# Function

- Chapters 9, 10

I. Nervous & Sensory systems

II. Biological Rhythms

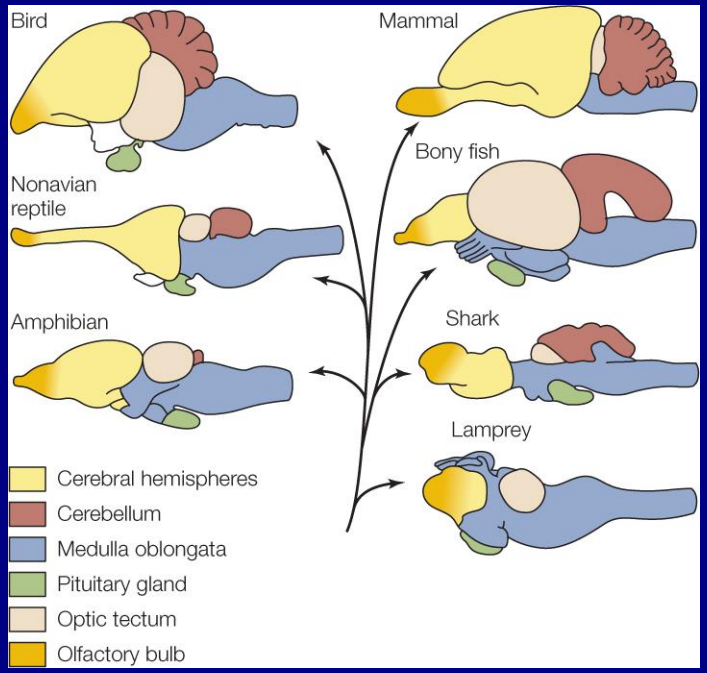
III. Thermoregulation

# Nervous System (Overview)

- 2 basic components of the nervous system
  1) Central nervous system – brain & spinal cord
  2) Peripheral nervous system – sensory & motor neurons

# A. Central Nervous System (overview)

- Consists of **brain** and **spinal cord**
- Spinal cord *mostly* similar to other vertebrates
- Major evolutionary changes to CNS in brain



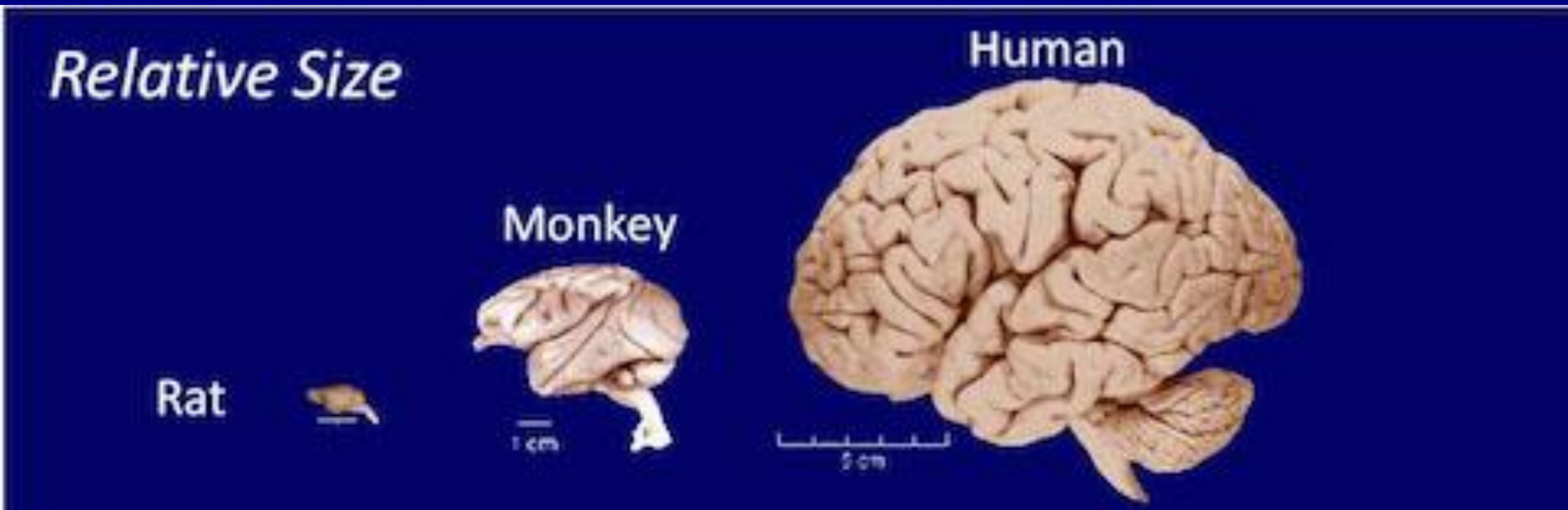
# A. CNS Mammalian Brain

- Unique features/adaptations

1. Expanded **neopallium** (or **neocortex**)
   a. Conscious thought
   b. Reasoning
   c. Sensory perception
2. Increased ratio of brain:body size
3. Increased surface area (some mammals)

➢Is 2 or 3 best indication of intelligence?

