

Radiation

- Radiation across a variety of wavelengths
- Temperature affects amount and wavelength of radiation
- For a given substance:
 - **Emissivity** – ability to emit radiation
 - **Reflectance** – ability to reflect radiation.
 - **Absorptivity** – ability to absorb radiation
- All of these vary by wavelength

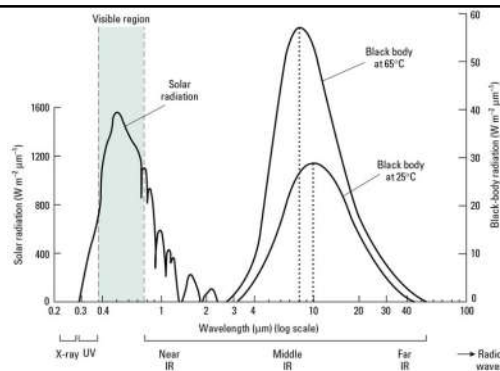


Table 8.9 Emissivities and reflectances of various materials.

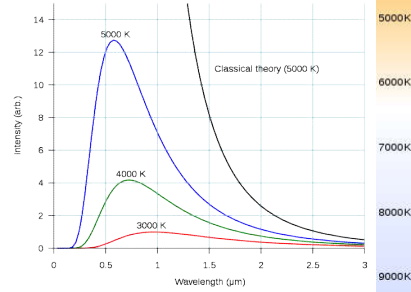
Material	Emissivity	Reflectance (%)
Water	0.95	
Cork	0.95	
Glass	0.94	
Wood	0.90	
Ice	0.92	
Steel	0.07	
Aluminium	0.20	
Copper	0.03	
Insect cuticle		
Black matt		2-5
Black shiny		4-23
Pale colours		5-25
White		10-35
Snail shell		
Dark		2-30
White		95
Human skin		
'Black'		5-9
'White'		5-10

Perfect Black Body

- Emissivity, reflectance and absorption assessed in comparison to a black body that absorbs and emits perfectly on all wavelengths

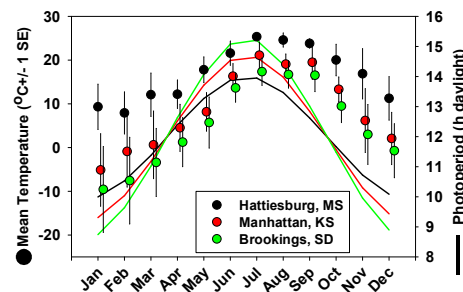
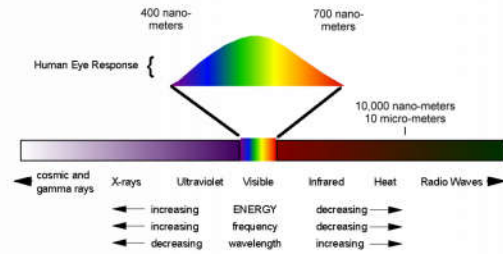


