Equilibrium, Energy Conservation, and Temperature

Chapter Objectives

1. Explain thermal equilibrium and how it relates to energy transport.

2. Understand temperature ranges important for biological systems and temperature sensing in mammals.

3. Understand temperature ranges important for the environment.

1. Thermal equilibrium and the Laws of thermodynamics

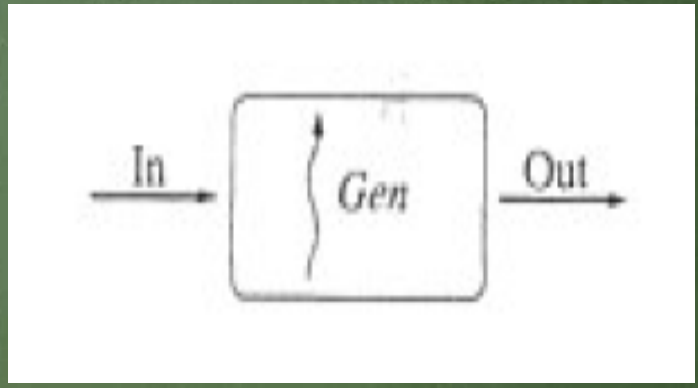
Laws of Thermodynamics

Energy of the system
+
Energy of surrounding
= Constant

⇨ Energy Conservation

1. Thermal equilibrium and the Laws of thermodynamics

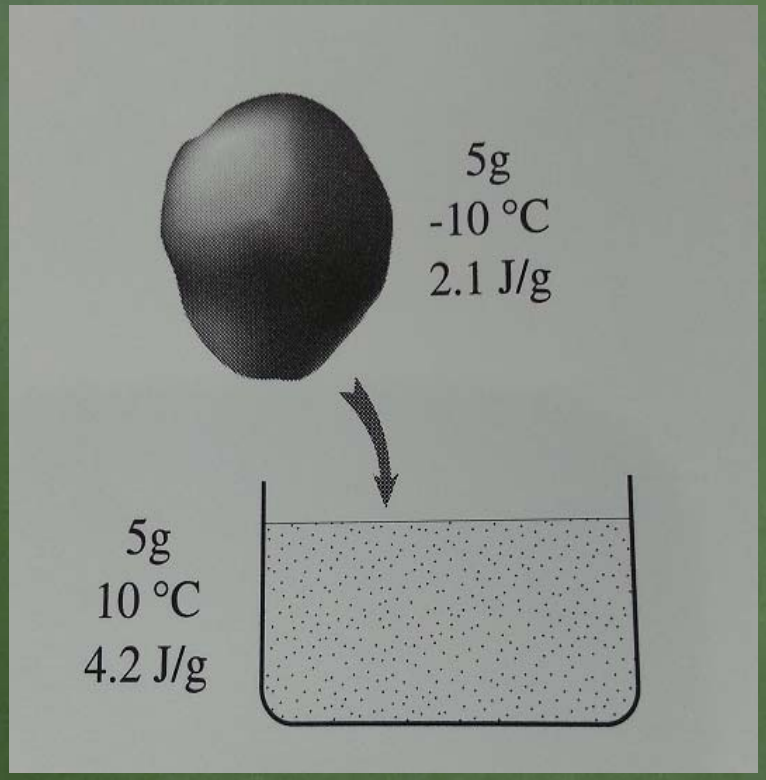
- Energy conservation



Rate of Energy In − Rate of Energy Out + Rate of Energy Generation = Rate of Energy Storage

1. Thermal equilibrium and the Laws of thermodynamics

Ex) Solid is put in the liquid.