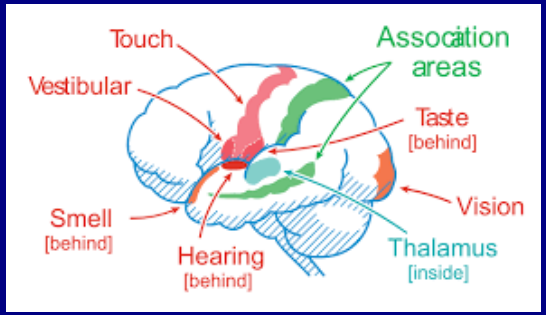
## *Relative Size*



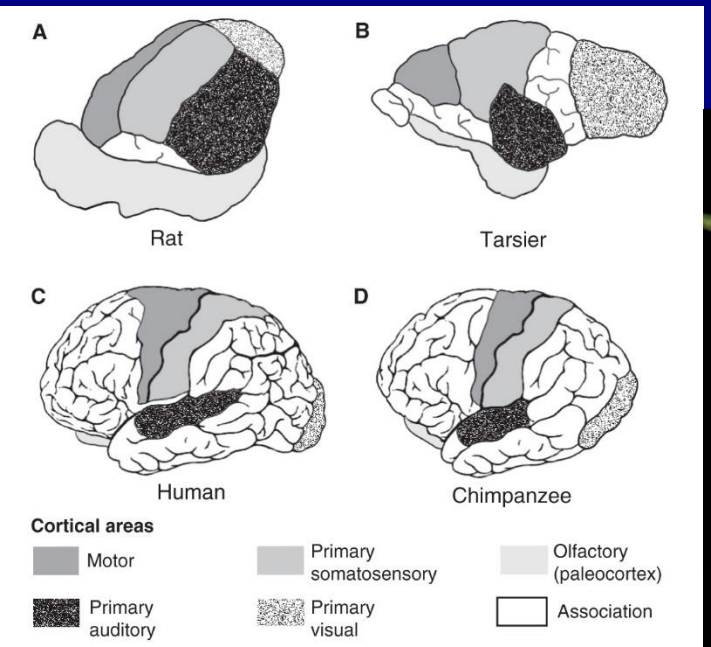

## *Relative Complexity*

# B. Sensory Systems

1. Vision
2. Olfaction
3. Hearing




➢Neopallium divided into areas that process info from each of these systems




# 1. Vision

a. Important to most mammals

b. Who would it be less important to???

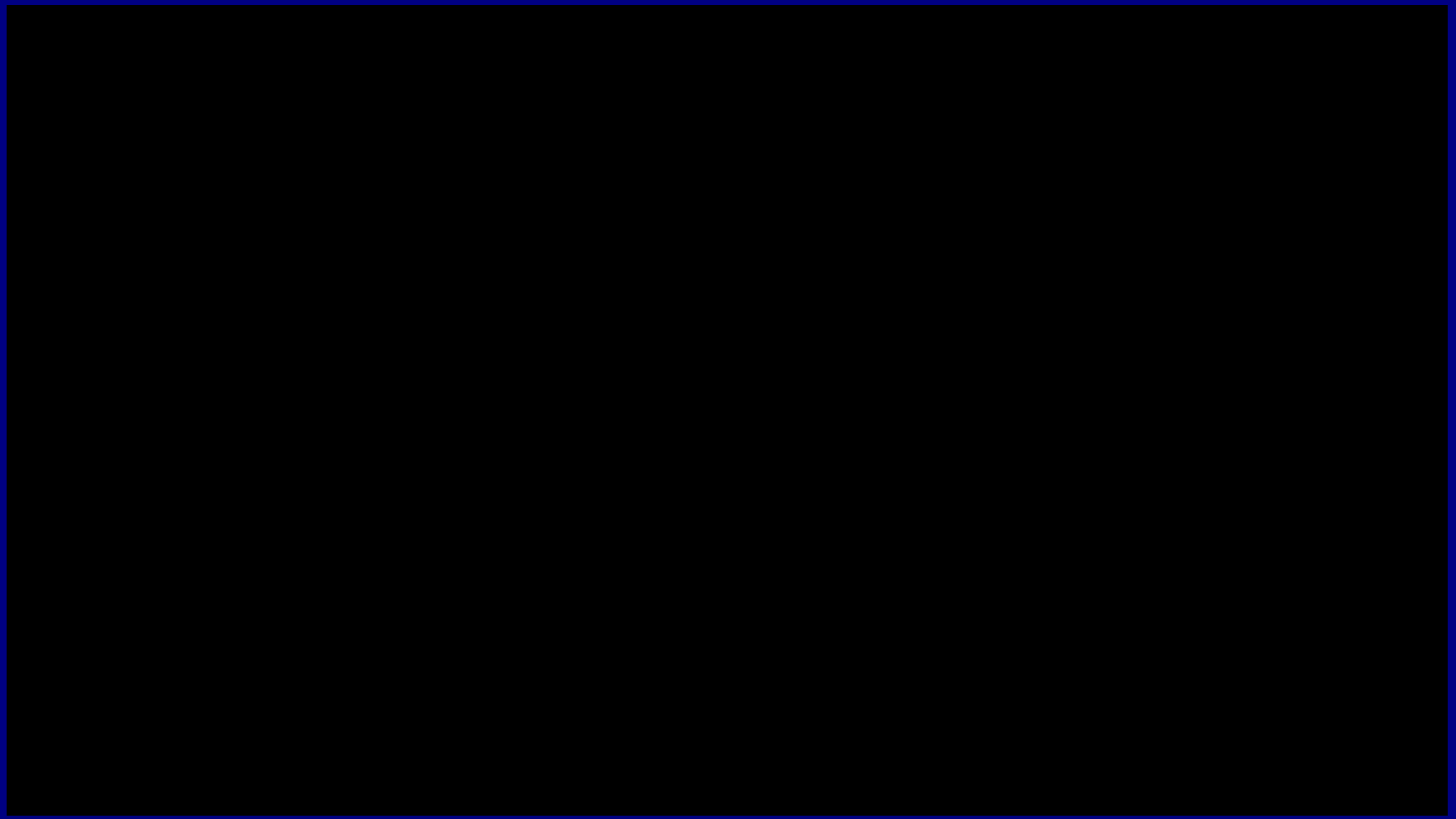
**c. Stereoscopic vision –** depth perception
   – Predators (felids)
   – Primates