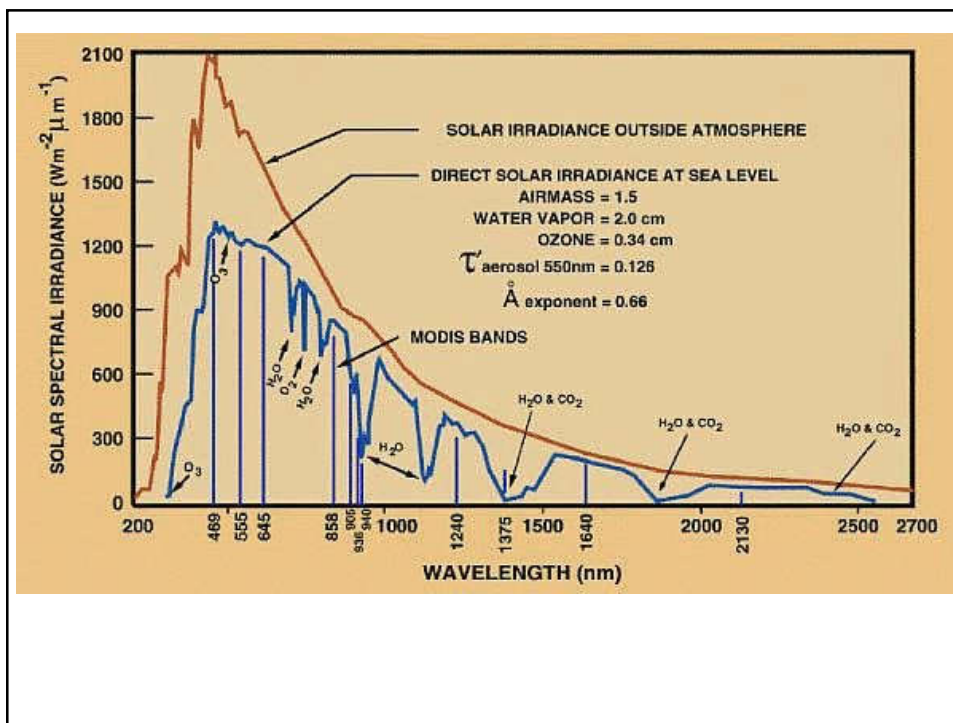
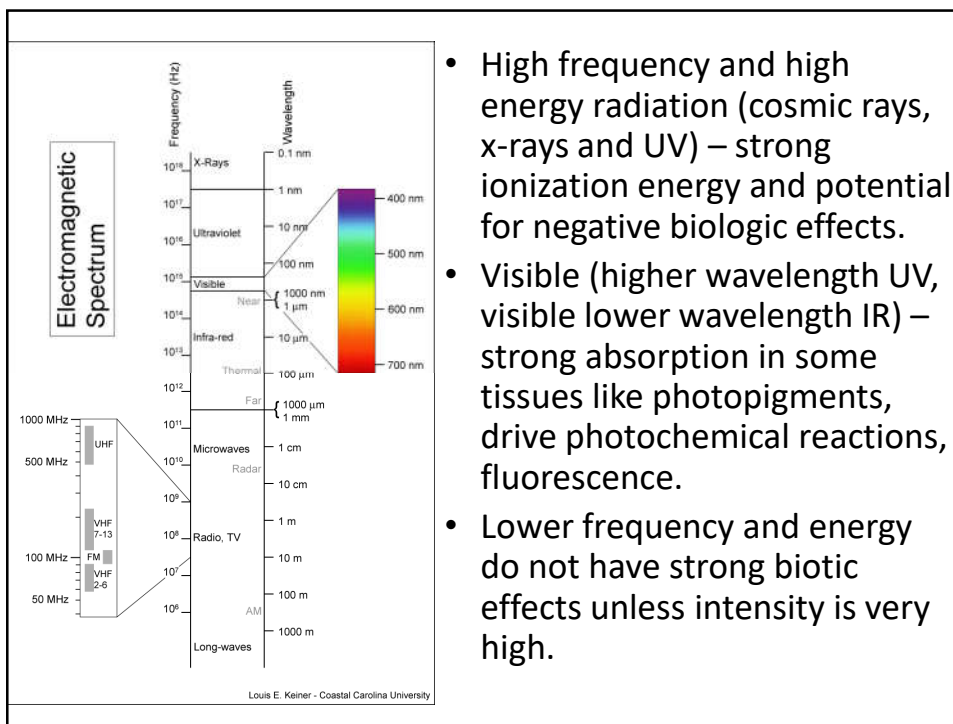
- Color depends on temperature
- Structural color



Radiation

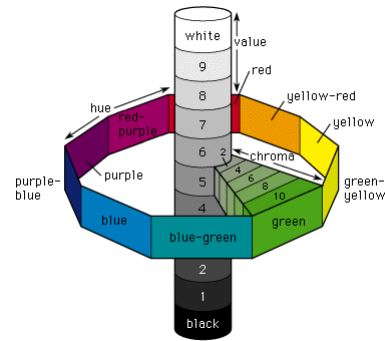
- Electromagnetic spectrum
 - Intensity, wavelength
 - Duration and photoperiod
- Sources of variability
 - Absorption (air, water)
 - Altitude – Hopkin’s Law – 1 deg latitude = 122 m altitude
 - Seasonality





