

Lecture 20



Energy exchange and methods of its research. Body temperature and regulation of its stability

Substance & energy exchange

- Anabolism – biosynthesis of complex substances of the cell
- Catabolism - breakdown of complex molecules to form simple substances

Basal Metabolic Rate (BMR)

- **Total intensity of exchange processes measured at the state of rest**

STANDARD CONDITIONS TO MEASURE BMR

- 1. IN THE MORNING (after waking up)**
- 2. AFTER 12-16 hours FASTING**
- 3. AT THE STATE OF PHYSICAL REST (in the lying posture)**
- 4. AT THE STATE OF MENTAL & EMOTIONAL REST**
- 5. IN COMFORTABLE TEMPERATURE (18-22°C for dressed body. 25-26°C for naked)**

FACTORS INFLUENCING BASAL METABOLISM

- 1. AGE**
- 2. SEX**
- 3. HEIGHT**
- 4. WEIGHT**

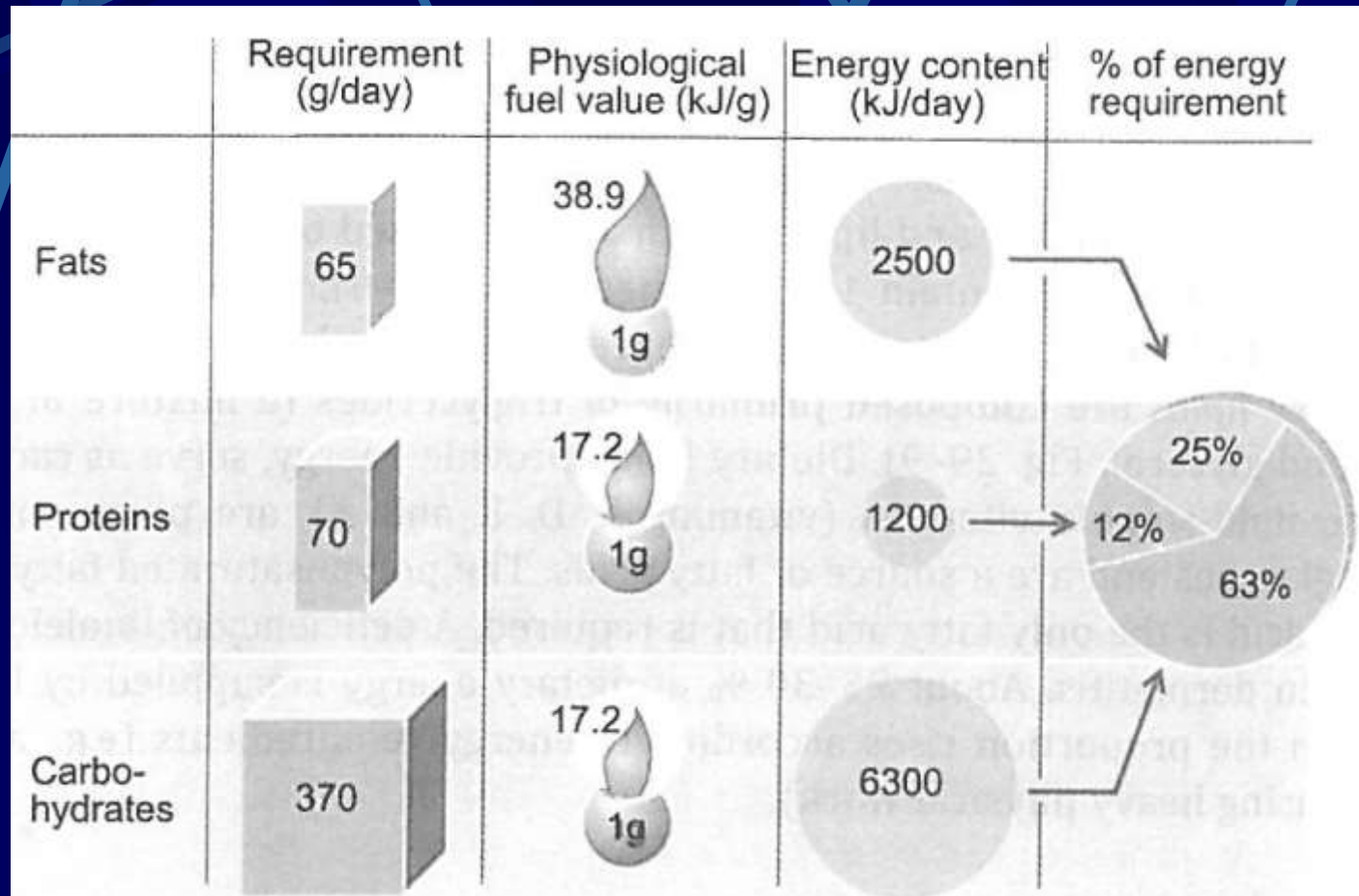
**PROPER BASAL METABOLISM (TO BE
DEFINED BY THE TABLES)**

**WORK ALLOWANCE - energy spent
above basal metabolism to perform
work**

Energy value of food substances

Substance	RQ	CV Kcal	Heat of combustion value (kcal)
PROTEINS	0,6- 0,8	4,46 - 4,8	4,1
FATS	0,7	4,7	9,3
CARBOHYDRATES	1	5,05	4,1
MIXED FOOD	0,86	4,86	

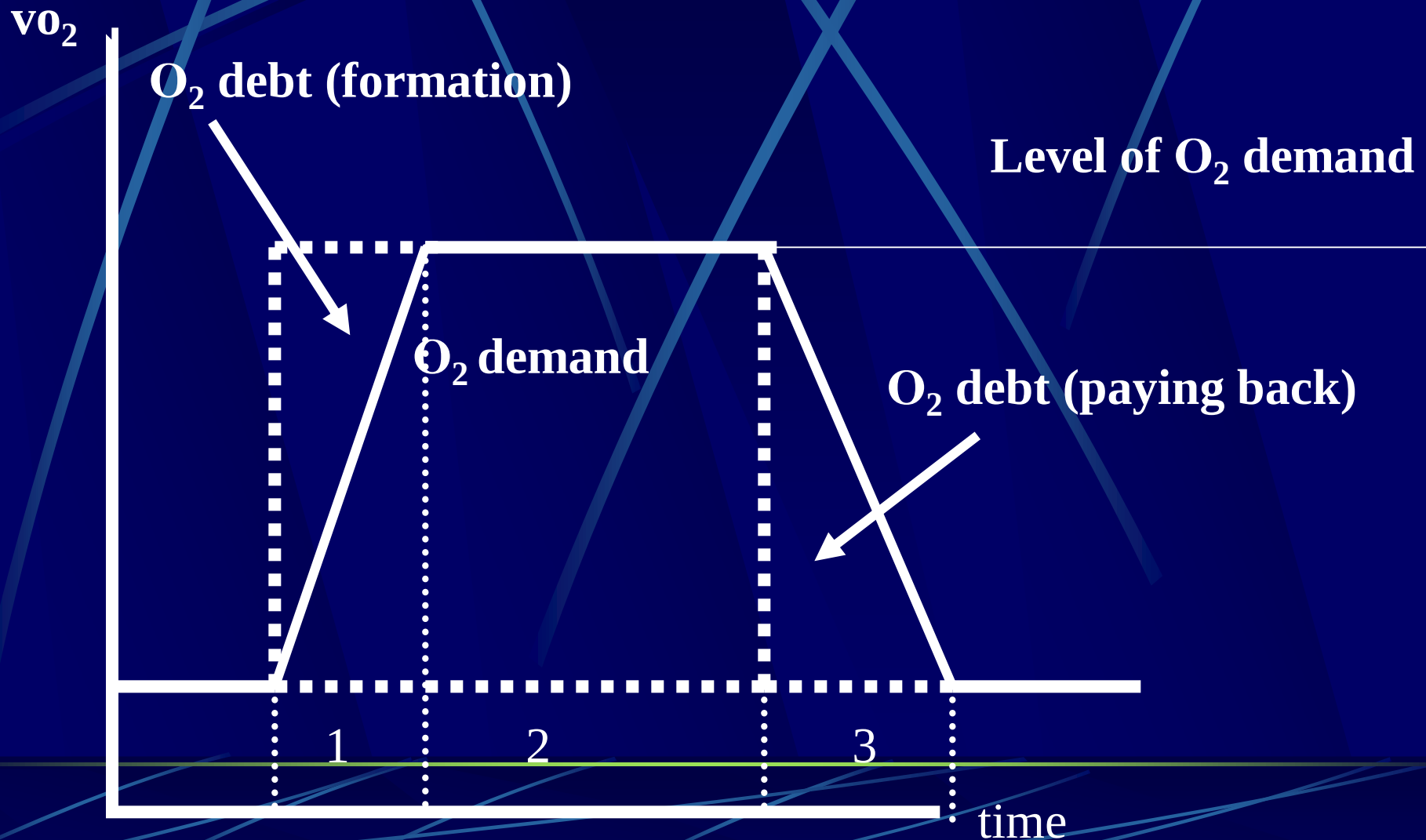
Daily energy requirement and the energetical content of the foodstuff (by Moroz)



