Mammals

Mammals generally maintain body temperature within a narrow range (36-42º for most birds) that is usually considerably warmer than the environment. Because heat always flows from a warm object to cooler surroundings, birds and mammals must counteract the constant heat loss. This maintenance of warm body temperatures depends on several key adaptations. The most basic mechanism is the high metabolic rate of the endothermy itself. Endotherms can produce large amount of metabolic heat that replace the flow of heat to the environment, and they can vary heat production to match changing rates of heat loss.

Heat production is increased by such muscle activity as moving or shivering. In some mammals, certain hormones can cause mitochondria to increase their metabolic activity and produce heat instead of ATP. This no shivering thermogenesis (NST) takes place throughout the body, but some mammals also have a tissue called brown fat in the neck and between the shoulders that is specialized for rapid heat production. Through shivering and NTS, mammals and birds in cold environment can increase their metabolic heat production by as much as 5 to 10 time above the minimal levels that occur in warm conditions. Another major thermoregulatory adaptation that evolved in mammals and birds in insolation (hair, feathers, and fat layers) which reduce the flow of the heat and lowers the energy cost of keeping warm. Most land mammals and birds react to cold by raising their fur or feathers, thereby trapping a thicker layer of air. Humans rely more on layer of fur just beneath the skin as

insulation; goose bumps are vestige of hair-raising left over of our furry ancestors. Vasodilation and vasoconstriction also regulate heat exchange and may contribute to regional temperature differences within the animal. For example, heat loss from a human is reduce when arms and legs cold to several degrees below the temperatures of the body core, where most vital organs are located. Hair loses most of its insulating power when wet.

Marine mammals such as whales and seals have a very thick layer of insulation fat called blubber, just under the skin. Marine mammals swim in water colder than their body core temperature, and many species spend at least part of their year in nearly freezing polar seas. The loss of heat to water occurs 50 to 100 times more rapidly that heat loss air, and the skin temperature of a marine mammal is close to water temperature. Even so, the bubbler insulation is so effective that marine mammals maintain body core temperatures of about 36º - 38º C with metabolic rates about the same as those of land mammals of similar size. The flippers or tail of a whale or seal lack insulating bubbler, but countercurrent heat exchangers greatly reduce heat loss in these extremities, as they do in the legs of many birds.

Through metabolic heat production, insulation, and vascular adjustments, birds and mammals are capable of astonishing feats of thermoregulation. For example, the small birds called chickadees, which weigh only 20 grams, can remain active and hold body temperature nearly constant at 40º C in environmental temperature as low as -40ºC – as long as they have enough food to supply the large amount of energy necessary for heat production. Many mammals and birds live in places where thermoregulation requires cooling

off as well as warming. For example, when a marine mammal moves into warm seas, as many whales do when they reproduce; excess metabolic heat is removed by vasodilation of numerous blood vessels in the outer layer of the skin. In hot climates or when vigorous exercise add large amount of metabolic heat to the body, many terrestrial mammals and birds may allow body temperatures to rise by several degrees, which enhances heat loss by increasing the temperature gradient between the body and a warm environment.

Evaporate cooling often plays a key role in dissipating the body heat. If environment temperature is above body temperature, animal gain heat from the environment as well as from metabolism and evaporation is the only way to keep body temperature from raising rapidly. Panting is important in birds and many mammals. Some birds have a pouch richly supplied with blood vessels in the floor and of the mouth; fluttering the pouch increases evaporation. Pigeons can use evaporative cooling to keep body temperature close to 40º C in air temperatures as high as 60º C, as long as they have sufficient water. Many terrestrial mammals have sweat glands controlled by nervous system. Other mechanisms that promote evaporative cooling include spreading saliva on body surfaces, and adaptation of some kangaroos and rodents for combating severe heats stress. Some bats use both saliva and urine to enhance evaporative cooling.

Taking from Barrow's Orientation to the TOELF IBT.