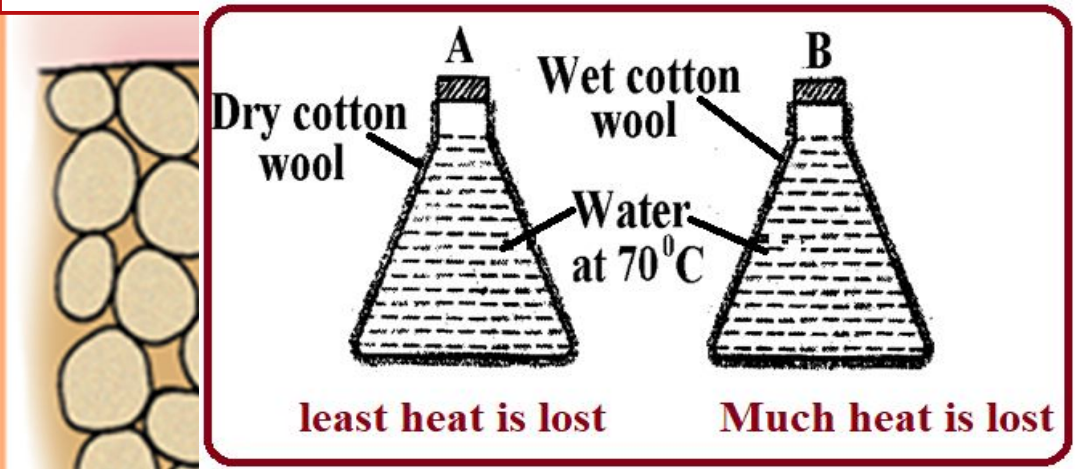
- Organisms can loss heat by a variety of mechanisms, namely:
  1. Evaporation of water e.g. during sweating or when the mouth is open widely;
  2. Conduction from the body to ground or other object;
  3. Convection from the body to air or water;
  4. Radiation from body to air, water or ground.
- Animals are categorized into two depending on their thermoregulation mechanisms, namely:

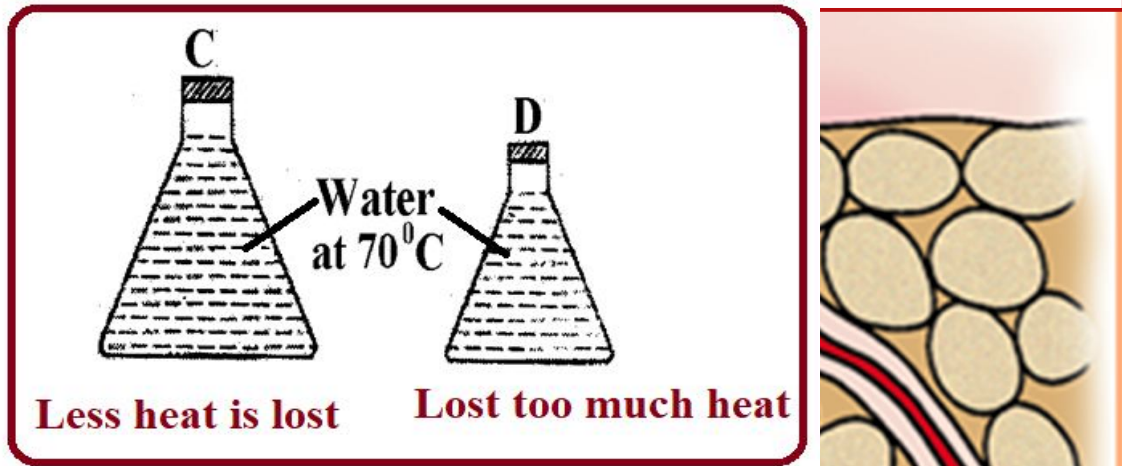
1. Ectothermic/ poikilothermic animals.
2. Endothermic/homoiothermic animals.



