Lecture 42
30 April 2008

Vertebrate Physiology
ECOL 437 (MCB/VetSci 437)
Univ. of Arizona, spring 2008

Kevin Bonine & Kevin Oh

1. Thermal Physiology (Ch 8)

http://eebweb.arizona.edu/eeb_course_websites.htm



## Housekeeping, 30 April 2008

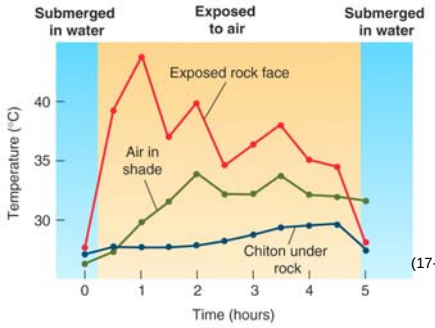
Upcoming Readings
Wed 30 Apr: Ch 8, Thermal Physiology
LAB 30 Apr, 07 May: Funding Panel Prep
Fri 02 May: Ch 8
Mon 05 May: Ch 8
Wed 07 May: Review for FINAL EXAM
LAB 07 May: Funding Panel Presentations/Decisions



# Thermal Physiology

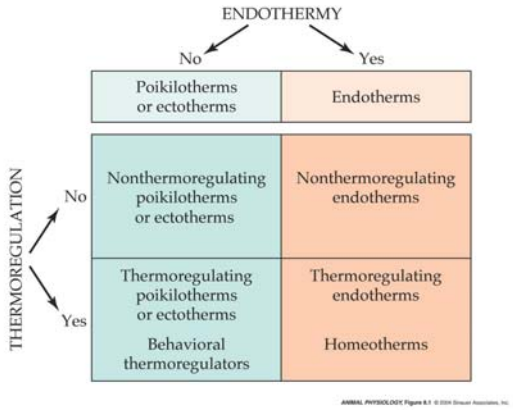


Microhabitat



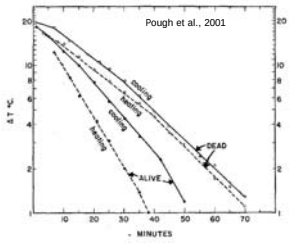

(17-10)



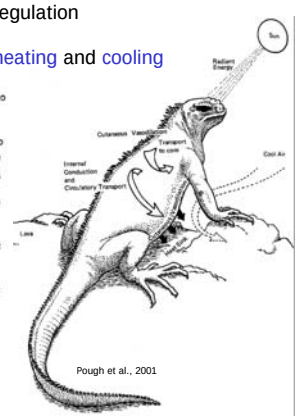



Thermoregulation

Cardiovascular control of heating and cooling

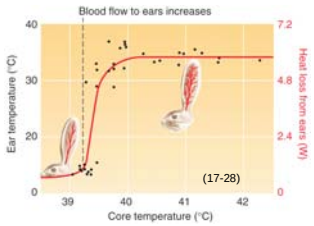



- Cardiac Shunts
- Peripheral Vasodilation



## Heat Windows

Rabbit Ears




Guanaco

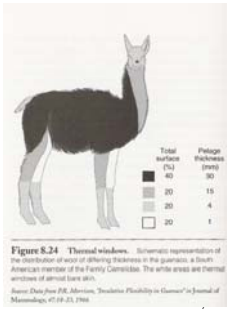
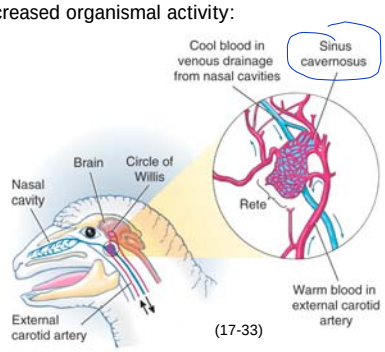


Figure 8.24 Thermal windows.

## Hot Body, Cool Brain

Keep brain cool during prolonged increased organismal activity:




(17-33)

-Countercurrent

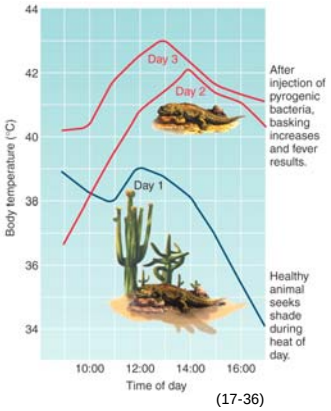
-Carotid Rete

8

Pyrogens

Fever

*Dipsosaurus dorsalis*



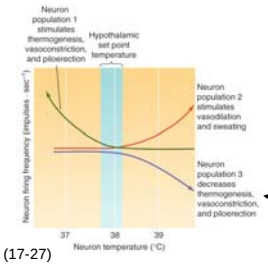

(17-36)

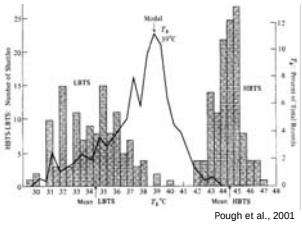
9

## Neuronal Control of Thermoregulation

Temperature Set Point
(season, reproductive state, infection)

Hypothalamus functions as thermostat



Pough et al., 2001

(17-27)