**d. Tapetum lucidum**

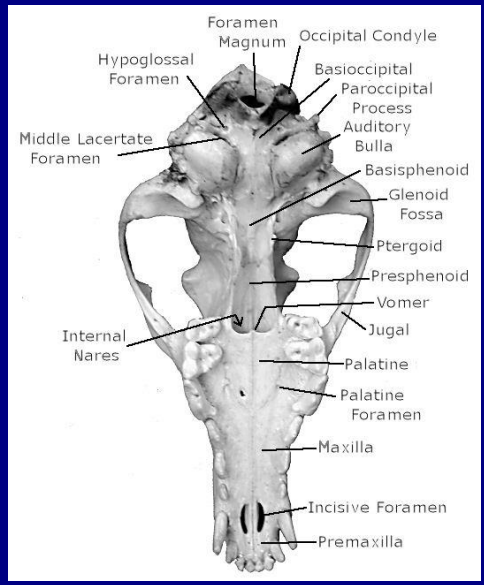
**e. Cones** (color) & **rods** (b & w)

# 2. Hearing

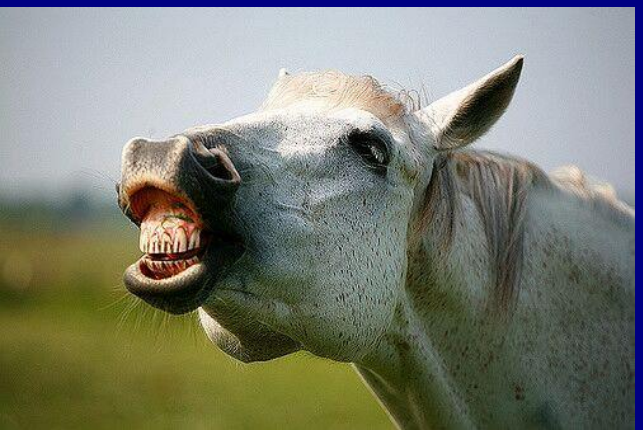
a. Hearing & olfaction primary in most mammals
b. Why???
c. Use of auditory cues
    i. Communication
    ii. Predator/prey detection
d. Pinnae
    i. Absent in some mammals… who??
    ii. Well developed & rotating in some
e. Infrasound (<20 mhz) – ultrasound (20K mhz)

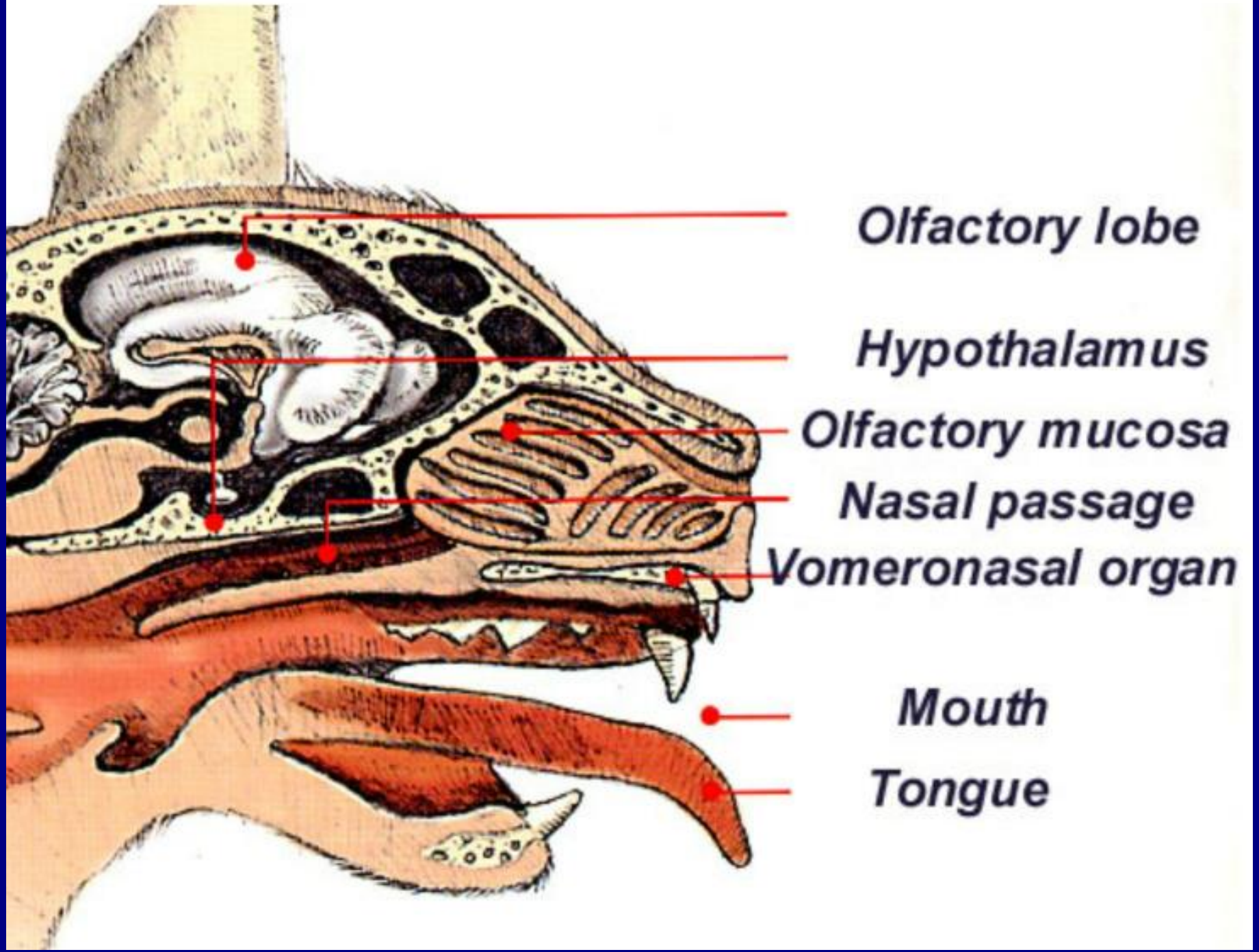


# 3. Olfactory




a. Functions
   i. Locating food
   ii. Detecting danger
   iii. Communication – remember glands
b. **Olfactory receptors**
c. **Vomeronasal organ** (or Jacobsen's Organ)
   i. Function: detection of pheromones
   **ii. Flehmen reaction**
   **iii. Incisive foramina**