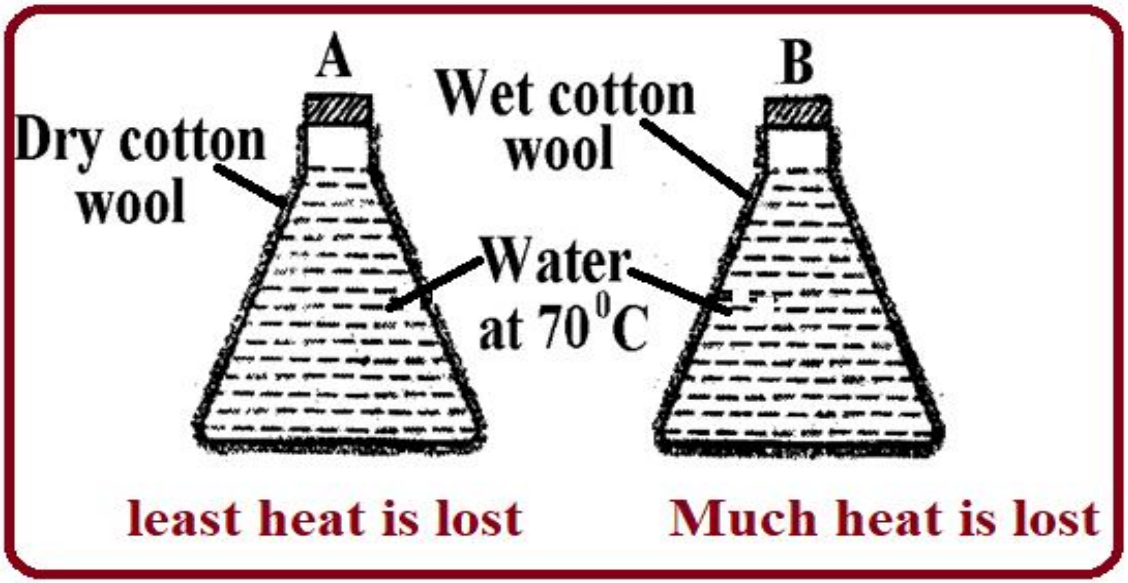
Factors that affect temperature control in animals

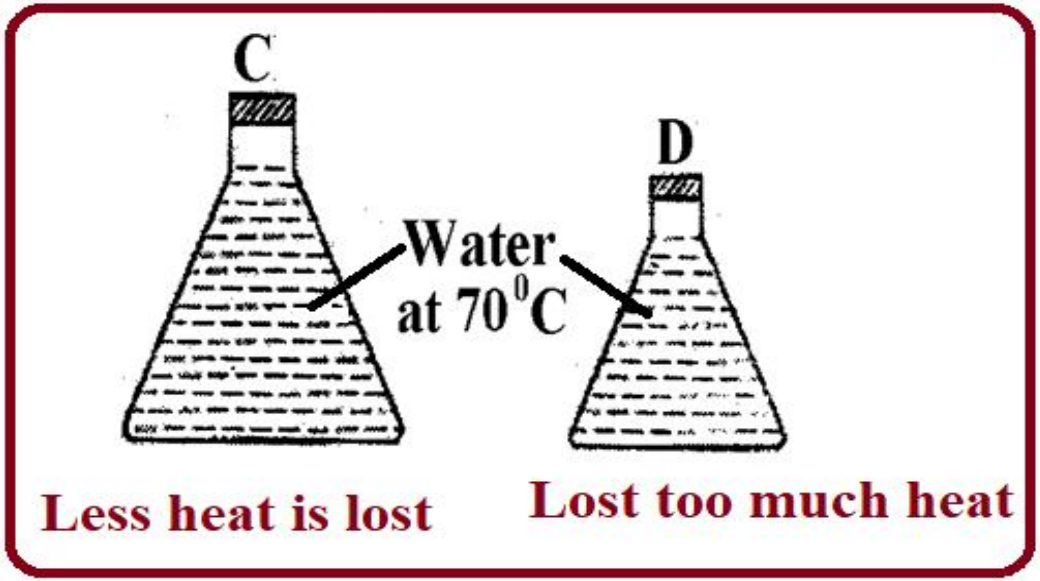
1. **Colour of the body:** A dark coloured organisms absorbs more radiations and therefore they lose heat slowly compared to organisms of light colour.
2. **Body size:** Small organisms have a larger surface area to volume ratio than large organisms. Therefore, small organisms lose heat more rapidly to the surroundings than large animals.
3. **Insulation**
   - Fur/hair, fat layer, feathers, or clothing/cotton wool act as an insulator to heat; so reducing heat loss.
   - When the fur/hair, fat layer, feathers, or clothing/cotton wool is thicker less heat is lost from the organism than when the insulator is thin.
   - When the insulator is dry, the organism loses less heat because the dry object absorbs less heat from the body.
   - When the insulator is wet, the body loses more heat because it absorbs a lot of heat by conduction from the body.





Assignment: Explain the heat loss in each flask.