RECOMMENDED PROPORTIONS OF NUTRIENTS



Dynamics of metabolism at work





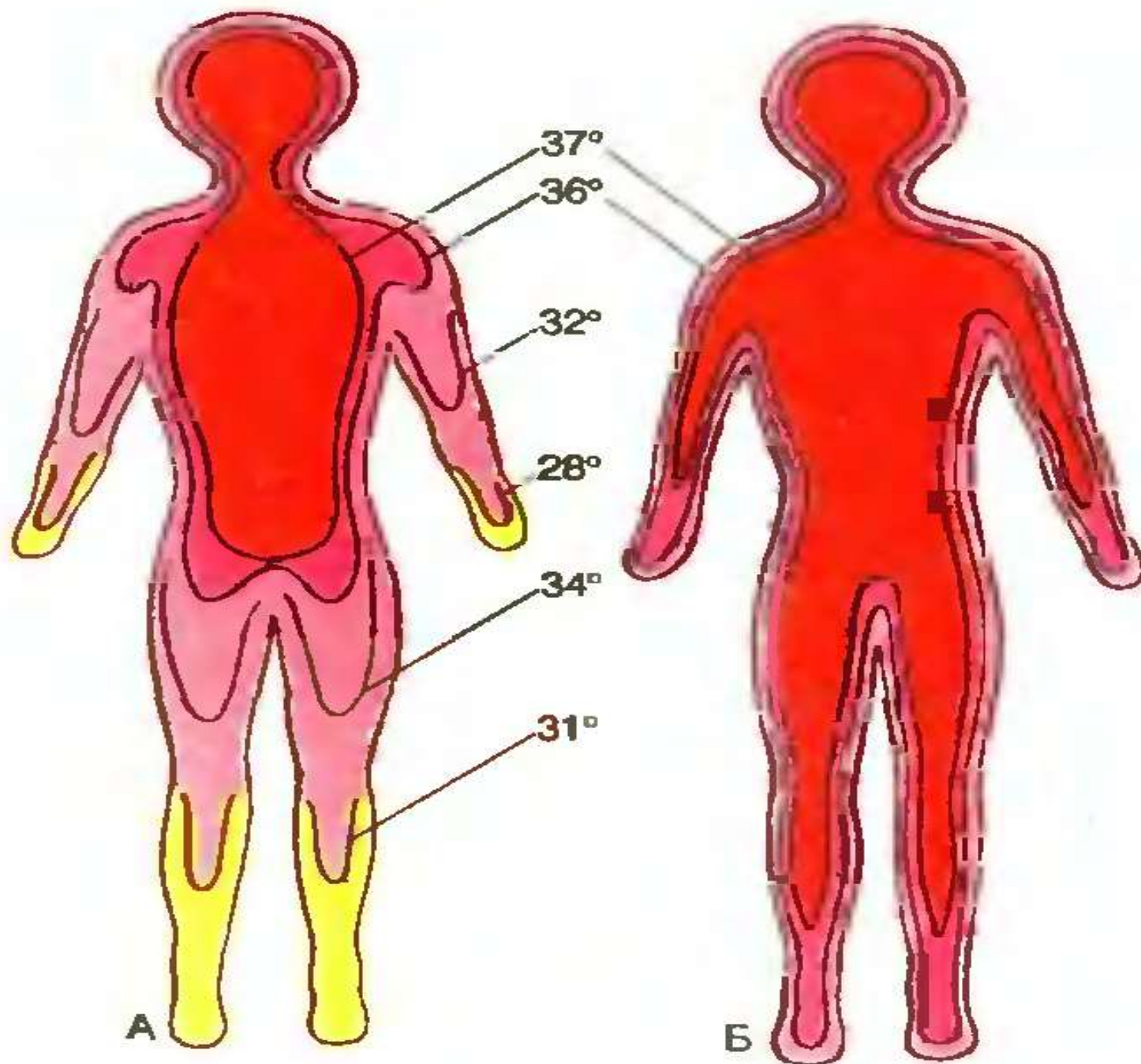
TERMOREGULATION

Homoiotherm vs poikilothermy

- The body temperature of humans remains relatively constant despite changes in the environmental temperature.
-
- Such constancy defines as *homoiothermy* applies only to the *core temperature* (appr. $37 \pm 5^\circ \text{C}$) of the body. Within this range, there are individual differences and diurnal variations.
- Important to note that *core temperature* reaches its highest point in late afternoon and evening and lowest point in the early morning hours. The opposite situation means that some cold-blood animals live with the real *poikilothermy* that means that body temperature closely depends upon the surrounding temperature.

