Function

- Chapters 9, 10

I. Nervous & Sensory systems

II. Biological Rhythms

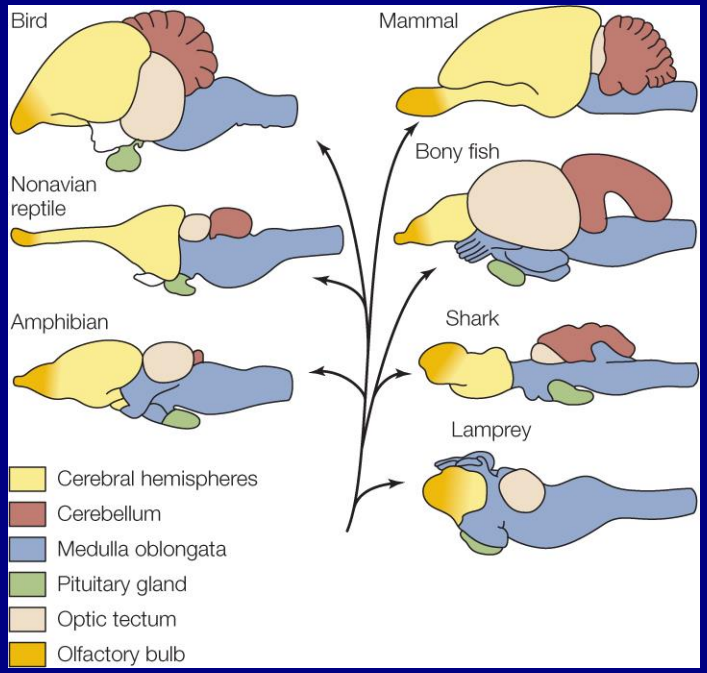
III. Thermoregulation

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



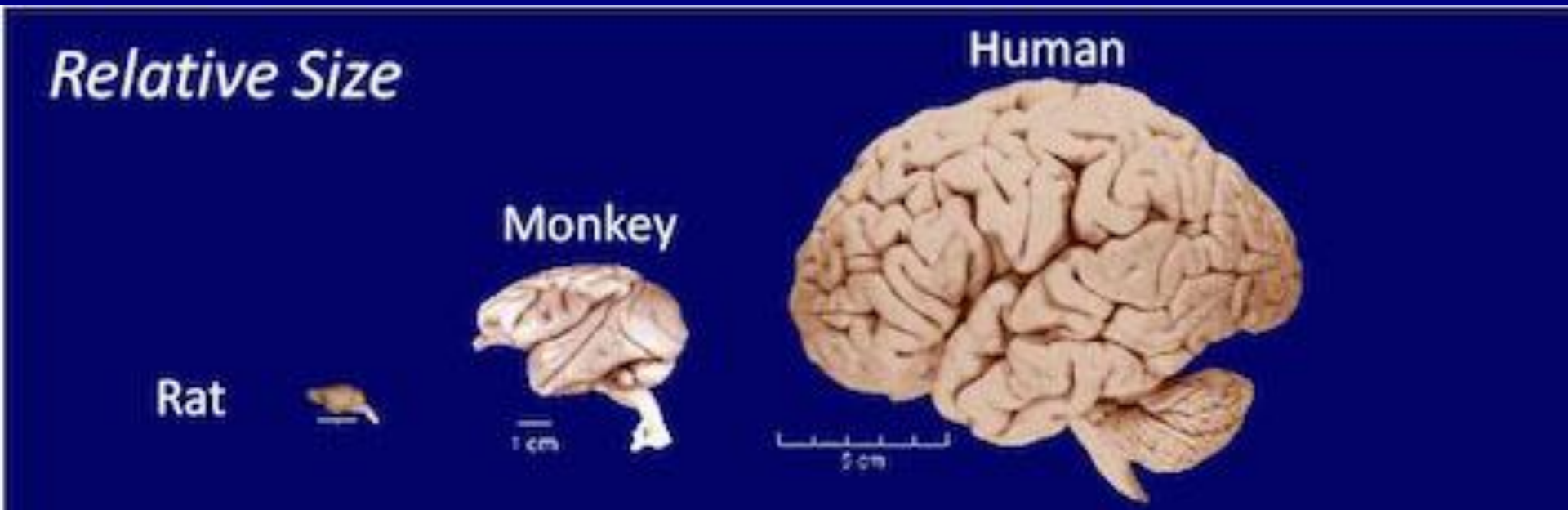
A. CNS Mammalian Brain

- 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?