Olfactory lobe
Hypothalamus
Olfactory mucosa
Nasal passage
Vomeronasal organ
Mouth
Tongue

# 4. Tactile or Touch

a. Vibrissae
b. Snout & lips
c. Hands & digits
d. Tails
e. Functions
    1) Locomotion
    2) Processing food
    3) Social behavior

# 5. Taste

a. Often not as important as other senses
b. Humans can eat without taste
   - Why did it evolve?
c. Detection of noxious food (e.g., noxious moths)

# II. Biological Rythms

- 3 general time periods

A. Circadian rhythm - daily

B. Circannual rhythm - annual

C. Ultradian rhythm – within 1 day

# A. Circadian Rhythm

1. Endogenous rhythm occurs in ~24 hr period
   – *Can occur without external cues*
2. Photoperiod (amount of daylight) is external cue
   a. "sets the clock"
   **b. Photoperiodism**
3. Mammals have daily patterns of activity
   a. e.g., sleep is a circadian rhythm – photoperiod helps
   b. Activity periods
      **i. Diurnal**
      **ii. Nocturnal**
      **iii. Crepuscular**

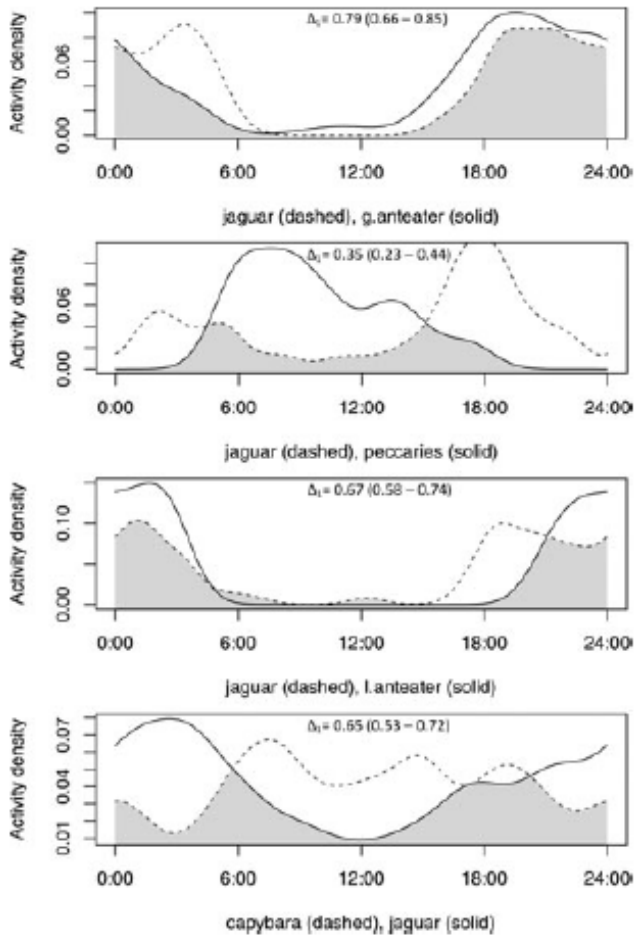



FIGURE 2. Coefficient of overlapping of daily activity patterns between the jaguar and its main preys species in four study areas in Brazil; Emas National Park (row 1, top), sample sizes: jaguar ($N$ = 50), g. anteater ($N$ = 110); Santa Fé Ranch (row 2), sample sizes: jaguar ($N$ = 89), peccaries ($N$ = 33); Serra da Capivara National Park (row 3), sample sizes: jaguar ($N$ = 170), l. anteater ($N$ = 27); and Refúgio Ecológico Caiman (row 4), samples sizes: jaguar (111), capybara (105). Overlap is represented by the shaded area.

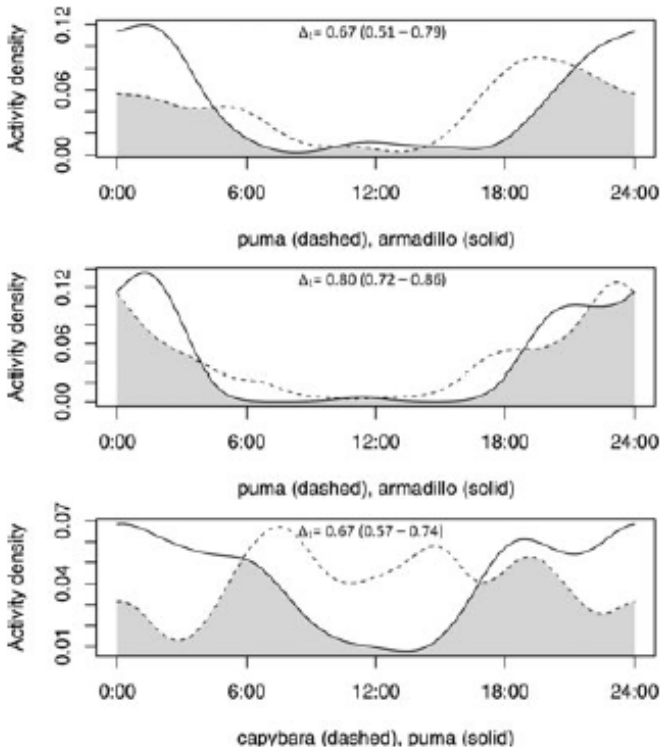



FIGURE 3. Coefficient of overlapping between the puma and its main prey species in four study areas in Brazil; Emas National Park (row 1, top), samples size: puma ($N$ = 37), armadillo (49); Serra da Capivara National Park (row 2), samples size: puma ($N$ = 112), armadillo (115); and Refúgio Ecológico Caiman (row 3), samples size: puma ($N$ = 96), capybara (105) Overlap is value represented by the shaded area.