Physiology and Behavior

10

Endotherms in the COLD…

Countercurrent Heat Exchange

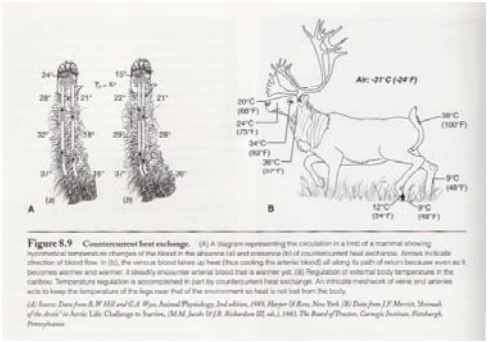
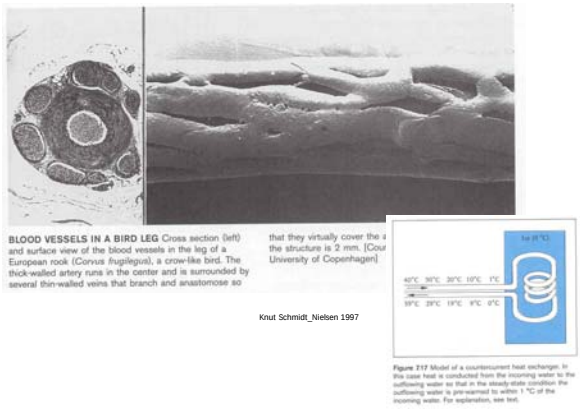


Figure 8.9 Countercurrent heat exchange.

11



BLOOD VESSELS IN A BIRD LEG Cross section (left) and surface view of the blood vessels in the leg of a European rook (*Corvus frugilegus*), a crow-like bird. The thick-walled artery runs in the center and is surrounded by several thin-walled veins that branch and anastomose so that they virtually cover the a the structure is 2 mm. [Cour University of Copenhagen]

Knut Schmidt_Nielsen 1997

Thermogenesis

Endotherms in the COLD…

Shivering (or locomotion)
antagonistic muscle contractions
heat byproduct

Non-shivering
fats metabolized,
but produce heat instead of ATP
brown fat specialized

sympathetic stimulation:
1. ATP hydrolysis used to pump ions needlessly
2. Proton leakage in mitochondria,
rather than production of ATP
in presence of thermogenin

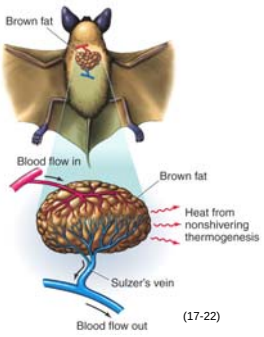
13

Endotherms in the COLD…

Thermogenesis

Shivering (or locomotion)
-antagonistic muscle contractions
heat byproduct

Non-shivering
fats metabolized, but produce
heat instead of ATP
- brown fat specialized

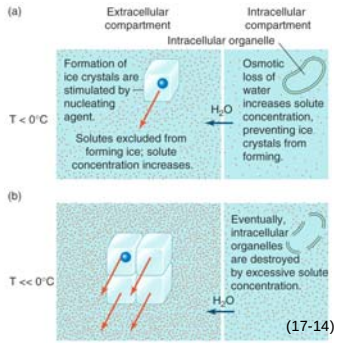


(17-22)

14

Ectotherms in the COLD

Freeze Tolerance vs. Supercooling/Antifreeze



(17-14)

-Extracellular Nucleation

-[Solute]

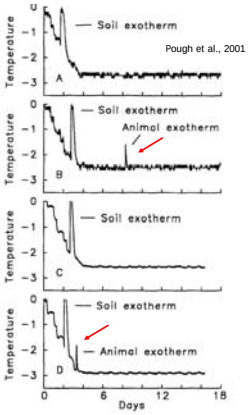
-Rate

15

Thermoregulation

Freezing - ice crystal formation
-alter osmolality
-physical destruction

Freeze Resistance
supercool
prevent ice crystals
*(Sceloporus jarrovii)*
*(Chrysemys picta)*



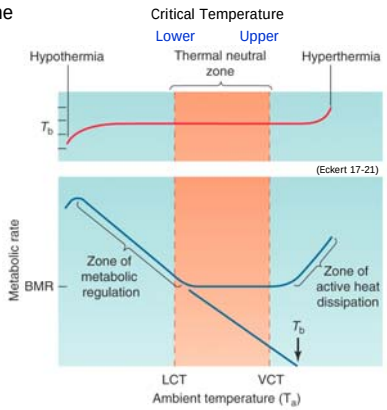
Pough et al., 2001

Thermal Neutral Zone

Within TNZ:
-Vasomotor
-Posture
-Insulation
fluff fur/feathers

Below TNZ:
-Increase metabolism
above basal

Above TNZ:
-Cool via evaporation



(Eckert 17-21)

birds

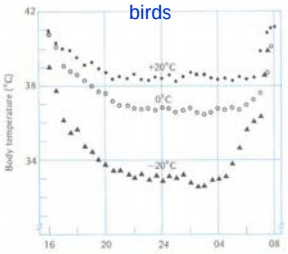
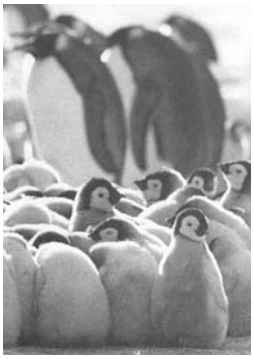


Figure 7.11 Body temperature of a willow tit (*Parus montanus*) during the night hours at three different ambient temperatures. The records are from midafternoon one day to the following morning. [Reinertsen and Haftorn 1986]

Knut Schmidt_Nielsen 1997



Knut Schmidt_Nielsen 1997

19

COST/BENEFIT ANALYSIS

Would you rather be an ectotherm or an endotherm?

Ectothermy vs. Endothermy

1. Ectotherms
   -lower metabolic rate
   -require less water
   -require less food (foraging time)
   -greater proportion energy into growth and repro

   -small body size works (different shapes)

   -reliant on environmental heat sources
   -seasonal and daily limits on activity
   -low aerobic capacities

2. Endotherms with 'opposite' costs and benefits

21