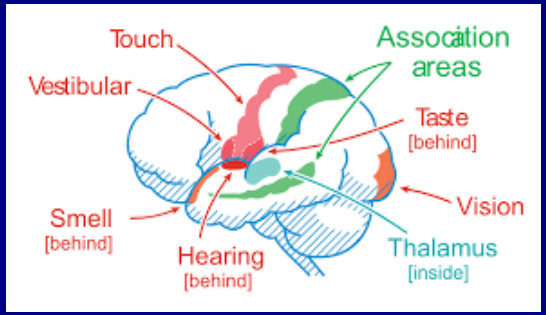
Relative Size



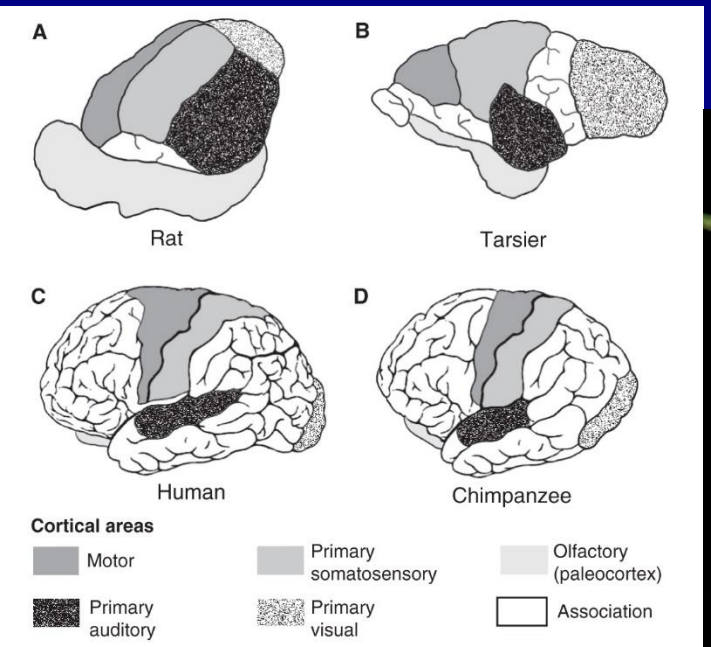
Relative Complexity

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???

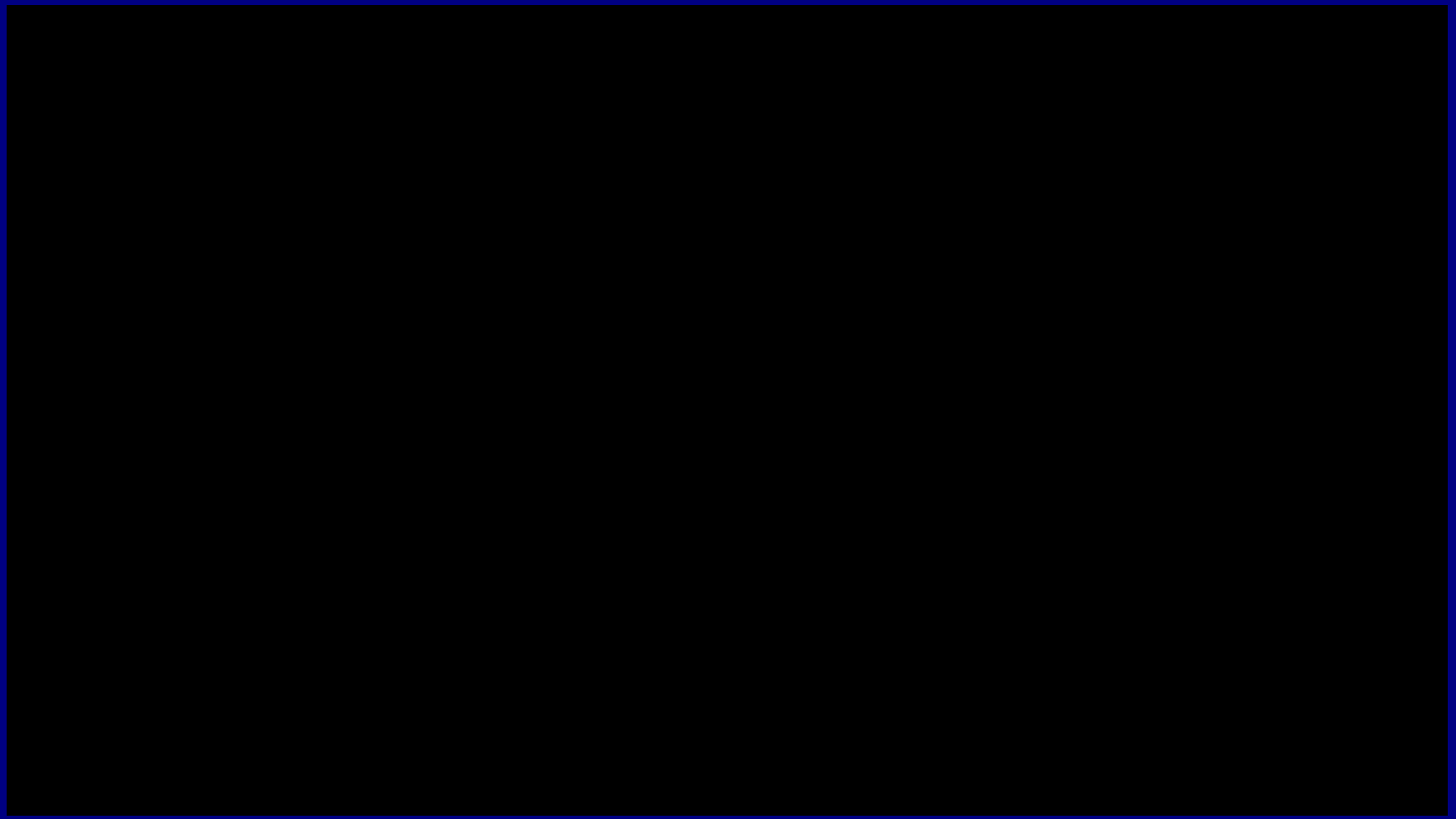
c. Stereoscopic vision – depth perception
   - – Predators (felids)
   - – Primates