(Fig. 1) and here, also, we observed the lowest average coefficient of overlapping with other study areas ($\Delta_1$ = 0.77; SE = 0.05). The comparison of daily activity patterns between jaguars and pumas showed high and very similar $\Delta_1$ values in all study areas (average $\Delta_1$ = 0.86; SE = 0.15). The lowest $\Delta_1$ value was observed in SCNP (0.82), followed by ENP (0.83) and SFR

# B. Circannual Rhythms

1. Endogenous rhythms that occur over ~ 1 year
   – Photoperiod is external cue
2. Examples:
   a. Reproduction
   b. Migration
   c. Hibernation/Torpor
   d. Molt
3. Most circannual patterns tied to food avail.

# Ultradian Rhythms

1. Cycles of activity that occur in periods <1 day
2. Less is known about them
3. Small mammals – several short activity bouts
   a. Photoperiod probably not a cue
   b. Regulated by metabolic activity & foraging
   c. Rodents, shrews, etc. have high metabolism

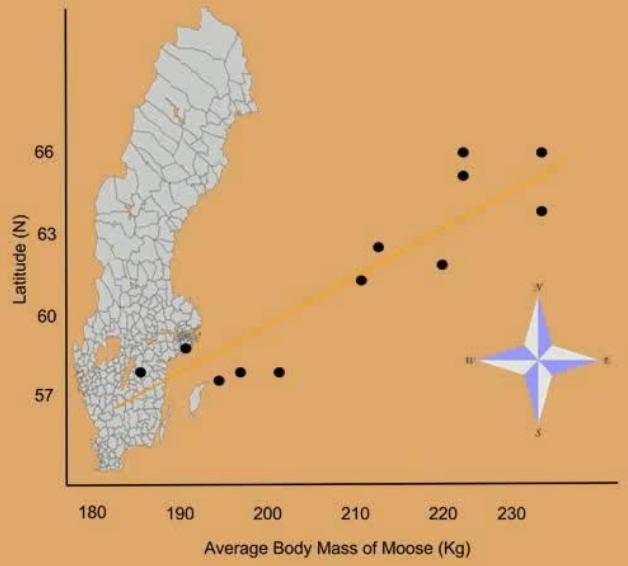
# III. Thermoregulation

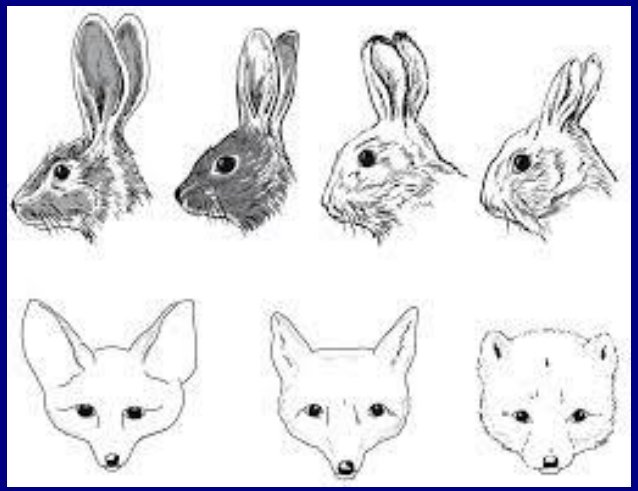
- **Endothermy** – body temperature controlled primarily by metabolic activity
  - *Body temps influenced by exchange w environment*
- Energy requirements for TR are high & fluctuate based on surrounding environment
  - All about the *temperature differential*
- Surface area:volume ratio
- Endothermy is *energetically expensive*
  - Allows activity under a variety of temps
  - Allows activity at all times of day
  - Supports high levels of activity by mammals

# A. Adaptations to Cold

1. Larger body size
   a. Bergmann's Rule
   b. Allen's Rule
2. Increased insulation
3. Behavioral thermoregulation
   a. Nesting
   b. Curling up
   c. Huddling
   d. Piloerection
   e. Basking

# Bergmann's rule

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# A. Adaptations to Cold (cont)

4. Increased rate of metabolic heat production
   a. Higher overall metabolic rate
   **b. Shivering**
   **c. Non-shivering thermogenesis** (brown fat)
5. Drop body temperature to ambient
   **a. Regional heterothermy**
   **b. Adaptive hypothermia** (daily or seasonally)
      – **Torpor or Dormancy** (lower temp & metabolic rate)
         **i. Hibernation** (most extreme)
         **ii. Winter lethargy** (less extreme)

