ACCLIMATION vs. ADAPTATION

Physiological Systems Acclimate and/or Adapt to different Environmental Conditions. While there are an enormous number of different environments / habitats, for the purposes of this course, consider them to be relatively few:

Environmental Comparison	**Problems / Concerns**
aquatic vs. terrestrial	water/dehydration, gravity, sunlight – photosynthesis and UV damage
salt water vs. fresh water	salinity – water balance, salt balance – osmoregulation
cold aquatic vs. warm aquatic	temperature – gas solubility (O_2 availability), enzyme kinetics
aquatic: nutrient load	energetics, O_2 availability (eutrification)
cold terrestrial vs. temperate terrestrial vs. hot terrestrial	temperature, enzyme kinetics, water balance, excretion
dry terrestrial vs. humid terrestrial	water balance, dehydration, salt balance, excretion

In general, you, the student, can consider there to be one or two major differences within each of these comparisons. When you are asked to compare a physiological system working in two different environments, first define the difference between the two environments (IN THE CONTEXT OF THE PHYSIOLOGICAL SYSTEM IN QUESTION), and then consider how that physiological system might become adjusted to work under those conditions.

An organism may change its environment, by either moving to a different environment or by literally modifying its environment (building a nest, inventing an airconditioner). An organism may change itself to accommodate the environment. Both choices are also seen to be made internally by either changing a homeostatic setpoint, or by modifying conditions (high blood pressure > decrease blood volume).

Organisms take two approaches to adjust to a changed environment: ACCLIMATE or ADAPT.

Acclimation is a physiological change that allows the organism to cope with a changed condition. It is a homeostatic response. An example is the production of more Red Blood Cells to deal with low [O2] at high elevations (assuming you stay there for a few days). Another example might be increasing your metabolic activity to cope with a lowered ambient temperature, under control of the thyroid hormone pathway. Acclimation is essentially a physiological adjustment that maintains a level of comfort or mitigates a level of discomfort. Organisms may also acclimate by accommodating (changing with the environment). Animals in an estuarine environment live in water that changes salinity every time the ocean tide goes out (and fresh water runs in from streams). These animals may regulate to a constant osmolarity (**osmoregulator**) or change their internal osmolarity to match the external environment (**osmoconformer**). However, internal systems must then adjust (acclimate) to their new environmental osmolarity.

Adaptation is evolution. Adaptation involves the evolutionary selection of gene alleles. Every individual of a population (same species) has the same genes, but each gene may be represented in the population by different versions (alleles). If the activity of a biochemical process is particularly sensitive to environmental conditions, then the specific properties of the proteins of that process might be important. A higher affinity of O2 might to Hb might be good under some environmental condition but not so good under other environmental conditions, where "good" relates to overall survivability and mating success (passing on the genes). A gene is represented by multiple alleles (versions) among a population. The environment changes. Individuals with one specific allele end up predominating in the mating rituals and that representation of that allele in the next generation increases (or maybe decreases). **Adaptation refers to specific alleles.**

Both Acclimation and Adaptation can have a genetic basis. ACCLIMATION might involve changing the amount of gene expression (make more Hb). Acclimation might also involve replacing one gene for another (isozymes): some fish have "cold water genes" and "warm water genes", expressing proteins with different kinetic properties with respect to temperature. In the summer the warm water genes are expressed and the cold water genes suppressed, and the reverse occurs in the winter. All individuals possess both genes, but regulate which gene is expressed. This is really quite common. Consider yeast which express different enzymatic pathways to metabolize under aerobic vs. anaerobic conditions. Consider humans where the fetus expresses a fetal hemoglobin subunit that has higher affinity of O2 than maternal Hb, and is replaced by expression of the "adult" Hb gene shortly after birth. And consider the very interesting situation of sex change, where certain fish species are known to be able to alter the sex of individuals to maintain certain sex ratios – genes maintaining maleness are suppressed and genes maintaining femaleness expressed. Also, **ADAPTATION** may involve the selection of genes whose regulation is different (same coding region, different regulatory region) or the selection of genes which are regulated the same but encode proteins with different properties, or both.