d. Tapetum lucidum

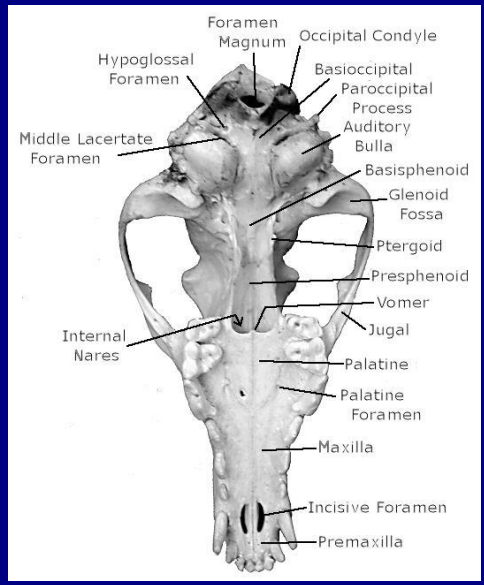
e. Cones (color) & **rods** (b & w)

2. Hearing

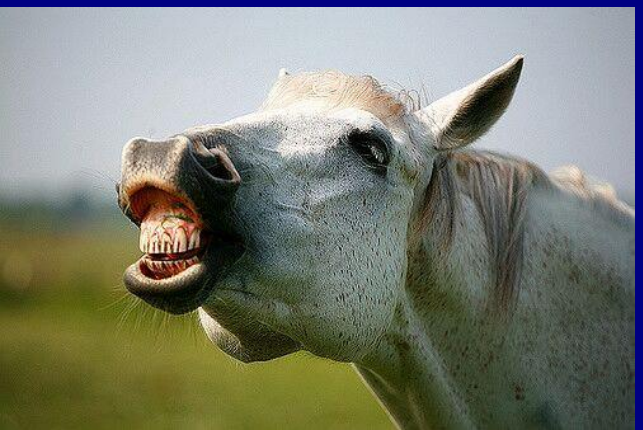
a. Hearing & olfaction primary in most mammals
b. Why???
c. Use of auditory cues
    i. Communication
    ii. Predator/prey detection
d. Pinnae
    i. Absent in some mammals… who??
    ii. Well developed & rotating in some
e. Infrasound (<20 mhz) – ultrasound (20K mhz)