# Countercurrent heat exchange

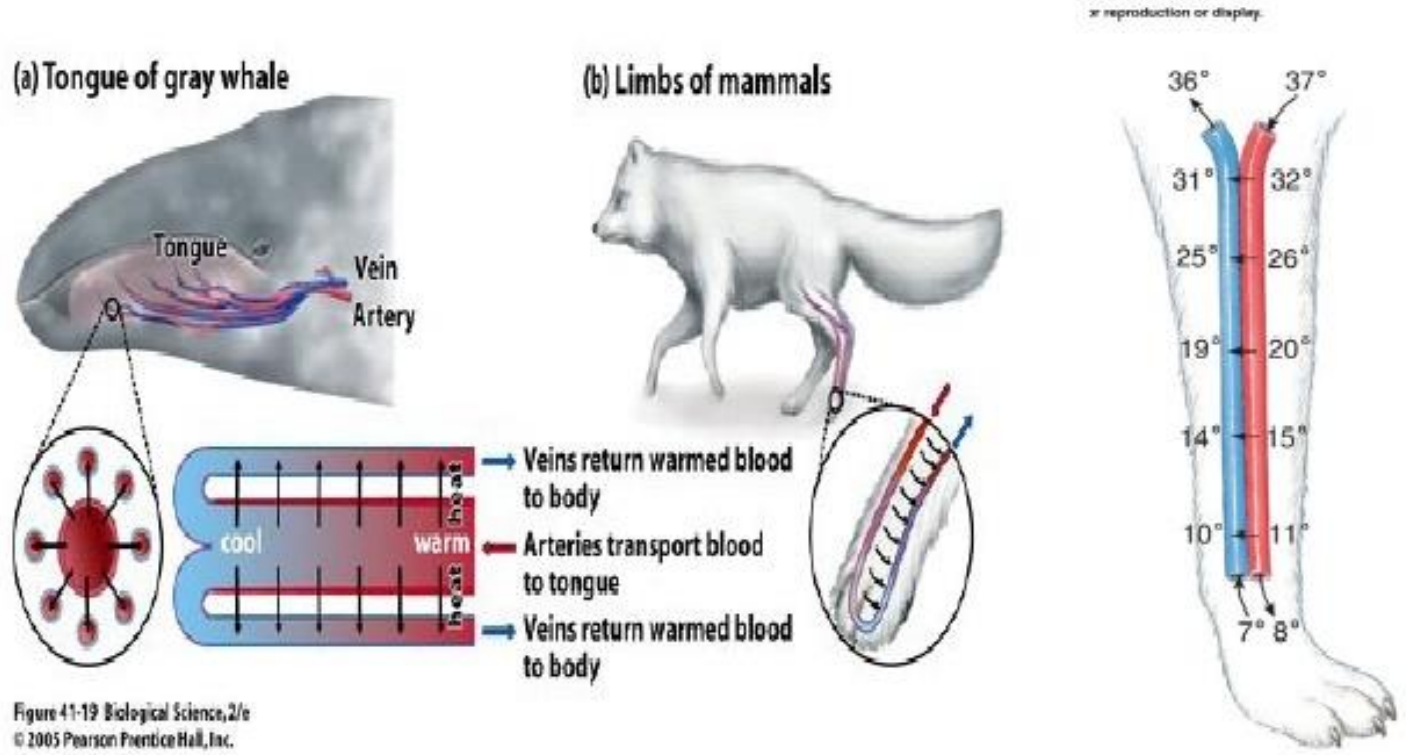
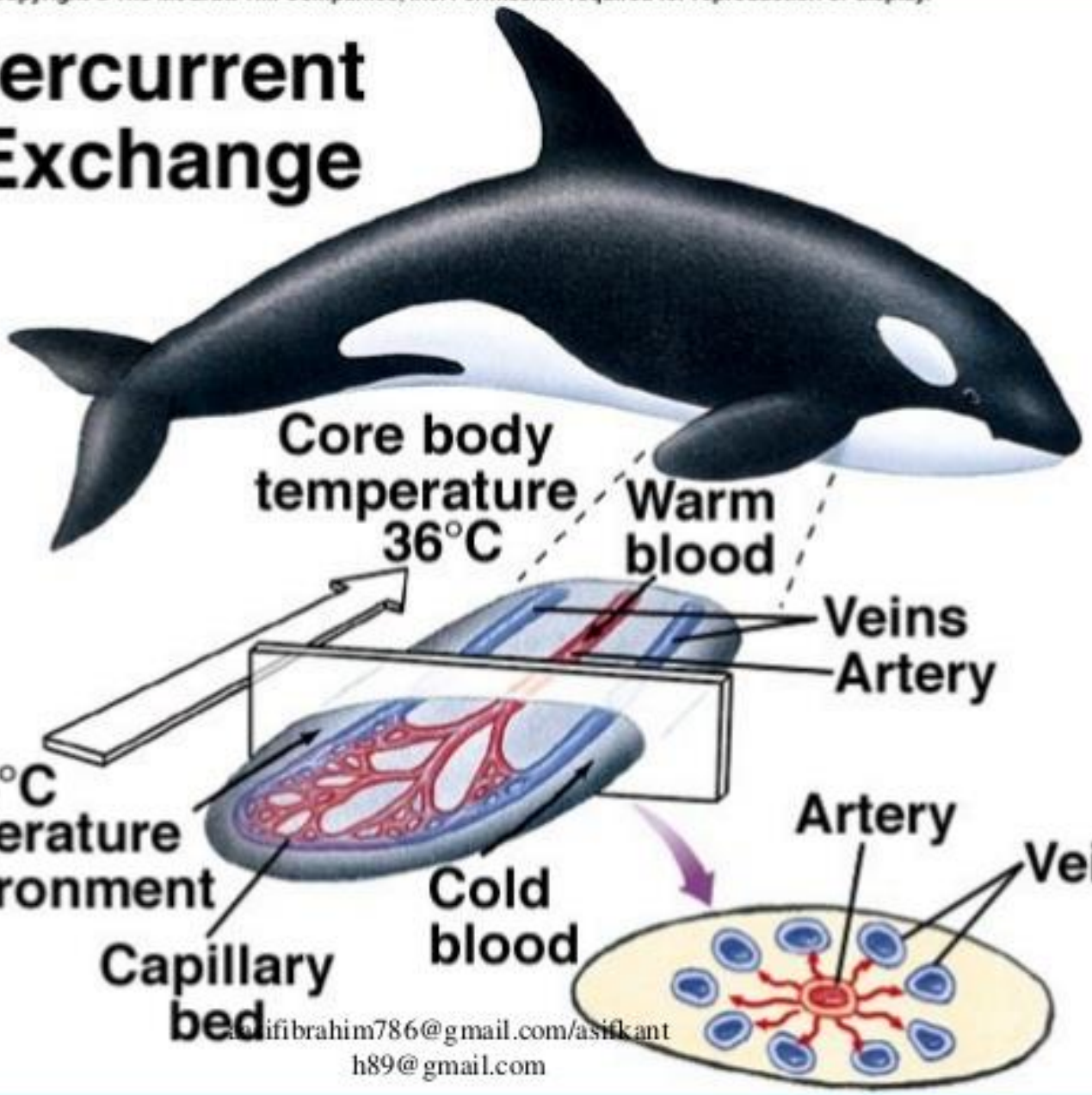



