and again arch 6 contributes to pulmonary circulation, with arches 3-5 carrying gills. In neotenic salamanders, arch 6 disappears.

Endothermic animals have different circulatory requirements to ectothermic animals:

- Ectotherms have a lower metabolism and resting body temperature than endotherms.
- Ectotherms therefore do not require as much energy (and O₂) as endotherms.
- Endotherms require high pressure delivery of blood to the body, and mammals and birds have therefore lost the 2nd systemic arch to facilitate this delivery.
 - In birds, the right systemic arch remains.
 - In mammals, the left system arch remains.
- Endotherms have completely separated ventricles, as this allows blood to be delivered under higher pressure to the systemic circuit and lower pressure (to avoid damage) to the pulmonary circuit.



The circulatory system of a human foetus:

- Blood is oxygenated by the mother's placenta instead of the lungs.
- Oxygenated blood returns to the heart through the inferior vena cava into the right atrium.
- Blood passes through the foramen ovale (incomplete interatrial septum) into the left atrium, left ventricle and system trunk, bypassing the lungs.

- Cranial kinesis is used by snakes to enable them to ingest prey larger than their head. They have lost their upper and lower temporal bars, and have mobile joints between the rostrum, braincase and jaw suspension, allowing the skull to deform by separating the left and right halves of the braincase.
- Lizards have lost their lower temporal bar. Their joints allow the snout to life upward or • bend downward about its mesokinetic articulation, which changes the angle of closure of the teeth when it grabs a prey item, preventing forward forces that could result in prey loss.
- Woodpeckers also use cranial kinesis to enable it to repeatedly bash its head against a tree at a high frequency.
- Amongst mammals, cranial kinesis only occurs in some baleen whales and leporids (rabbits and hares).
- Crocodiles have both temporal bars present and no evidence of kinesis. Like mammals they possess a secondary palate which separates the nasal passageway from the mouth.

Metakinesis	Hinge across the back of the skull allowing rotation between the neurocranium and outer dermatocranium.	Found in most modern lizards.
Mesokinesis	Hinge passes through the dermatocranium behind the eye.	Found in conjunction with metakinesis in many modern lizards. Monokinetic mesokinesis is rare but found in some burrowing lizards.
Prokinesis	Hinge in the dermatocranium passes in front of the orbits.	Found in snakes and birds
Streptostyly	Quadrate can undergo independent rotation.	Found in the second s
Monokinetic = one hine W from 14 of 24 Dikineto two inges Page		

Constraints may prevent cranial kinesis in mammals:

- While reptiles mostly bolt their food, mammals chew before swallowing (mastication) which requires food to stay in the mouth for a period of time. Therefore, separation of feeding and breathing passages is essential.
- Furthermore, mammals depend on their capacity to breathe while suckling, and hence on their independent nasal and oral passages which separate early in mammalian development.
- The fully ossified elongate palate divides the two cavities, requiring a solid connection • between parts of the skull and limiting the capacity for joints besides the dentary-squamosal (jaw) joint to exhibit mobility. The mammalian palate may therefore be a constraint preventing cranial kinesis - when ingesting milk, the mammal must generate negative pressure inside the mouth, which must not collapse due to a mobile joint elsewhere in the skull giving way due to that pressure.
- Mammals also have precise tooth occlusion (coming together of upper and lower teeth in alignment) which requires a firm skull, and would not be possible with cranial kinesis.

Heat generation (thermogenesis) occurs in two main ways:

- Via shivering thermogenesis
 - Shivering thermogenesis increases as body temperature decreases.
 - Some pythons use shivering thermogenesis to incubate their eggs, but are still classified as poikilothermic ectotherms. Shivering pythons have been shown to have a wider thermal tolerance and are able to reproduce in colder environments than non-shivering pythons.
 - The primary motor centre for shivering lies in the dorsomedial part of the posterior hypothalamus and is normally inhibited by signals of warmth from the preoptic area of the hypothalamus. In the cold, these inhibitory signals are withdrawn, and the primary motor centre for shivering sends impulses down the brainstem and lateral columns of the spinal cord to anterior motor neurons. Although these impulses are not rhythmic, they increase muscle tone, and consequently metabolic rate. Once the tone exceeds a critical level, the contraction of one group of muscle fibres stretches the muscle spindles in other fibre groups in series with it, eliciting contractions from those groups of fibres via the stretch reflex, and so on, resulting in shivering.
- Via non-shivering thermogenesis
 - Aerobic respiration
 - The hypothalamus produces thyrotropin-releasing hormone (TRH) which stimulates the pituitary gland to produce thyroid-stimulating hormote (TSH), which in turn leads to the secretion of thyroid hormones +3 and T4 into the bloodstream. This is detected by a dryconhormone receptor in the inner mitochondrial membranes are binding of the thyroid hormone to this receptor increases 40P up take by the mitrobordria, and consequently increased by Unetabolic rate.

Certain respiration produces leat as a by-product.
O₂ construction mixed decreases in response to lower ambient temperature, whereas O₂ consumption increases in birds and mammals to increase aerobic respiration in order to sustain constant body temperature.

- Endotherms use more energy and therefore need to eat more than ectotherms. For example, a rattlesnake requires its own body mass in food once a year, while small endotherms require their own body mass in food every day.
- Cells that form part of internal organs have a greater mitochondrial density than other cells. Endotherms have a higher proportion of viscera (organs) relative to their body mass than ectotherms.
- \circ Na⁺/K⁺ ATPase
 - The Na⁺/K⁺ ATPase removes excess Na⁺ from the cell, producing heat.
 - T4 (thyroxine) increases the permeability of membranes to Na⁺, which increases the activity of the Na⁺/K⁺ ATPase and consequently increases heat production.
- o Brown adipose tissue
 - Brown adipose tissue or brown fat is fat tissue that uses glucose and produces heat.
 - It contains high levels of mitochondria and blood capillaries.