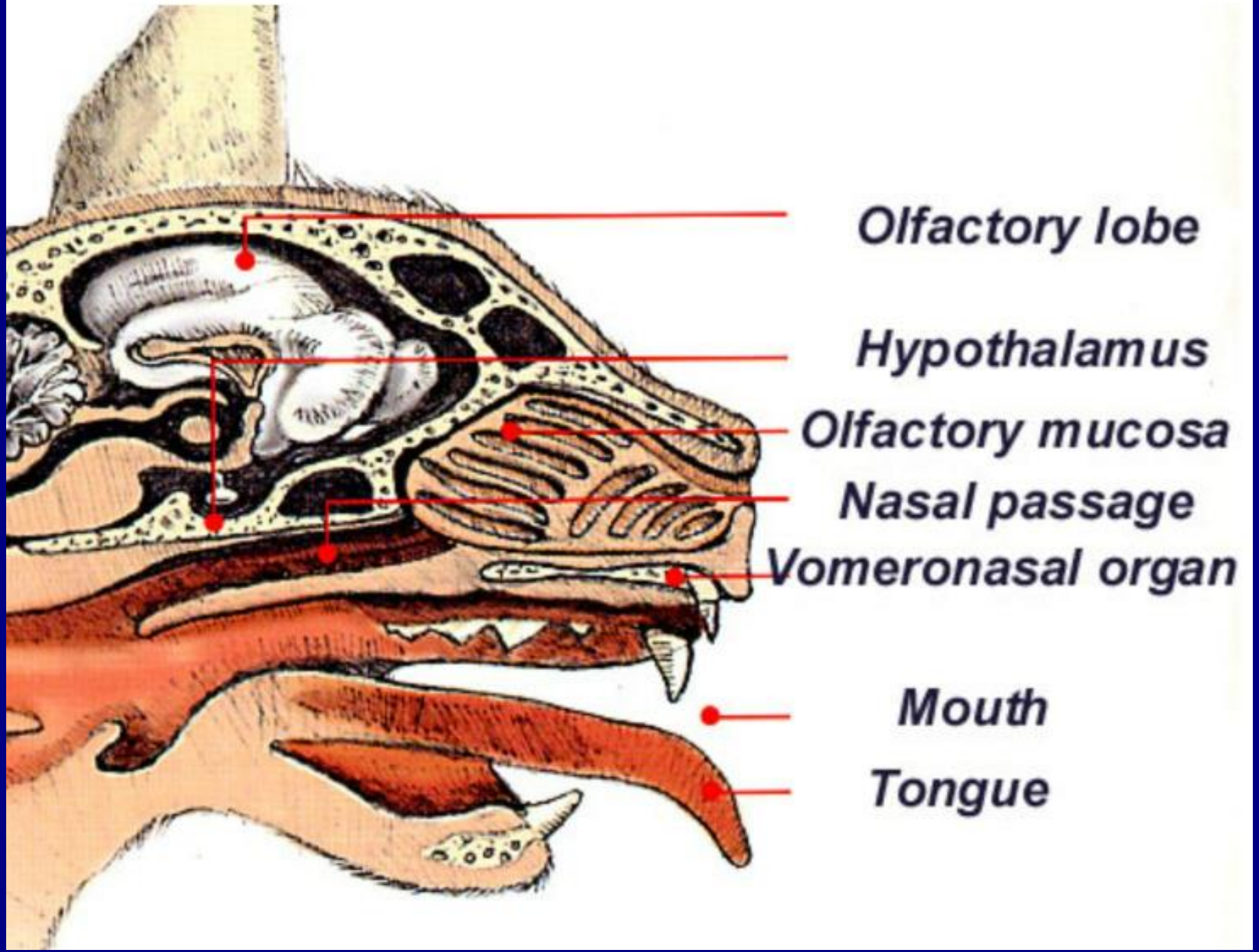


3. Olfactory



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

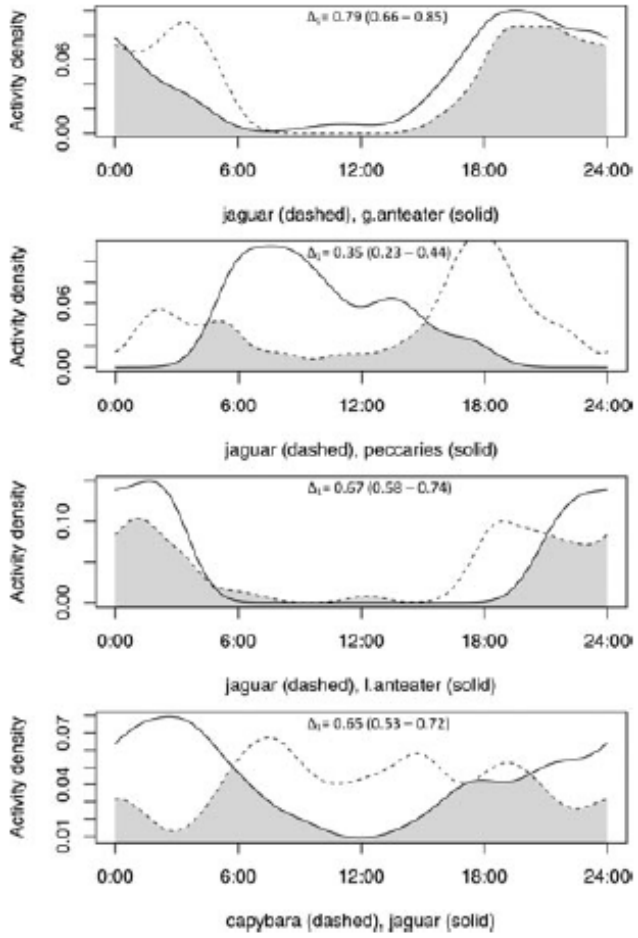


FIGURE 2. Coefficient of overlapping of daily activity patterns between the jaguar and its main preys species in four study areas in Brazil; Emas National Park (row 1, top), sample sizes: jaguar (N = 50), g. anteater (N = 110); Santa Fé Ranch (row 2), sample sizes: jaguar (N = 89), peccaries (N = 33); 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.