Figure 41-19 Biological Science, 2/e

# Countercurrent Heat Exchange

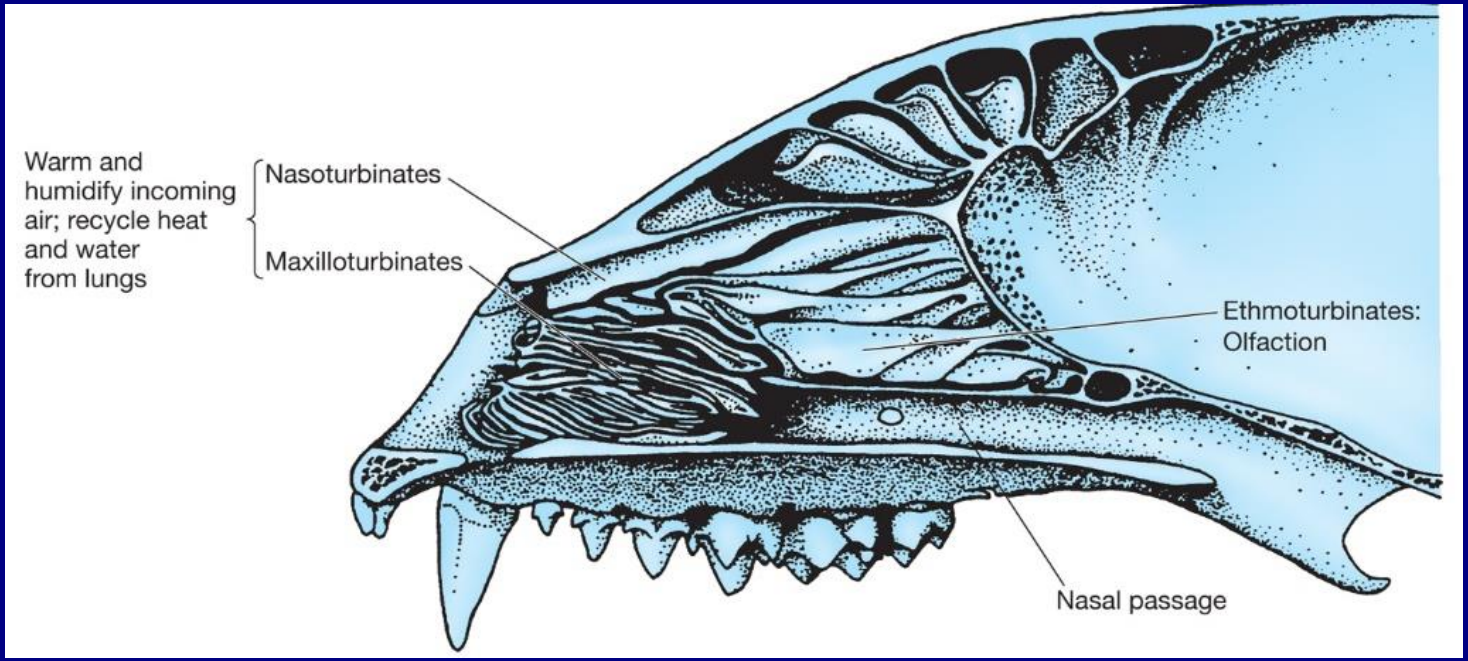


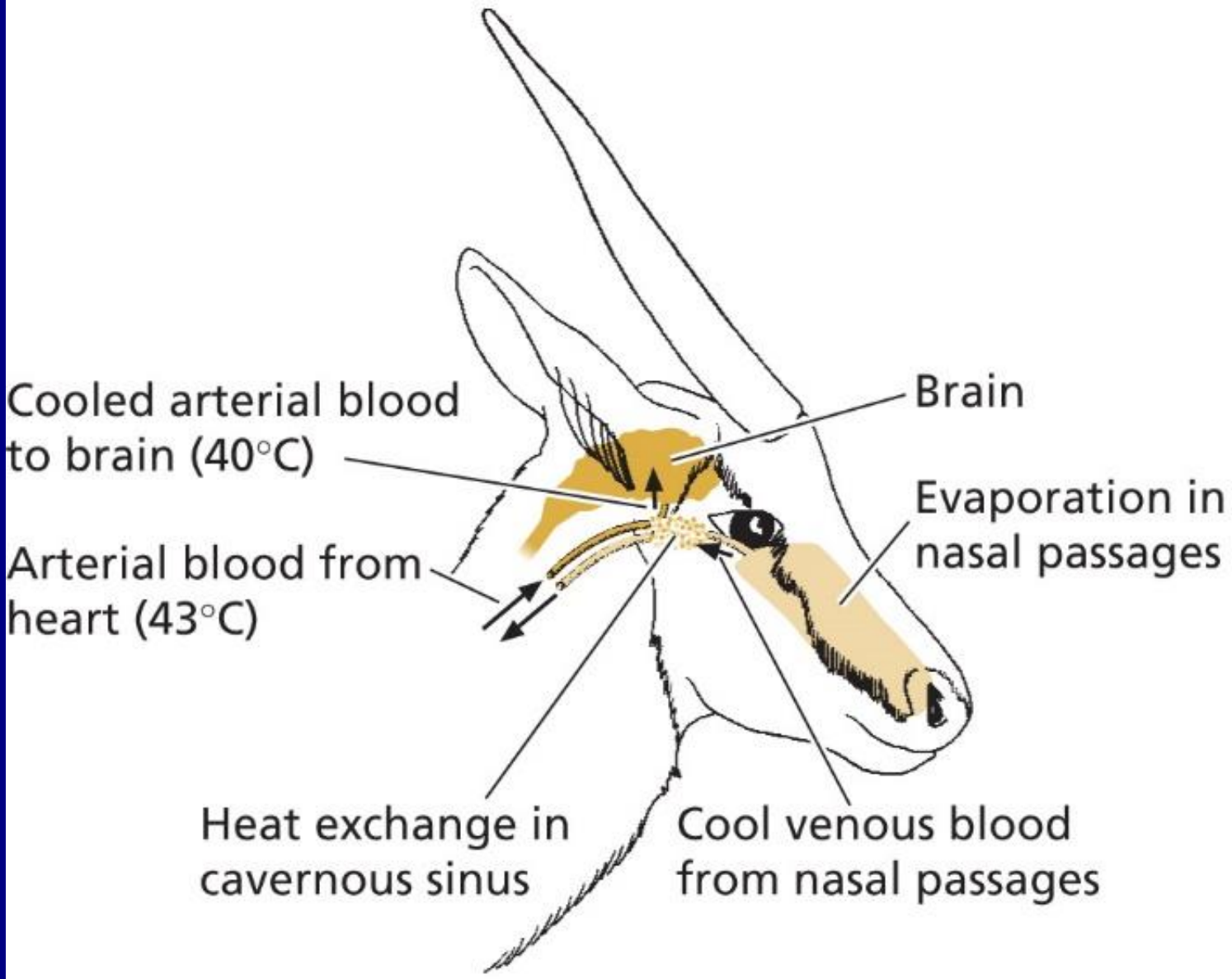
# B. Adaptations to Heat

1. **Evaporative cooling**
    a. **Sweating**
        i. **Eccrine glands**
        ii. **Apocrine glands**
    b. Panting
2. Behavioral thermoregulation
    a. Burrowing
    b. Shade
3. Hyperthermia

# Turbinates

- Provide more SA to recycle heat & water
- **Respiratory turbinates** – protrude into respiratory path = air passes over with each inspiration & expiration
- Ex. canids




Cooled arterial blood to brain (40°C)
Arterial blood from heart (43°C)
Brain
Evaporation in nasal passages
Heat exchange in cavernous sinus
Cool venous blood from nasal passages

- Cheetah must stop when body & brain = 40.5° C
