Temp. regulation in homeotherms i.e. Birds & Mammals.

- Elephant 36oC, Man 37oc, Rat, Horse, Cow – 38oC, Cat, Pigs, Dogs, Sheep – 39oC
- Rabbit, Chicken – 41oc, Sparrow 43oC
- In general
- Monotherms }
- } 30 – 36oC
- Marsupials }
- Higher mammals have 36-38oC Birds 39 to 42oC

Heat production in homeotherms

1] Exergonic oxidative reaction

- **Food is oxidised to produce energy. These reactions are carried through out the life. Heat production is non-shivering type heat energy or thermogenesis.**
- **Ingestion of food – Casuses rise BMR & also lead to increase in temperature. This is known as specific dynamic action of food. Spicy food causes more rise in temperature.**

- **2] <u>Muscular contraction</u>**
- High muscular activity& exercises increases body temperature (tb)from 37o C upto 40 0C.
- **Shivering thermogenesis –** When exposed to cold, rapid muscle contraction is shown by the animals. It produces 16000 Kcal/m2/24hrs
- Ex. Man in 40C bath show 18 fold rise in heat production by shivering.

3] **Endocrine factors (are fast in action)**

- Non-epinephrine & epinephrine rise metabolic rate, therefore temperature increases.
- Thyroxins - (are slow in action)
- Hyperthyroidism – rises metabolic rate

  rises temperature by 0.50C
- Hypothyroidism – decreases metabolic rate decreases temperature by 0.50C

- **<u>Brown Fat</u> – B.A.T. – (Brown adipose tissue) a special tissue in mammals.**
- **Special thermogenic tissue found in new born mammals including man. Present in all new born mammals in cold region. It helps them to fight cold. Also present in hibernating mammals & helps them in Arousal.**

- **It produces heat by oxidizing fat and the heat production is so rapid, like a furnace.**
- **<u>Location</u> – found in neck & Thorasic region.**
- **It warms the heart & brain first.**
- **Then heat spreads through circulation.**

Difference between normal white fat and brown fat.

- White Fat
- → Cells round & small
- → Few fat droplets
- → Few vacuoles
- → Few mitochondria

- **B.A.T.**
- **→ Cells large, polygonal**
- **→ Numerous fat droplets**
- **→ Many vacuoles**
- **→ Numerous small mitochondria**
- **→ It also has high protein & phospholipids**
- **→It also has cholesterol, enzyme, myoglobins, flavin compounds, cytochrome and they give reddish brown colour**.

How BAT gets stimulated and releases energy?

Stimulus through sympathetic Adrenelgic nerves

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Secrete N Epinephrine

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Binds numerous receptors on BAT cells.
1,50,000/cell ! Therefore cells are very sensitive.

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ATP —(**ATPase**)→ **AMP (acts as 2nd messenger)** → **Mobilizes lipase**

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Free fatty acids(FFA)

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Oxidized in mitochondria &
& this leads to rise in O_2 consumption

- **<u>Heat loss</u> – It has to be regulated because at low temperature heat production has to be increased. Metabolic rate rises, food requirement rises. But food availability less due to winter.**
- **Therefore heat conservation has to be done. In different environment, heat loss is by different ways :-**
- **Aquatic life – conduction more**
- **Terristerial life – Evaporation – 40 %**

  Radiation - 55 %

- **At low temperature, heat loss is by conduction & radiation whereas at high temperature, heat gain is by conduction & radiation.**
- **Evaporative heat loss is always there i.e. 0.6 Kcal/gm evaporation of water.**
- **There are different mechanism to regulate heat loss.**

- **Mammals in hot environment increase sweating to raise evaporative heat loss. They also show panting to raise evaporative heat loss. Some mammals become nocturnal to avoid evaporative heat loss.**

- **Birds don’t have sweat gland. They tolerate hyperthermia (Tb 20C more warmer than mammals). They also show evaporation from respiratory surface & also from thoracic & abdominal air sacs.**
- **An experiment was done on Birds. The air sacs were inactivated which caused 50 – 60 % reduction in evaporation leading to hyperthermia.**

In hot air, pigeons show rise in tidal volume (i.e. volume of air / breath) which causes more evaporation & cooling.
For this purpose, air sacs are useful for pigeons.

Temp	Resp. Rate / min	Tidal Vol. / min.	Total air flow / min.
42^0C	46	4	184 ml/min.
44^0C	51	12	612 ml/min

- **Birds show panting & <u>Gullar</u> <u>fluttter</u>. (Rapid movement of floor of mouth & throat). By this they achieve cooling by evaporation.**
- **Storks & Egrets dip legs in water. In storks they often urinate on legs (1 urination / min).**

In cold environment insulation is useful to prevent heat loss.
Birds have feathers & mammals have hair.

- **Mammals adjust their coat thickness. the coat is thicker in winter & thinner in summer. They even change their colour.**
- **Mammals in temperate region have thicker fur.**
- **Small animals can’t have thick fur.Therefore shelter in burrows e.g. Mice.**
- **Some mammals have naked skin like pigs, whales and walrus. But they have a thick fat layer below skin which has low melting point , so it remains in fluid condition in low temperature also.**
- **The Eskimos use this fat & apply it to their shoes to keep it soft. This fat acts as insulator & also as source of energy.**

- **The animals living in cold environment have skin which is resistant to cold & the sensitivity of skin is lower due to fat deposition. But still the nerves are sufficiently sensitive.**
- **Eg. Pigs remain comfortable at 80C but man becomes uncomfortable at 310C . In seal when skin is at 00C, 5 cm below the body is warm.**
- **In Whales fat layer is present called as Blubber for body heat regulation**.

- **Arctic fox has thick fur & is comfortable at –400C. This insulation which protects the animal during cold becomes a problem when the animal is active and warmed up because it prevents heat loss.**
- **During metabolic activity, metabolism is fast so more heat is produced which has to be given out.**

- **For this purpose animals have thinly insulated extremities.**
- **In Arctic fox, legs are thinly insulated so while sleeping it curls up to cover the legs.**
- **When active, heat is given out through the legs.**
- **In Gulls, Arctic dogs & Reindeers have extremities thinly insulated.**
- **- But they can tolerate cold**
- **- Remain sensitive**
- **- Remain flexible (low M.P. fat)**

- **Rete Mirabile**
- **Arterial blood gives heat to cool venous blood which is going in body therefore heat is conserved. During activity fast circulation through rete mirabile therefore useful in going out heat.**

Figure

- **In JackRabbit, external ears are big which help in giving out heat in summer. But in cold environment circulation is reduced in the ears.**
- **In cold environment, X-Ray of ears looks black**
- **In hot environment, X-Ray of ears looks bright**

Thermostat (Regulator)

In mammals – Hypothalamus

In Birds – Spinal cord

Anterior hypothalamus protect against heat. Post hypothalamus protect against cold.

Stimulii from different parts of the body are received.

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Messages to body through effector nerves. Message is also sent to Autonomous nervous system which controls sweat gland, cutaneous blood flow, pilo erection.

Even if Autonomous Nervous System is damaged, blood vessels respond to lower blood temperature.

In cold, the Blood vessels contract & in hot , the Blood vessels expand.

When there is prolonged change in Ta

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It Stimulates endocrine system.
(Thyroid) – long term effect.
(adrenal) – short term effect.

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In cold, secretion rises
In hot, secretion decreases

Affect Metabolic rate to regulate temperature. Animals extreme cold show adaptation of body i.e. C.N.S. tolerate & functions at low Ta. Nerve Axons, heart also tolerant & functional at low Ta.