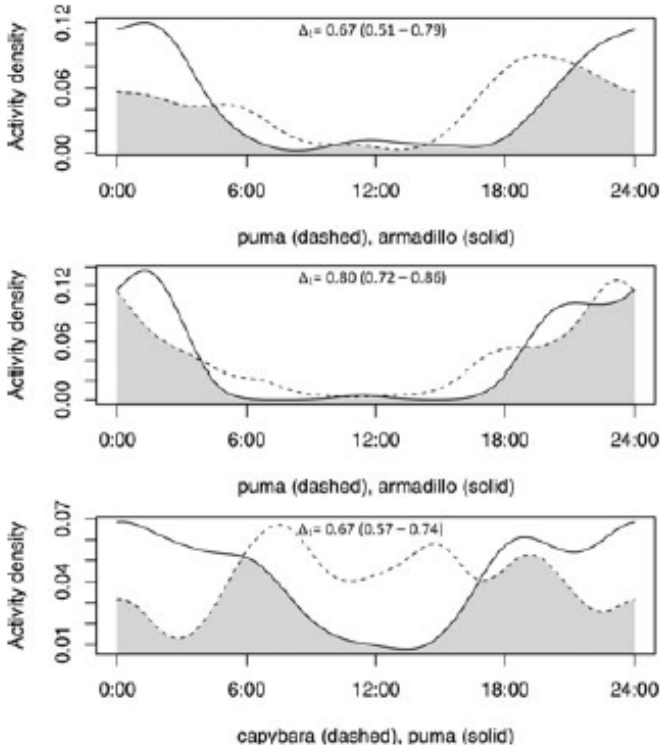


FIGURE 3. Coefficient of overlapping between the puma and its main prey species in four study areas in Brazil; Emas National Park (row 1, top), samples size: puma (N = 37), armadillo (49); Serra da Capivara National Park (row 2), samples size: puma (N = 112), armadillo (115); and Refúgio Ecológico Caiman (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 (Δ_1 = 0.77; SE = 0.05). The comparison of daily activity patterns between jaguars and pumas showed high and very similar Δ_1 values in all study areas (average Δ_1 = 0.86; SE = 0.15). The lowest Δ_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

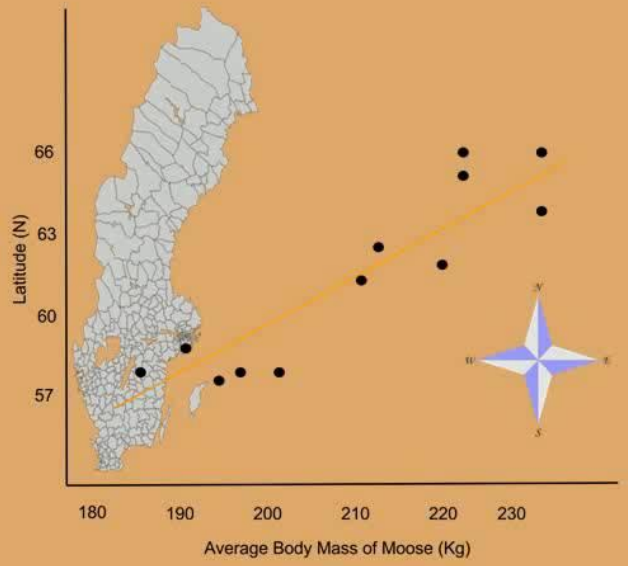
III. Thermoregulation

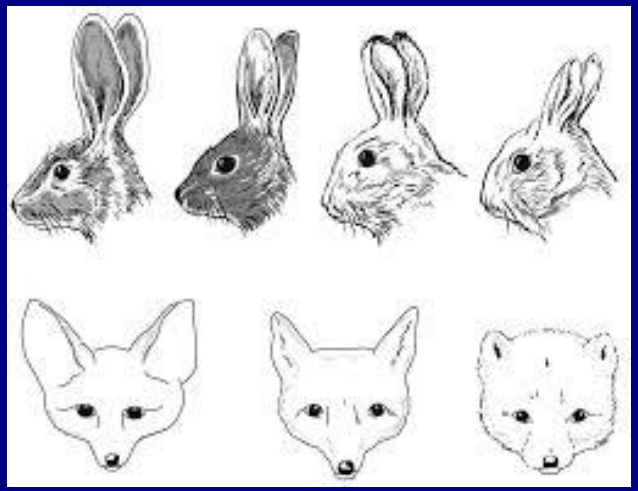
- **Endothermy** – body temperature controlled primarily by metabolic activity
  - *Body temps influenced by exchange w environment*
- Energy requirements for TR are high & fluctuate based on surrounding environment
  - All about the *temperature differential*
- Surface area:volume ratio
- Endothermy 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