Perception of light

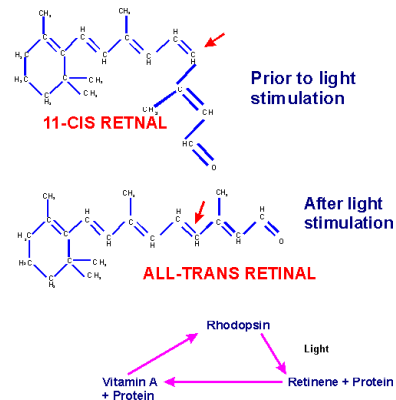
- Photoperiod as a measure of seasonality (**pineal gland** and **melatonin**)
- What is color?
 - Chroma – “purity” of color
 - Hue – dominant or characteristic wavelength
 - Intensity – amount of light
- Color vision – highly variable, independently evolved
 - Tradeoff: vision in low intensity (night vision, no color) and high resolution of wavelengths (daytime color vision)



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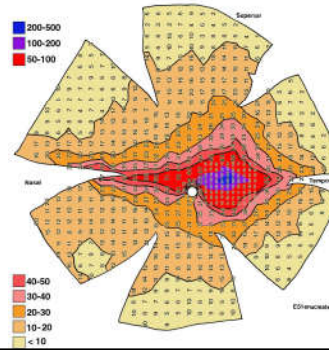
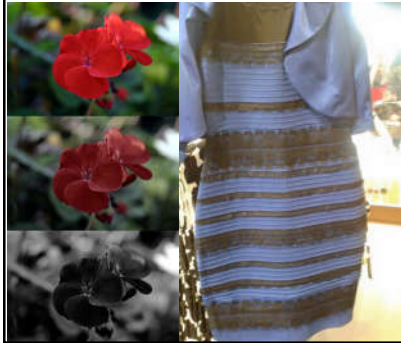
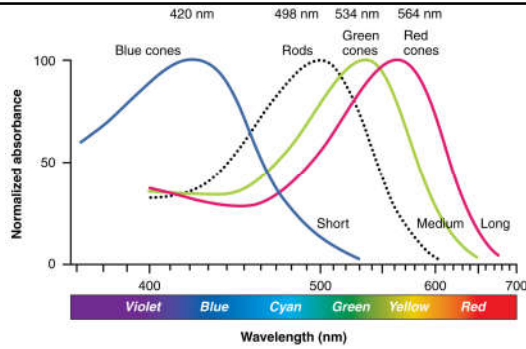
Color Vision

- **Opsins** – light sensitive membrane bound proteins. Gene family = sensitivity to different wavelengths.
- Vertebrates: 3-4 pigments common
 - Some UV sensitivity
 - Some polarized light vision
 - E.g. goldfish 380 nm, 460 nm, 540 nm, 660 nm and polarized
 - Extraretinal receptors in many reptiles
- Invertebrates
 - UV and polarized light common
 - IR extraretinal structures common
 - E.g. mantis shrimp – 16 pigments including UV, IR. Polarized light and stalked eyes for 360° view



Purkinje Effect/Shift

- Rods and Cones have different levels of light sensitivity.
- At lower light levels, sensitivity shifts to blue.



Radiation and Thermoregulation

Thermoregulatory significance of wing melanization in *Pieris* butterflies (Lepidoptera: Pieridae): physics, posture, and pattern

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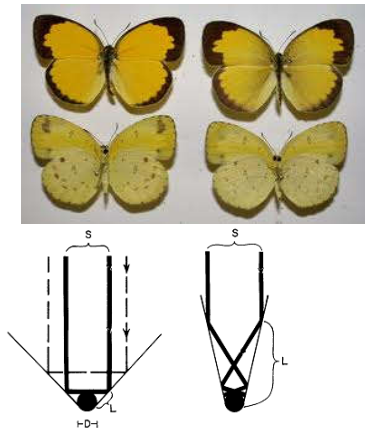


Fig. 1. Diagram illustrating the reflection of solar radiation from the wings to the body. The figure shows a cross-section through the butterfly perpendicular to the body axis. *D* is the diameter of the black body. Beams of radiation (dashed lines) approach the butterfly from above and reflect off the wings. *L* is the reflective wing length; *S* is the area of radiation interception