	mass	specific heat	temperature
Solid	m_1	C_{p1}	T_1
Liquid	m_2	C_{p2}	T_2

Energy = $mC_p(T - T_{ref})$

1. Thermal equilibrium and the Laws of thermodynamics

Energy In = $m_1 C_{p1}(T_1 - 0)$

Energy Out = 0

Energy Generation = 0

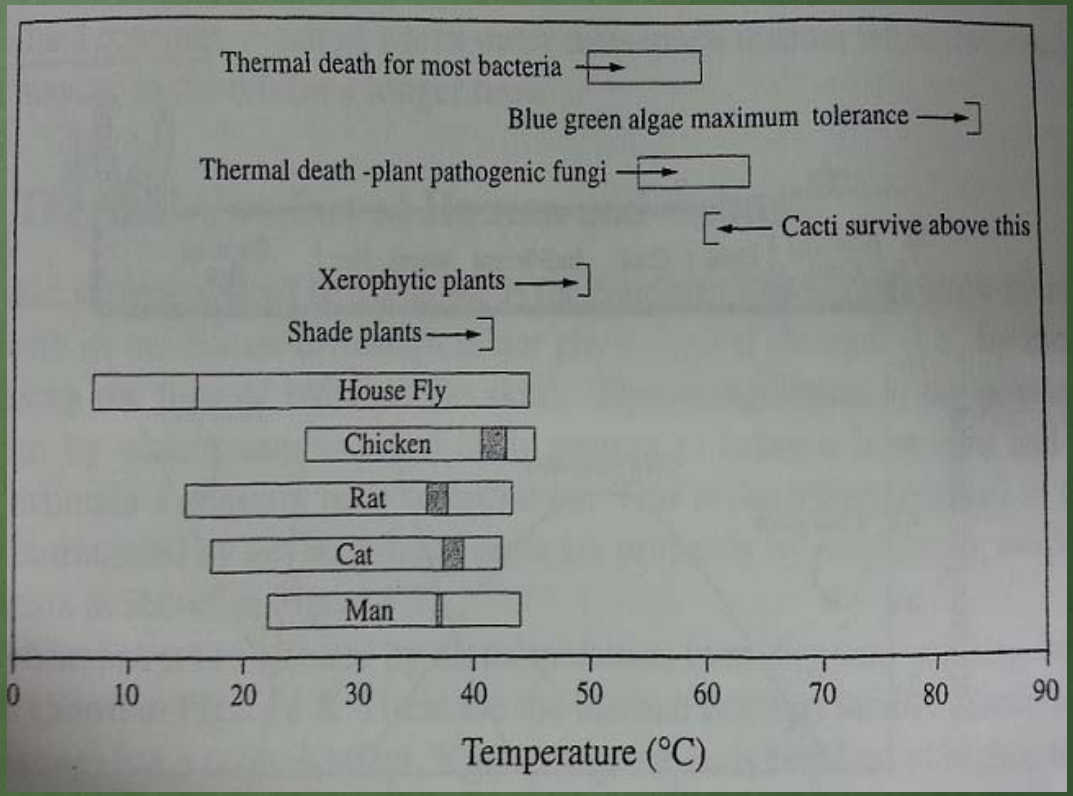
Energy Storage = $(m_1 C_{p1} + m_2 C_{p2})(T - 0) - m_2 C_{p2}(T_2 - 0)$

>> Use the numerical values as shown in last page's picture and equation of energy conservation.

⇨ Using energy conservation, we can find the final or equilibrium temperature.

2. Temperature in Living System

Most biological activity is confined to a rather narrow temperature range of 0~60℃