- Gazelle can keep running when > 43° C (brain = ~40°)
- Predator-prey arms race

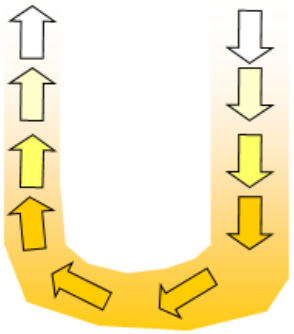
➢Survival advantage of TR adaptation

# C. Water Regulation

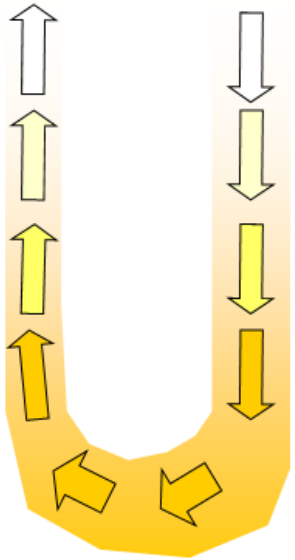
- Adaptations to limited water

1. Periodic drinking
   - Example: camels:
   a. **Adaptive hyperthermia**
   b. **Hyperosmotic urine**
   c. **Absorb water from fecal material**
   d. Lose water from interstitial fluid not blood
      - *Normal circulatory function when dehydrated*
2. Dietary moisture
   a. Plants
   b. Animals
3. Metabolic water

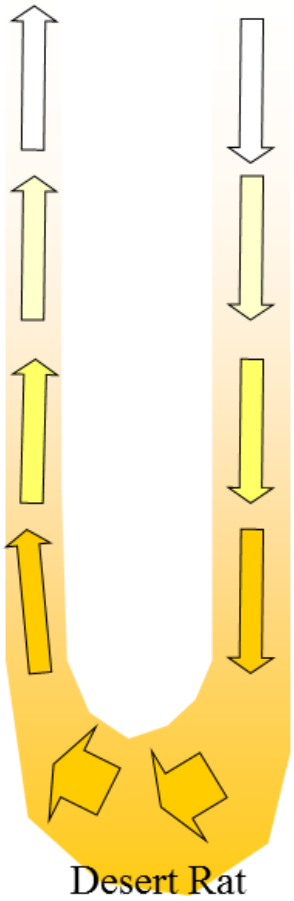
# Loop of Henle



Beaver



Human



Desert Rat

The length of the loop of Henle is related to the environment that the animal lives in. A longer loop will conserve more water, so animals in drier environments have longer loops.