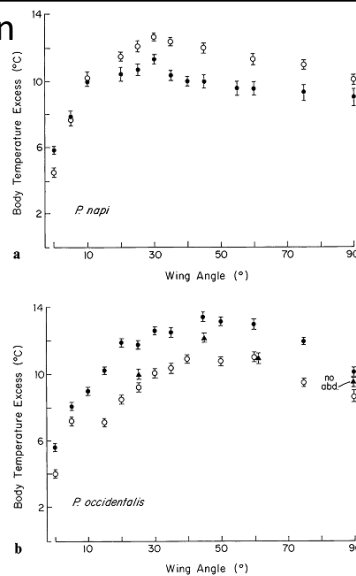
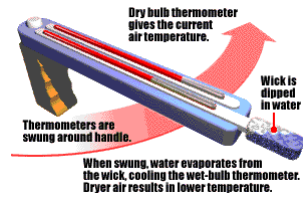
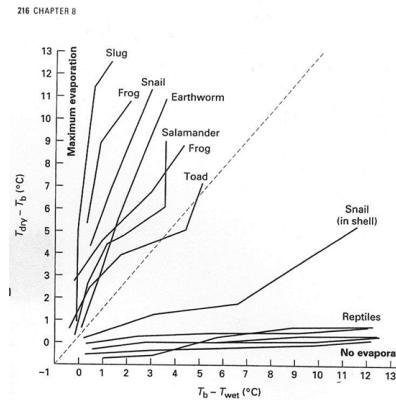


Fig. 7 a, b. Laboratory results showing the body temperature excess ($[T_b - T_a]$, in °C) as a function of wing angle (θ , in °) for *Pieris* butterflies. The different circle symbols (○ and ●) represent means for different individual butterflies; the error bars represent standard errors. a *P. napi macdunnoughii*. b *P. occidentalis*. The triangles represent results for the closed circle (●) individual after ligation of the abdomen. The effect of ligation is to decrease body temperature

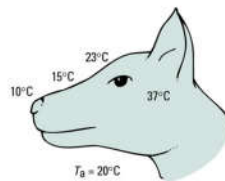
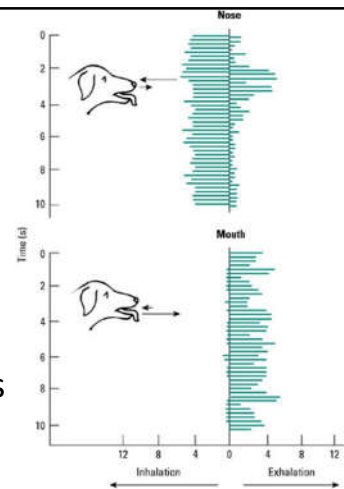
Evaporation

- Recall skin R-values
 - High R – greater evaporative heat loss capability
- **Relative humidity** – ratio of water vapor partial pressure to saturation water vapor pressure
- **Psychrometer** – used to measure relative humidity. Wet bulb vs. dry bulb temperatures.



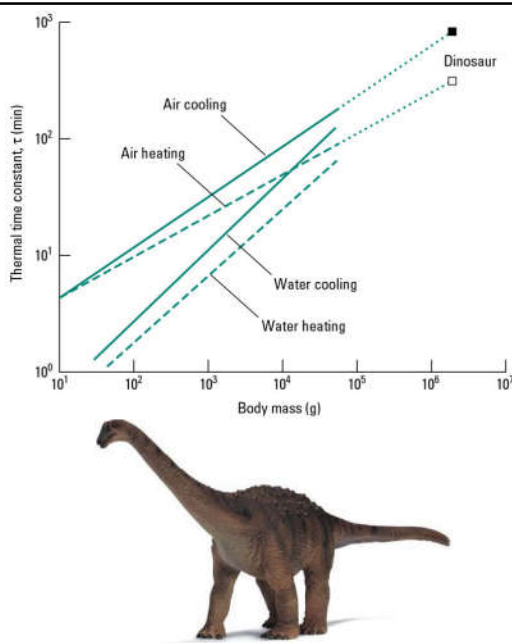
Panting

- Evaporative cooling via respiratory system
 - Mammals usually sweat or pant, panting most common in carnivores
 - Physics is similar to nasal exchange in k-rats that conserves water



Thermal Inertia

- Body size, shape and posture all dictate rate of heat exchange
- Rate of exchange greater for water than air



Body Size and Shape Trends with Temperature

- Bergman's rule
- Allen's Rule