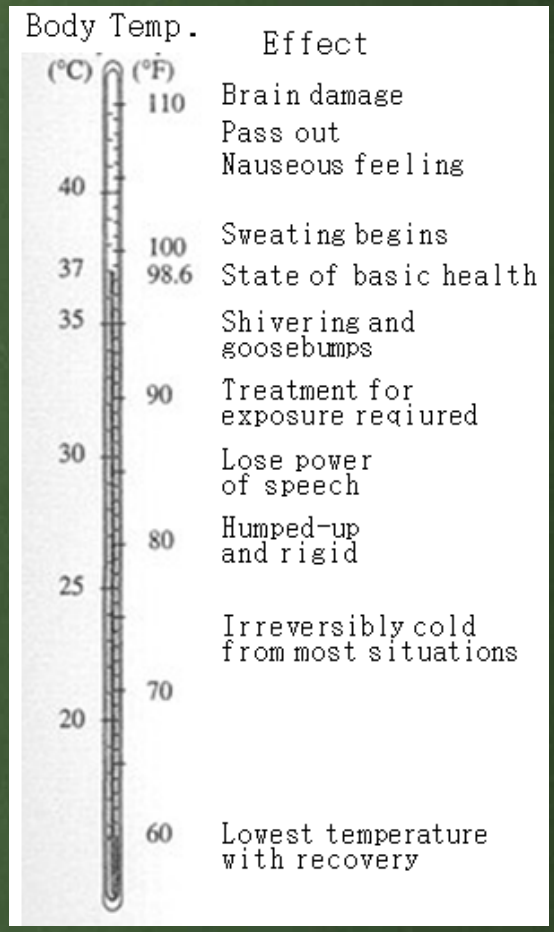


2. Temperature in Living System

Temperature Response to Human body

How temperature affects the state of human body?

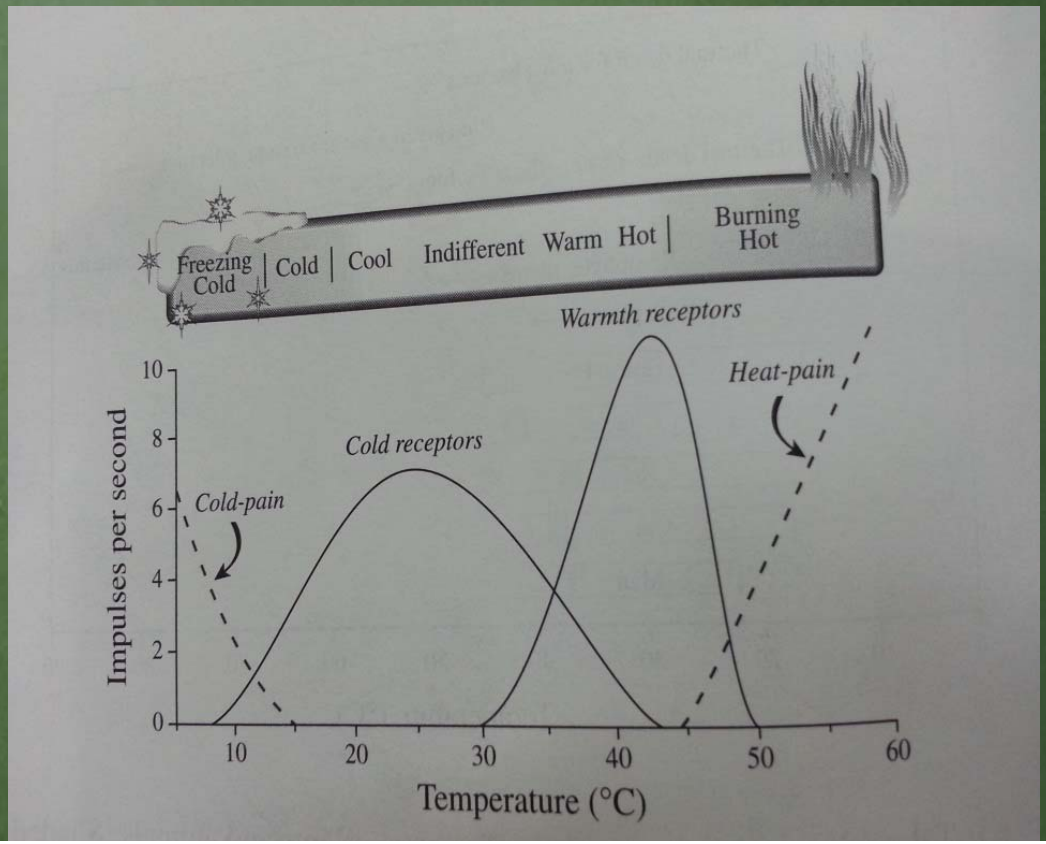
- As shown in this picture, it is obvious that temperature needs to be controlled.