© Fajar Andriyanto/Solent

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

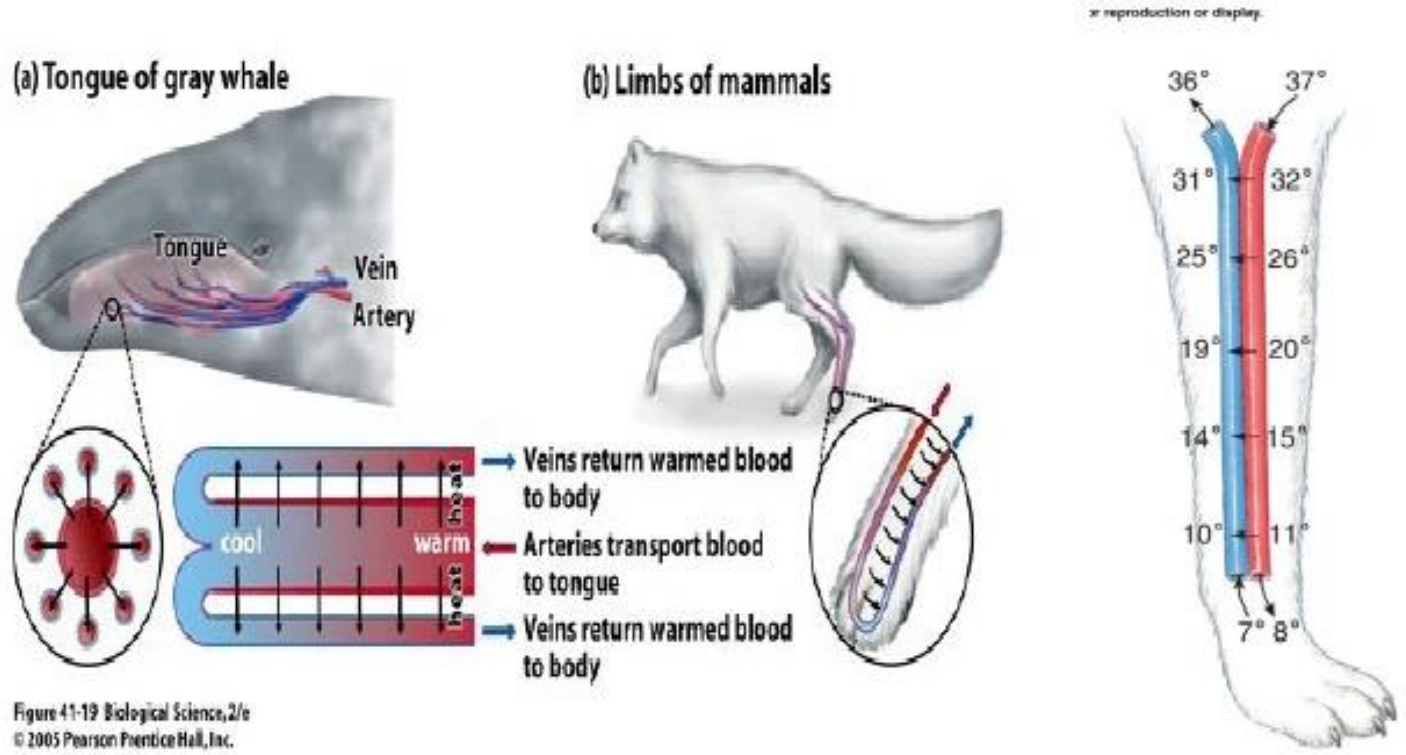
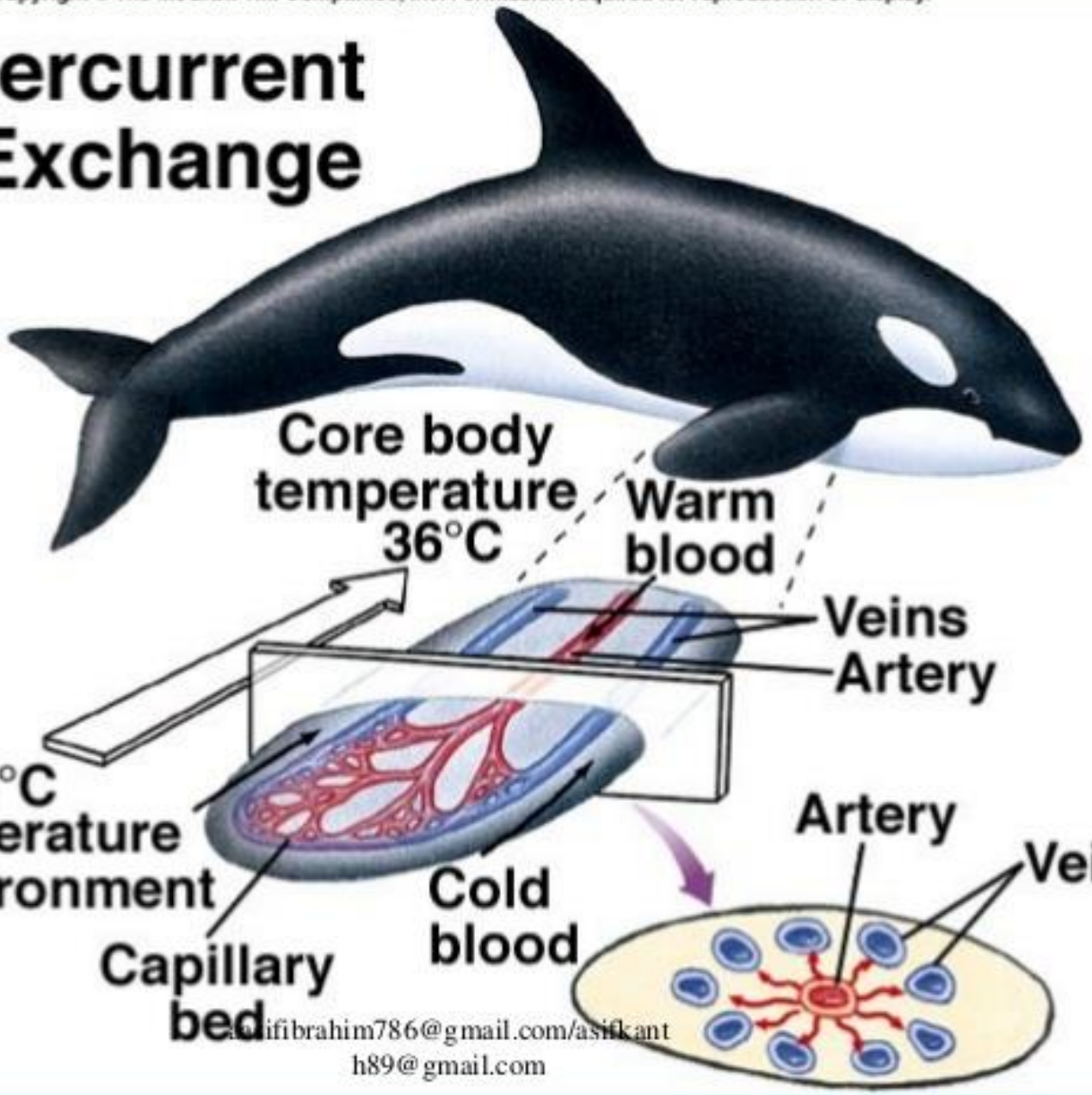