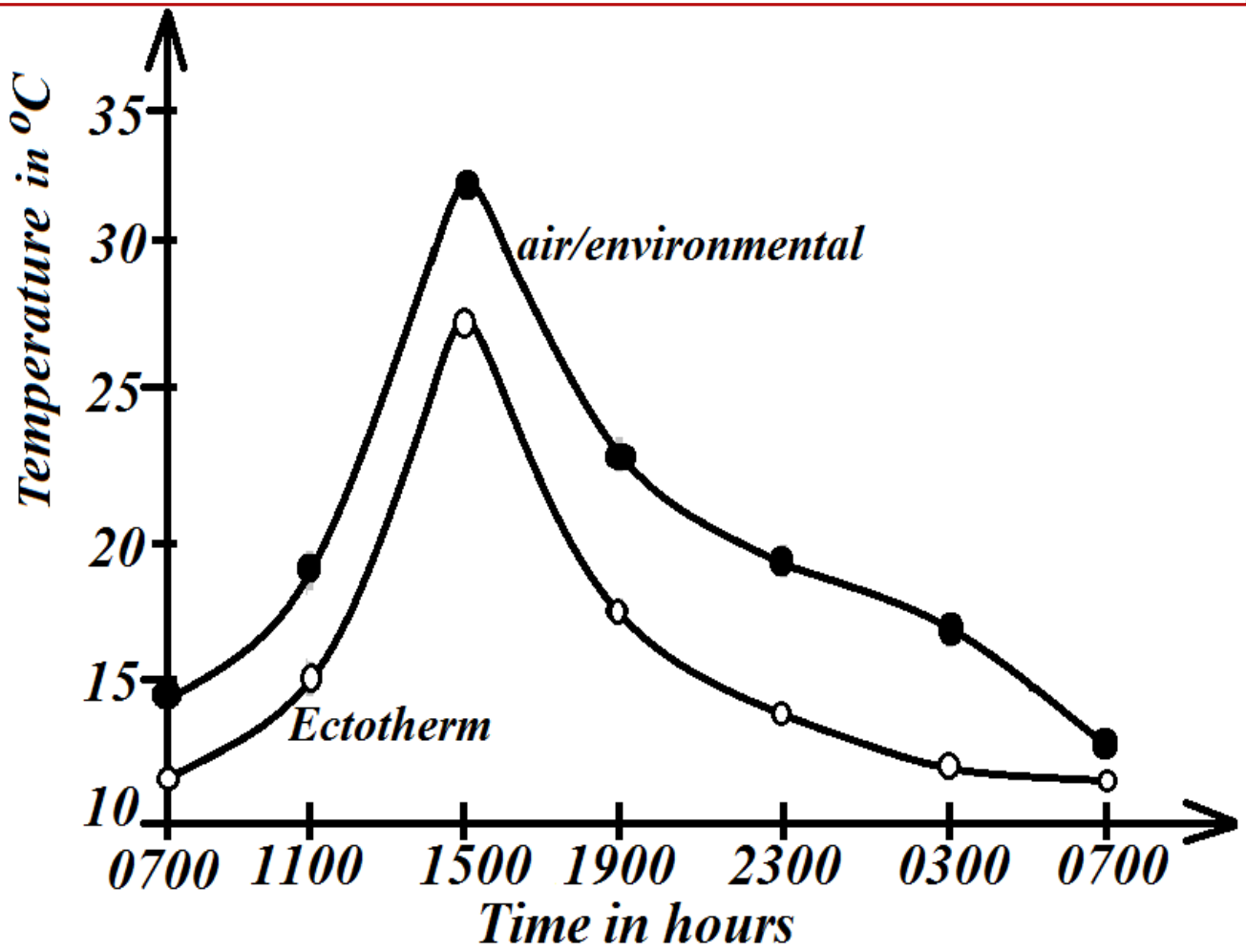


Flask A lost least heat than B; because dry cotton wool absorbed less heat from the from the hot water by conduction;	Flask B lost much heat than A; because wet cotton wool absorbed less heat from the from the hot water by conduction;	Flask C lost less heat than D; because flask C is large with smaller surface area to volume ratio than flask D; so C lost heat slowly than D; Alternatively: Flask C lost much than A and B; because C was not insulated;	Flask D lost much heat than C; because flask D is smaller with large surface area to volume ratio than flask C; so D lost heat rapidly than C;

Ectothermic/Poikilothermic animals

- **Poikilothermic animals** (“poikios” meaning “various” and “therme” meaning “heat”) or **ectotherms** (“ecto” – meaning “outside”) are animals that cannot regulate their own body temperature internally but their body temperature varies with environmental temperature.
- Therefore, ectotherms **have low metabolic rate due** to fluctuation in body temperatures enzyme activities cannot occur continuously.
- **Examples of ectotherms** include all invertebrates and some vertebrates such as fish, reptiles, and amphibians.

A graph showing the variation of temperature of ectotherm and air with time of the day

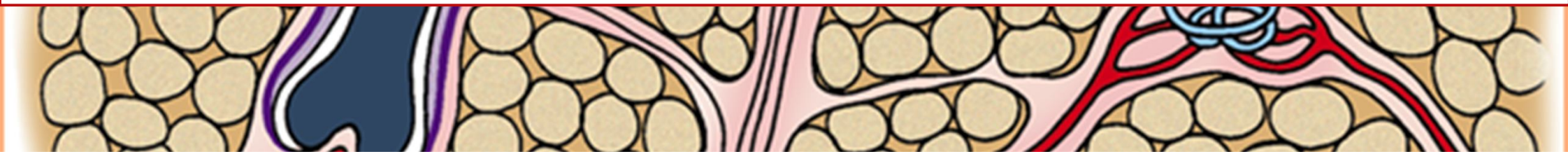


Advantages of being ectothermic

1. The animal consumes little food (conserves food) because heat energy to maintain body temperature is obtained from the external environmental temperature.
2. The animal spends less or no energy to maintain their body temperature.
3. The animal produces fewer waste products due to low metabolic rate.