2. Temperature in Living System

Temperature Sensation in Humans

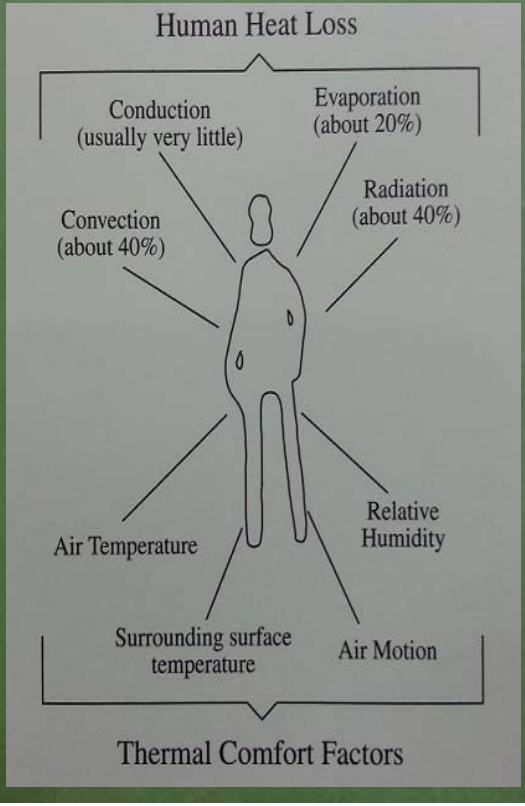
- The human being can perceive different gradations of cold and heat, as shown in this picture.