● «Shell» - skin, adipose tissue
poikilothermic

● «cor» - internal organs, skeletal
muscles
homoiothermic



External environment

Temperature, humidity, wind

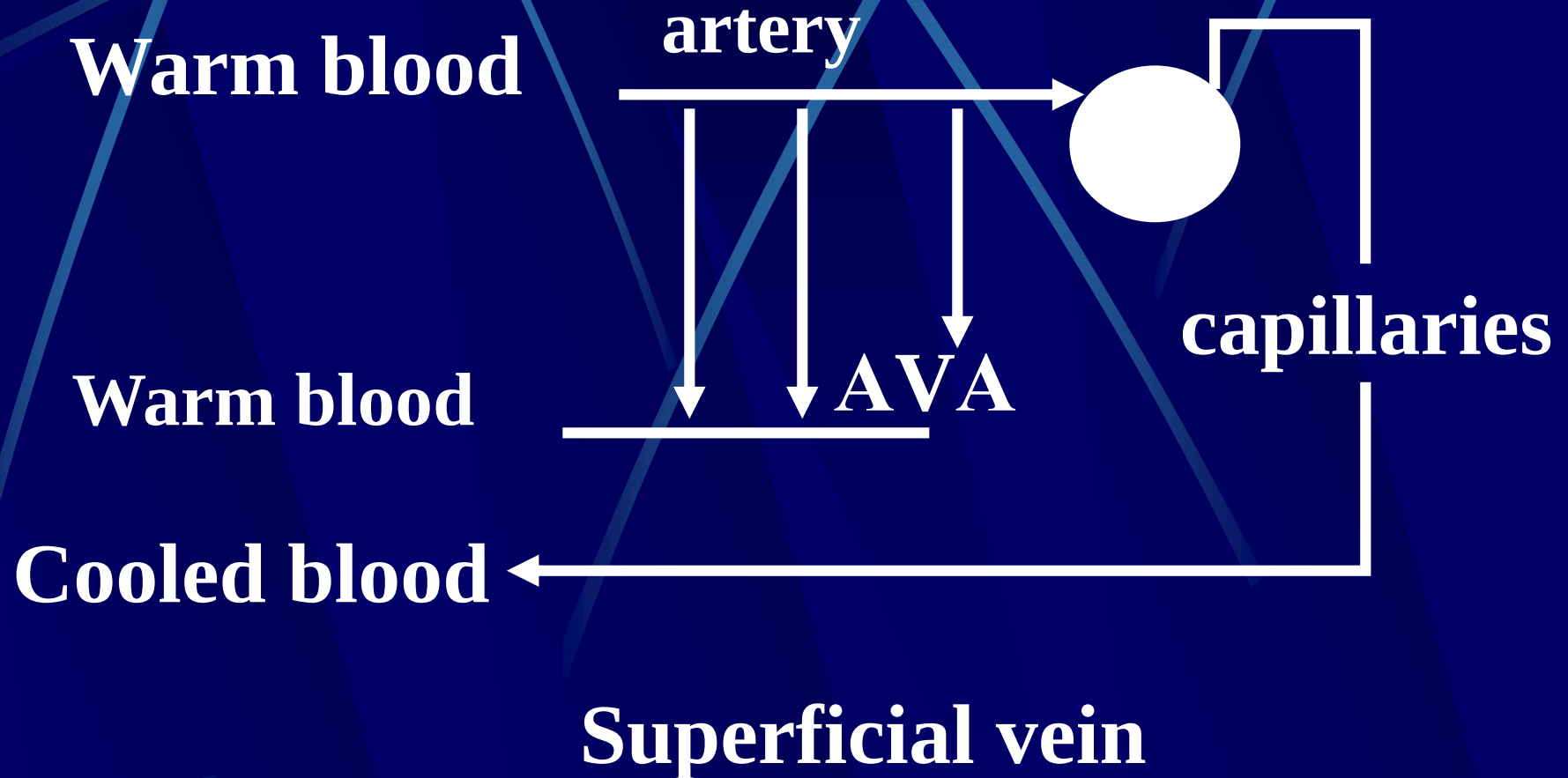


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graph TD; A[External environment  
Temperature, humidity, wind] --> B[Shell temperature]; C[Intensity of heat transport  
from nucleus] --> B;
```

Shell temperature

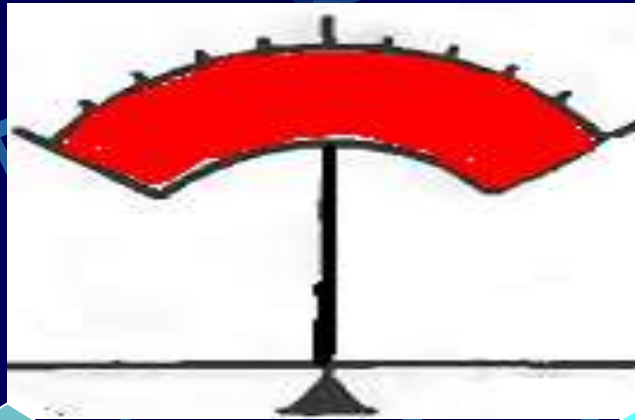
**Intensity of heat transport
from nucleus**

Role of skin vessels in thermoregulation



37°C

**Chemical
termoregu
lation**



36°C

**Physical
Termoregu
lation**

**Cell
metabolism**

**Radiation
Convection
Conduction
Vaporation**

ISOTHERMIA



PHYSICAL THERMOREGULATION

WAYS OF HEAT LOSS

- 1) **RADIATION** – *heat is given off by the skin directly into the air or to the objects immediately in contact with its surface (66%)*