Disadvantages of being ectothermic

1. At extreme environmental temperature (very high or very low temperatures), the animal is less active. This is because at very high temperatures, most enzymes are denatured and at very low temperatures, most enzymes are inactive. This slows down the rate of metabolism.
2. The animal responds slowly to stimuli due to low metabolic rate, especially at very low temperature.
3. The animal cannot live in wide range of varying environmental temperature.

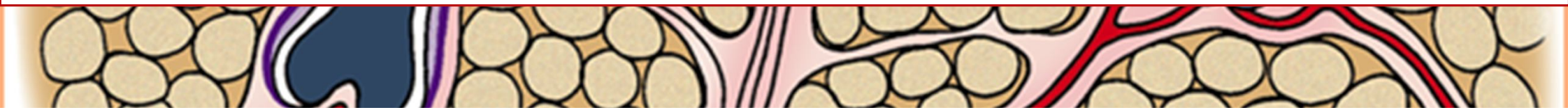


How do ectotherms respond to cold or low temperatures?

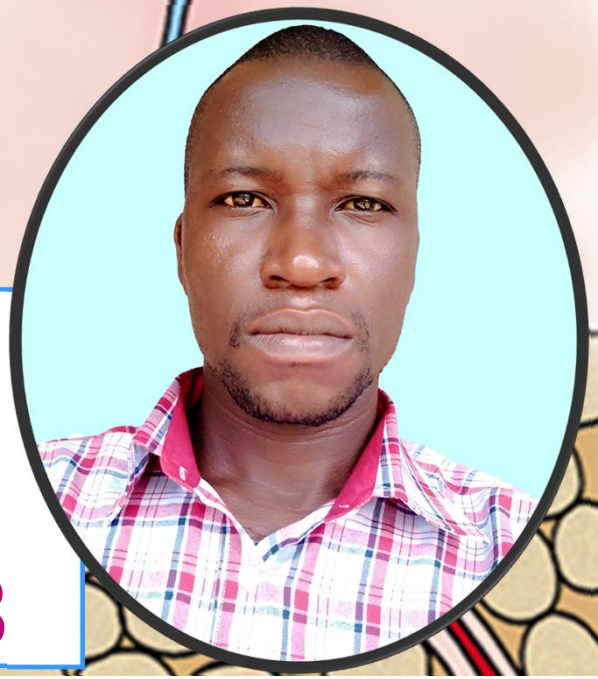
1. They bask (lie exposed to the warmth from the sun) to gain heat by radiation, e.g. lizards, and crocodiles.
2. Some ectotherms (e.g. amphibians) hibernate. Hibernation/torpor is a state of dormancy/rest in the cold/winter while living off reserves of body fat, with a decrease in body temperature and pulse rate and slower metabolism.
3. They burrow (hide underneath or delve) into cracks, crevices in walls, e.g. lizards.
4. Some ectotherms orientate (change their position) themselves relative to the sun's rays and they increase surface area exposed to heating during the cold, e.g. desert locusts.
5. Some ectotherms (e.g. Australian grasshoppers) change the colour of their cuticle to dark colour at low temperature and absorb solar radiations, thus heating up rapidly.
6. Most aquatic ectotherms mainly live in large water bodies (e.g. oceans) where the temperatures remain relatively stable/constant throughout the year other than small water bodies (e.g. water pod) where the temperature greatly fluctuates.

How do ectotherms respond to hot or high temperatures?

1. They aestivate. Aestivation is a state of dormancy/rest during the summer or during months of drought e.g. some amphibians, reptiles, earthworm, and insects.
2. Some ectotherm salivate onto their necks and legs e.g. in tortoise.
3. They move into shades to cool body temperature i.e. seeking favourable microclimate in environment.
4. Occasionally they open their mouth widely for a few minutes to allow evaporation of water, which carries away excess heat from buccal cavity, e.g. crocodile.
5. Some ectotherms orientate (change their position) themselves relative to the sun's rays and they reduce surface area exposed to heating during hot sunny day, e.g. desert locusts.
6. Some ectotherms (e.g. Australian grasshoppers) change the colour of their cuticle to lighter colour at high temperature and reflect solar radiations, thus reducing heating up.



End of the lesson!
For more information, contact



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