Figure 41-19 Biological Science, 2/e

Countercurrent Heat Exchange

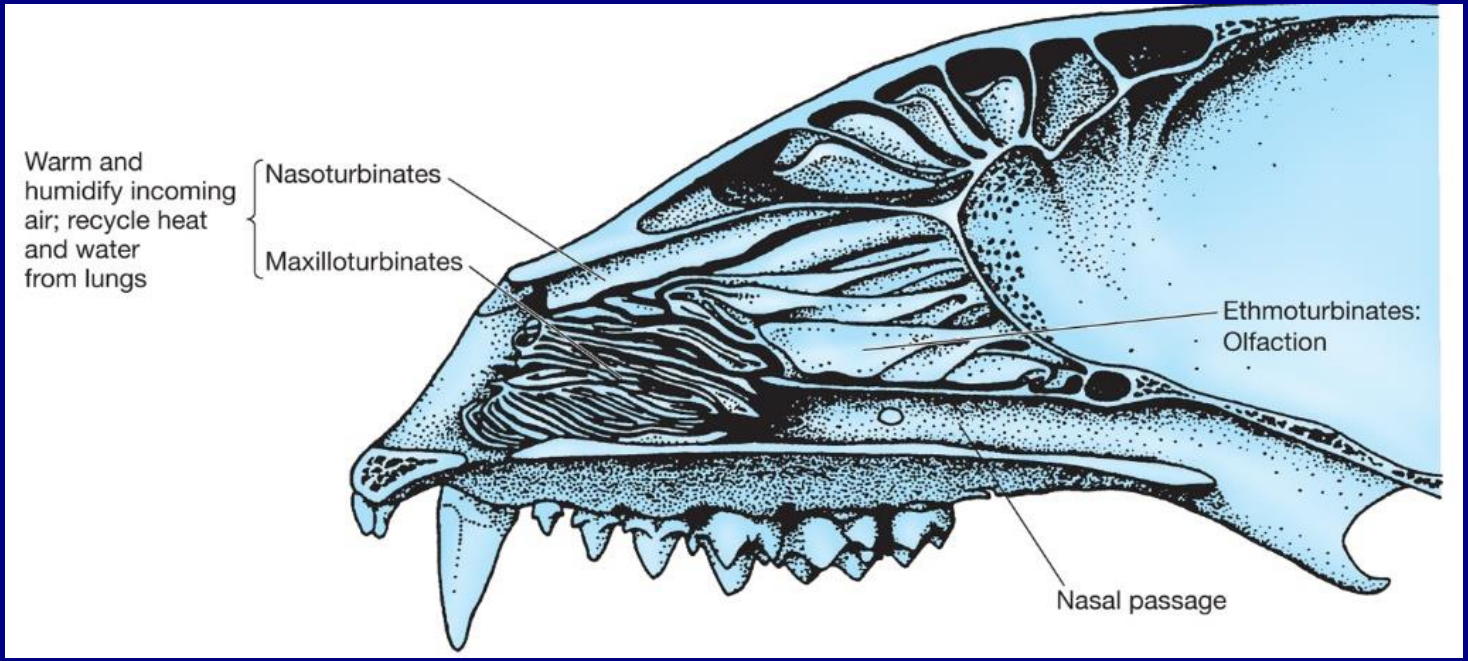


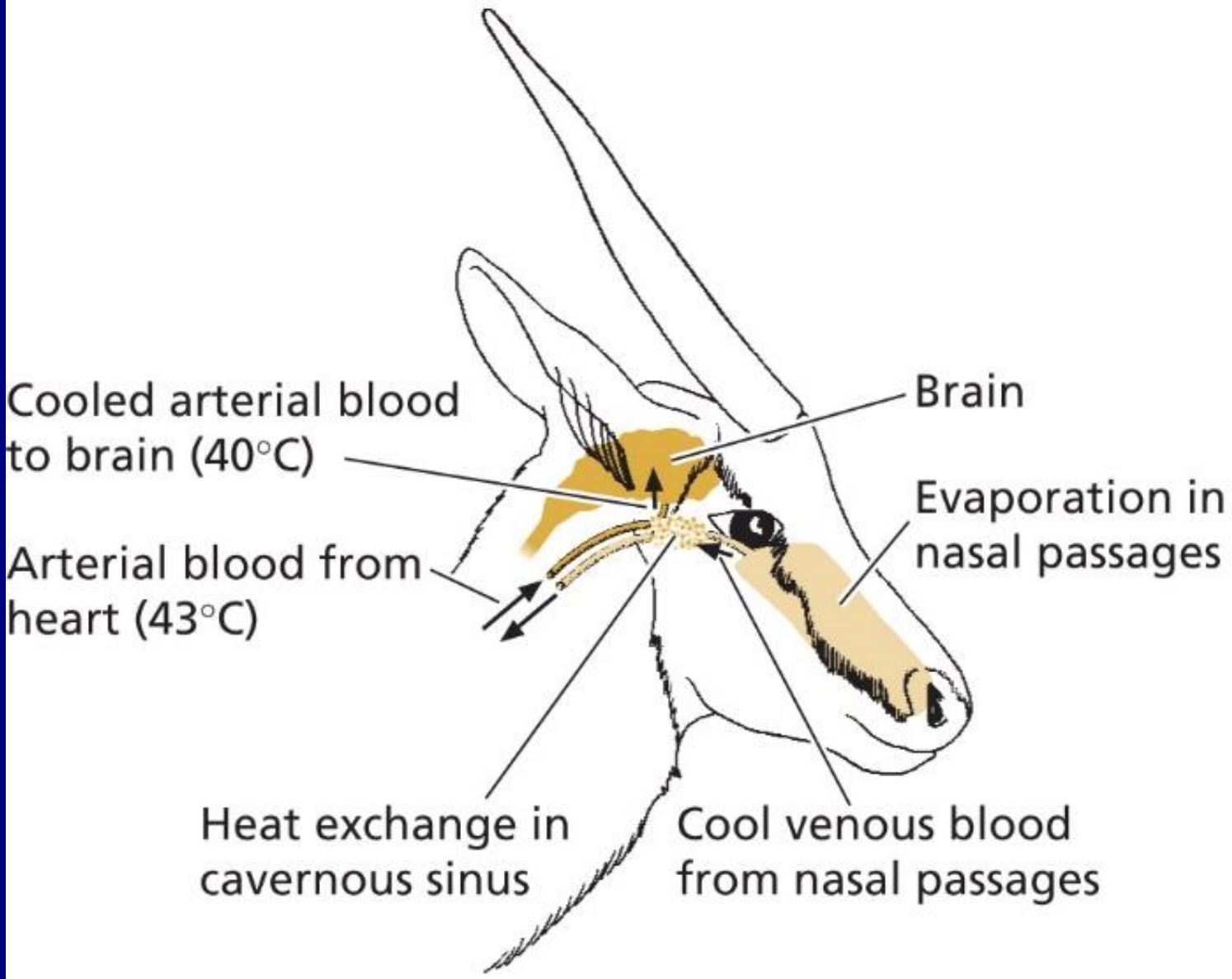
B. Adaptations to Heat

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

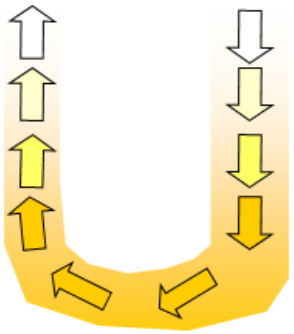