- 2) **CONVECTION** – *heat release in the process of water or air movement(15%)*

WAYS OF HEAT LOSS

- 3) **CONDUCTION** – *heat is lost at the contact of the body with some substance (e.g.clothing)*
- 4) **EVAPORATION** *with the sweat glands (19%)*



Chemical Thermoregulation

Heat production

muscles during contraction



Skeletal muscles

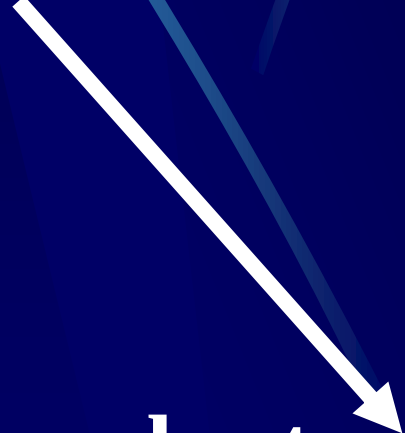


Muscular tone



Shivering

voluntary
movements



Heat production

Thermogenesis without muscular contr.

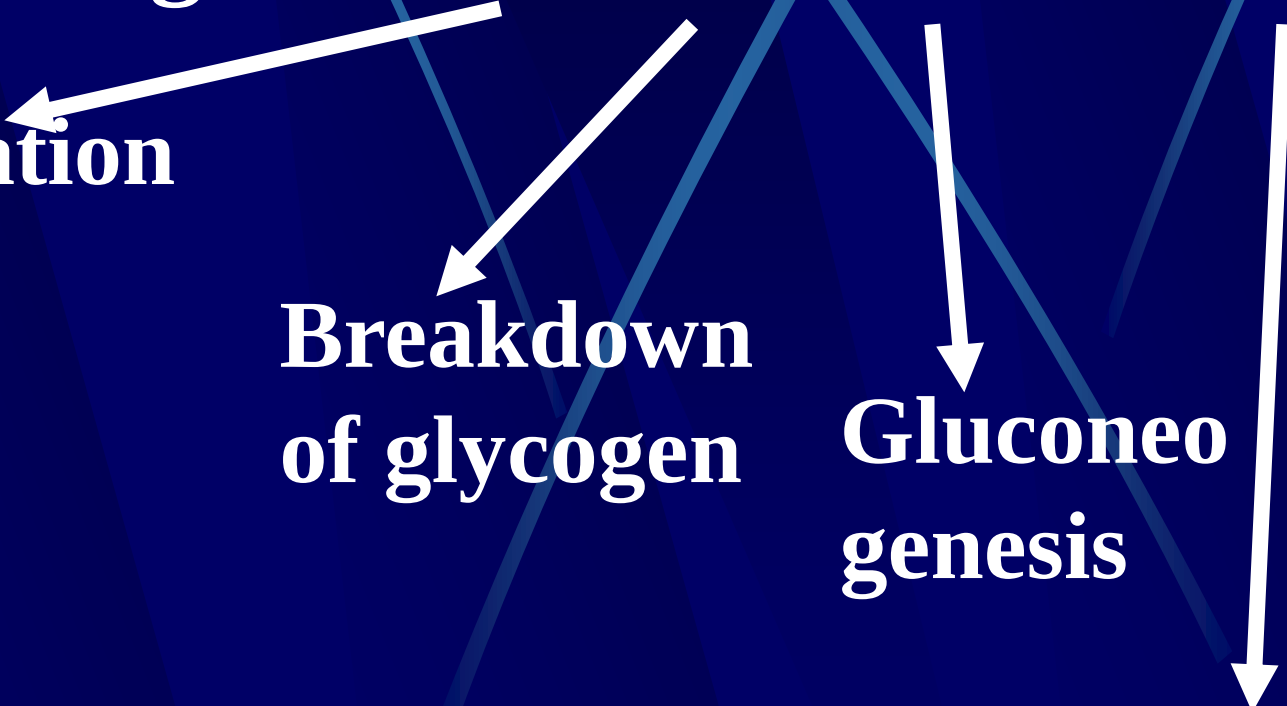
Oxidation

Fatty
acids

Breakdown
of glycogen

Gluconeogenesis

Oxidation increase



Skin thermoreceptors

- Cold receptors - Krause - are free nerve endings in the basal (germ) layer of the epidermis.
- They play an important role in protecting the body from hypothermia.

Skin thermoreceptors

- Heat receptors - Ruffini's - free nerve endings in the papillary dermis.
- There are more cold receptors than heat receptors

Skin thermoreceptors

- Cold range from 20 to 40 C
- Heat range from 25 to 47 C

Heat production

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graph TD; A[Heat production] --> B["The temperature of 'Core' (homeostatic parameter)"]; C[Heat loss] --> B;
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A diagram on a dark blue background with light blue diagonal lines. It features three text elements: 'Heat production' at the top left, 'The temperature of "Core" (homeostatic parameter)' in the center, and 'Heat loss' at the bottom right. A white arrow points from 'Heat production' to the central text, and another white arrow points from 'Heat loss' to the same central text.

**The temperature of
“Core”
(homeostatic parameter)**

Heat loss



The end

