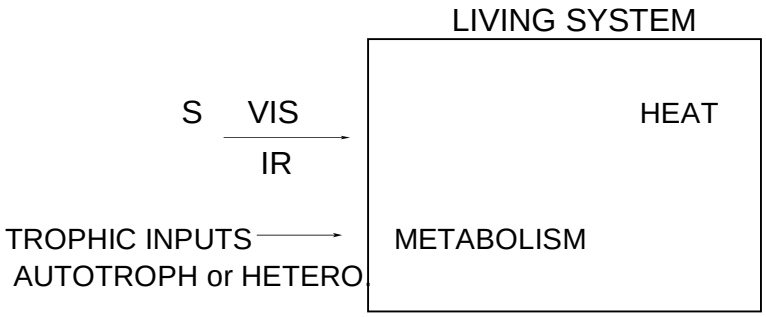
I. ENERGY INPUT-OUTPUT IN "GENERALIZED ORGANISM"



A. INPUTS

1. RADIATION –

2. TROPHIC INPUTS –

B. METABOLISM –

C. OUTPUTS -- R, C, L, IR, V, Excretion (Heterotroph)

> GENERAL RELATIONSHIP: $\text{FLUX} \propto \frac{\text{DRIVING FORCE}}{\text{RESISTANCE}}$

II. ENERGY OUTPUTS

A. REFLECTION -- depends upon surface properties; implications?

B. CONDUCTION -- energy transfer through molecular collisions

e.g. SKIN to AIR, or FOOT PADS to SOIL, or BODY to BODY

RELATIONSHIP: $Q_c = kA \frac{(T_b - T_a)}{d}$

Q_c = heat loss (Watts)
k = thermal conductivity
T_b = body core temp.
T_a = air temperature
A = area (cm^2)
d = distance (cm)

C. CONVECTION -- energy transfer via a moving fluid (gas or liquid)

1. SKIN or LEAF to AIR

2. BOUNDARY LAYER (BL) = shell of air influenced by the body it surrounds

>> What factors influence boundary layer thickness?

RELATIONSHIP: $$Q_L = kA \frac{(T_s - T_a)}{d}$$

Q_L = heat loss (Watts)
k = convection coeffic.
T_s = body surf. temp.
T_a = air temperature
A = area (cm^2)
d = distance (cm) (boundary layer thickness)

D. RADIATION -- release of energy as electromagnetic waves thru space

1. DEPENDS on the BODY TEMPERATURE AND ITS EMISSIVITY (not on air)

2. RADIATION is proportional to "fourth power" of TEMPERATURE

E. VAPORIZATION -- heat loss though change of water from liquid to vapor

1. 2450 joules/gram of water (540 cal/g)

2. Major route of heat loss from organisms

e.g. TRANSPIRATION, E = $$\frac{(c_l - c_a)}{(r_l + r_a)}$$

E = transpiration rate
c_l = vapor conc. in mesophyll
c_a = vapor conc. outside BL
r_l = leaf diffusion resistance
r_a = bound. layer resistance

or, TRANSPIRATION, E = $$A \frac{(\Psi w_{leaf} - \Psi w_{air})}{(r_l + r_a)}$$

E = transpiration rate
Ψw = water potential
r_l = leaf diffusion resistance
r_a = bound. layer resistance
A = transpiring surface area