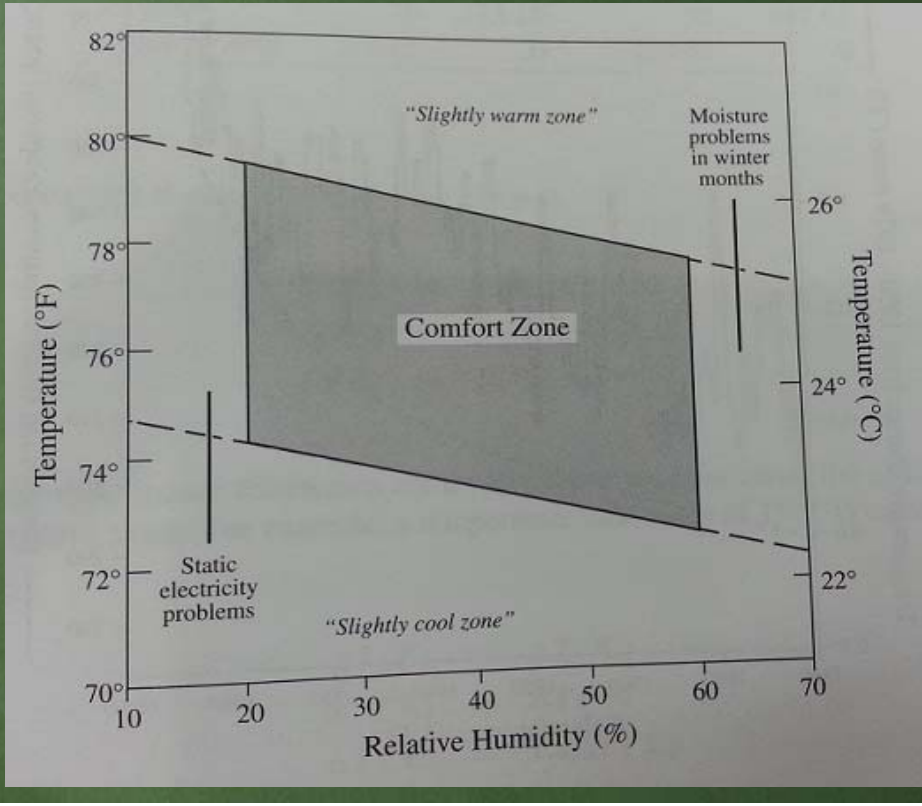


2. Temperature in Living System

Thermal Comfort of Human and Animals

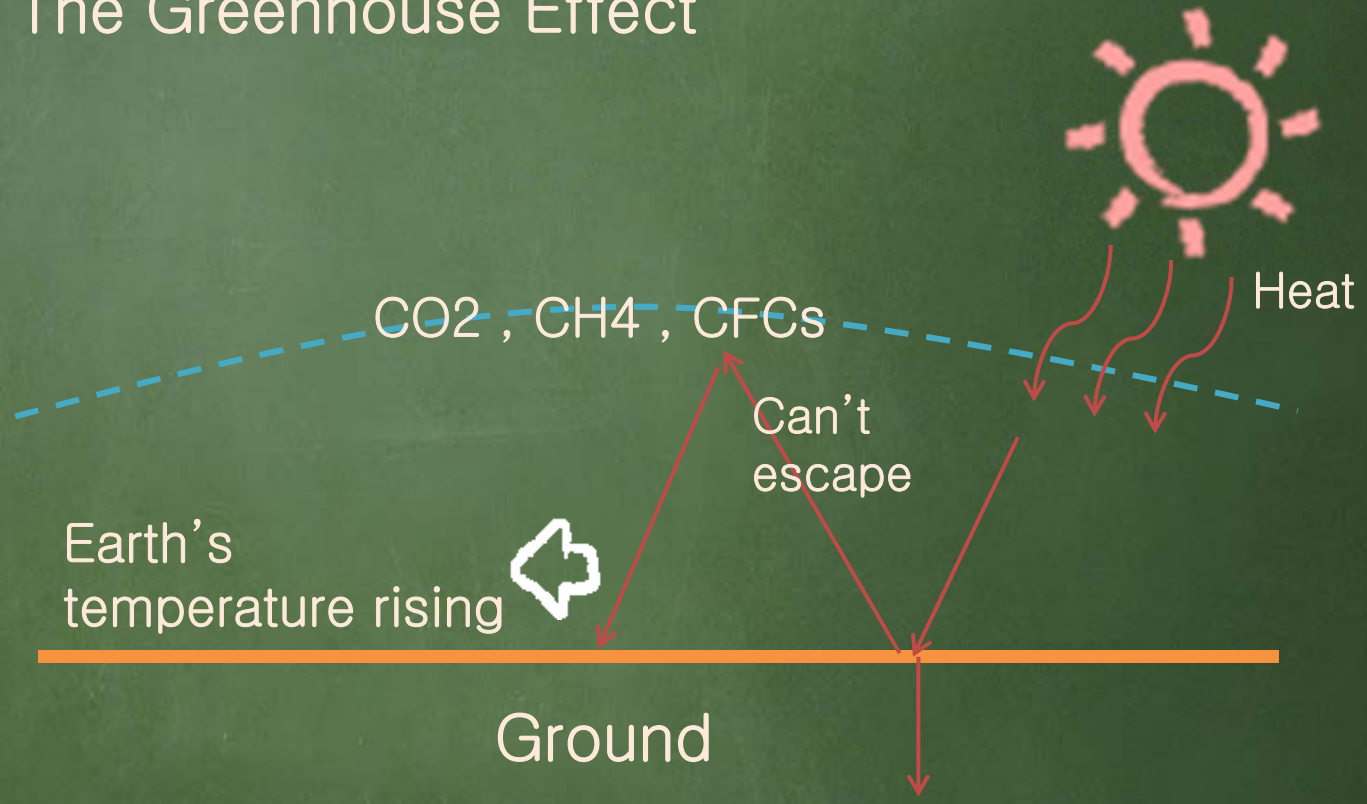
- Body heat losses are affected by air temperature, humidity, velocity and other factors.
- Especially, affected by humidity.