➢Survival advantage of TR adaptation

C. Water Regulation

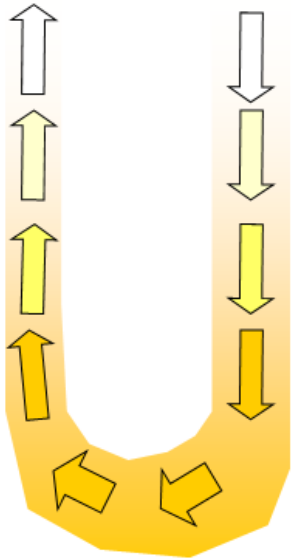
- Adaptations to limited water

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

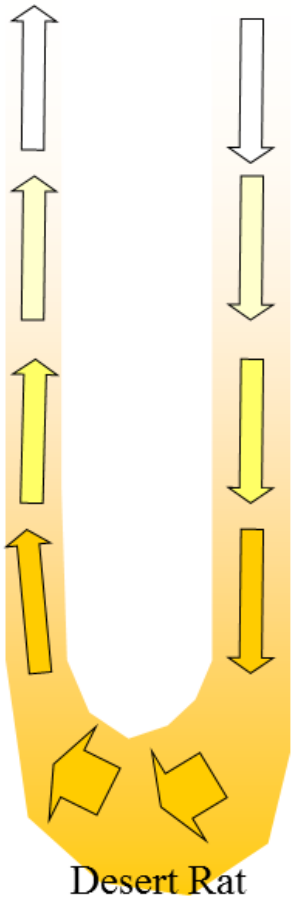
Loop of Henle



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.