COLD-BLOODED ANIMAL ACCLIMATIZATION TO COLD BIO 3610
Lecture/Study Outline #17

I. Reading: Chapter 3, pp 125-141

II. INTRODUCTION -- CH. 4 HAS TWO MAJOR SECTIONS:

A. "WARM BODIES IN COLD" -- strategy of H_____ which employ both...

1. P_____ THERMOREGULATION

2. P_____ THERMOREGULATION

B. "COLD-BLOODED GAMBLING" -- POIKILOTHERMS [insects, amphibians, etc.]

III. CHALLENGES

A. HOMEOTHERMS -- challenges of high (T_b - T_a), food scarcity, acclimatization, homeostasis

B. POIKILOTHERMS – A_____ or T_____ TISSUE FREEZING

C. SPECIFICALLY, IN INSECTS – which tend to be freeze avoiders

1. PREVENT INTRACELLULAR FREEZING -- some allow extracellular freezing

a. INTERSTITIAL FLUIDS (ISF) =

b. Open circulatory system --

c. Function of ISF = provides corporate homeostasis among cells by close assn. of intra- and extra- cellular fluids

2. FREEZE-RESISTANCE – because ISF normally has a high _____

3. BUT – if ISF Freezes --> "Freeze Concentration" --> Amplifies solute --> "osmotic shock"

> OSMOTIC SHOCK = Salt Imbalance in ISF → Dehydration of cytoplasm → Membrane protein denaturation

> RESULT = Isolates (disconnects) cells from needed "corporate homeostasis"

IV. FREEZE AVOIDANCE -- in arthropods that cannot tolerate ice formation

A. BASIS

1. WATER IN SMALL VOLUMES (in test tubes or cells) CAN S_____

2. Arthropod's amplify this tendency to supercool by the following mechanisms (B.)

B. STRATEGIES for freeze-avoidance

1. BEHAVIORAL -- overwinter in _____

2. MORPHOLOGICAL – waxy exoskeleton _____
– same applies to cocoons

3. CHEMICAL/BIOCHEMICAL

a. REMOVAL OR INACTIVATION OF I____-_____ FROM...

-- GUT -- starting in Fall
-- ISF -- remove lipoprotein nucleators

b. DECREASE WATER CONTENT -- partly by...

c. "ANTIFREEZE PROTEINS" -- interfer with...

d. "ANTIFREEZE COMPOUNDS":
Sugar/ Sugar Alcohols; (GLYGOGEN ---> GLYCEROL)

> MECHANISM = bind water and _____

> REDUCES freezing point (in free water samples) and SCP (in tissues)

C. RISK -- this supercooled state is vulnerable to _____
-- this strategy is favored where a) temps. aren't extreme; b) ice-nucleators absent

V. FREEZE TOLERANCE

A. EXAMPLES: INSECTS -- Coleoptera, Diptera, Hymenoptera, Lepidoptera
OTHER -- intertidal mollusks, barnacles, terrestrial frogs
garter snakes, painted turtle hatchlings

B. STRATEGY -- e_____, c_____, g_____ freezing of ISF

1. INDUCE ICE FORMATION JUST BELOW 0°C

a. EXTRACELLULAR INP's ACT --> physically to provide sites for crystallization

--> energetically to lower the "hump" to crystalization

b. EARLY crystallization, but SLOW development of SMALL crystals in "ISF"

c. ALLOWS TIME for osmotic adjustment -->H_2O leaves by osmosis --> dec. F.P. inside

2. RESTRICT ICE FORMATION TO E_____ SPACES

3. LIMIT AMOUNT OF ICE --> avoid excessive "freeze concentration" of solutes

   a. ANTIFREEZE PROTEINS -- A_____ to INP's to limit crystal growth

   b. CRYOPROTECTANTS -- polyols [glycerol, etc.] bind water from freezing

4. PROTECT MEMBRANES -- *e.g.* sugars

VI. ENVIRONMENTAL STIMULI

A. Low temperature (+5 to -5°C ("5°C trigger") --> synth. of G_____ (& other polyols)

B. Daylength and temperature via hormonal actions --> _____ or _____

VII. FROGS – i.e. terrestrial-"hibernating" species [spring peeper, etc.] under leaves/snow

A. NOT "A_____" as in INSECTS [see Parts IV.B. and VI. above]

B. MECHANISM OF STIMULUS/RESPONSE

1. BODY TEMPERATURE DROPS BELOW SCP --> FREEZING OF ISF

2. GLUCOSE RELEASE FROM LIVER GLYCOGEN --> 200X inc. in blood (diabetic)

3. HEART RATE INCREASES concurrently with...

4. ...BODY TEMP. RISE FROM CRYSTALLIZATION [2°C increase!!!]

5. HEART RATE remains high until ice content of body reaches 60-65%

6. HEART and BREATHING stops --> anaerobic metabolism -->

C. SNOWPACK THICKNESS is important in sustaining temperature above -7°C lethal temp.

VIII. "COLD SHOCK" IN INSECTS

A. DEFINED: Injury or death when exposed to sudden subfreezing temperatures above SCP perhaps due to membrane phospholipid "gelling"

B. SOME INSECT SPECIES avoid injury by --> glycerol production in minutes