3. Temperature in the Environment

The Greenhouse Effect



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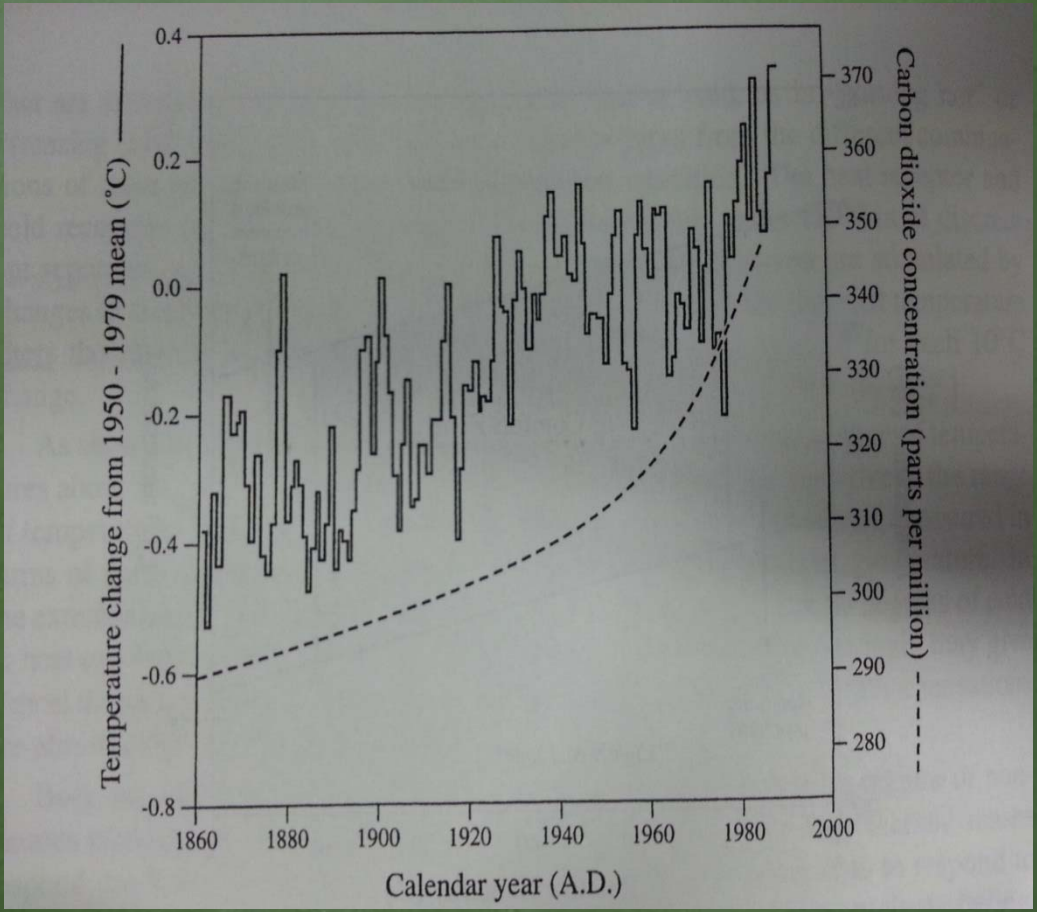

History of carbon dioxide concentration and global temperature change for recent times

4. Temperature Scales

Relationships between the scale

$$T(°F) = 1.8T(°C) + 32$$

$$T(K) = T(°C) + 273.15$$

$$T(°R) = T(°F) + 459.67$$

	Celsius(℃)	Kelvin(K)	Fahrenheit(°F)	Rankine(°R)
Steam point	100	373.15	212	671.67
Ice point	0	273.15	32	491.67
Absolute zero	-273.15	0	-459.67	0

5. Further Reading

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