Body - Building - Climate

To understand the climatic function of a building we need to understand both the body and the climate as the building mediates between the two.

Body Metabolism

- ‘Biological machine’. Which produces excess heat, while burning food as ‘fuel’ for energy to live.

- Interior body temperature: 98.5°F
Basic principles: Thermal energy

- Heat (Temperature, Mass, Heat capacity)
  - °F / °C / K
  - Sensible Heat (Temperature and Mass)
    - 1 BTU is needed to raise the temperature of 1 pound of water by 1°F
  - Latent heat (BTU needed for status change)
    - 144 BTU to melt ice!
      - Effect of Evaporative cooling (sweating)
      - Principle of refrigerator
  - Heat transport
    - historic: hot water bottle
    - now: forced convection

Basic principles: Heat transfer

- Conduction (cold cloth and fever)
- Convection (breeze)
- Radiation (cool down in the shade)
  - Radiant heat or infrared (part of the electromagnetic spectrum)
    - Net radiant flow from hot to cold objects through air
- Evaporation (sweating / water on face)

- Heat transfer medium
  - Air
  - Water
    - Difference in heat-holding capacity
Thermal conditions of the environment

- Air temperature: comfort range 68°F - 78°F
- (Relative) Humidity
- Air velocity (feet/minute)
- Mean radiant temperature (class room example)

Air at different temperature can dilute different amounts of humidity as air gets warmer it can hold more moisture.
- Psychrometric CHART as a function of air temperature and humidity

**Figure 4.5a** Each point on the psychrometric chart represents the properties of air at a particular temperature and moisture level. At point A, for example, the air sample has a temperature of 80°F, a relative humidity of 40 percent, and an actual moisture content of about 0.009 pounds of water per pound of dry air.
Thermal comfort

‘the condition of mind, which expresses satisfaction with the thermal environment.’

ASHRAE Standard 55-66
Thermal barrier / mediator

- Skin
- Clothing Measured as CLO Factor
  - Custom
  - Fashion
  - Common Sense
- Building
  - Create a comfortable environment inside the building

Climate Design

Climate = average weather

Macroclimate and Microclimate

Microclimate is Site specific (trees, mountains, cities, rivers, lakes etc)
Climate Design

- Climate - climate zones
  - Design for the seasonal average
  - Mind the extremes
  - Concentrate on dominant seasonal energy period
  - Look at indigenous / traditional CONCEPTS
- Human Comfort zones / Psychometric Charts
- Thermal and other Design standards
- Resources
  - Energy
  - Water
  - Materials

Day and Night

- Influence of clear and overcast skies
- Humidity in the air and radiation
Hot arid - Phoenix

- Warm and cool winter
- Warm fall and spring
- Hot and dry summer up to 115º

Design technique
- Sun Protection essential
- Little to no passive solar
- Big overhangs
- Ventilate under roof
- Can use evaporative cool
- Place heavy mass into buildings
- Set windows deep into the building

- Big day gain / night loss
- Loose clothing
Hot humid - Louisiana, Florida

- Warm winter
- Warm humid spring
- Hot humid summer
- Warm humid fall

- Design techniques
  - Ventilate roof
  - Ventilate floor / ventilate through the floor
  - Active solar for hotwater
  - Loose fitting clothing
Cold - Minneapolis

- Severely cold winters
- Cool springs
- Mild summers
- Long but cool autumns

Design techniques:
- Cocoon, minimal exposed skin, high Clo value
- Layered look
- Watch the indoor air quality
- Edge of passive solar in winter
- Wind breaks
- Superinsulate
- Snowload
- Snowinsulation
Mountain climate - Aspen

- Cold winters
- Cool springs
- Warm and dry summers (hot)
- Warm autumns

- Design techniques
  - Great for passive solar
  - No other heat needed
  - Good mass
  - Windows as desired
Temperate region - Iowa / NY

- Cold winters
- Spring is rainy & windy / cool
- Summer is hot and humid (not in Europe)
- Fabulous autumns

Design techniques:
- Insulate well
- Deciduous trees
- Good for passive solar
- South glass
Examples: Alvar Aalto: Viipuri Library

- Hybrid system:
  - > a combination of active and passive environmental control systems