ANIMAL PHYSIOLOGY – WINTER 2010
(Note: These is not an all inclusive outline!)
Lecture 1. Outline

Two major themes of course
1. Environmental media  2. Linking Structure and Function

A. ENVIRONMENTAL MEDIA
TWO PRIMARY MEDIA – AIR AND WATER

I. PHYSICAL PROPERTIES OF MEDIA
II. CHARACTERS OF ANIMALS  (Table 2 – handout)

Comparative physiology allows us to compared the unique characters of these extreme groups as well as intermediates (or transitional) animal groups

B. LINKING STRUCTURE AND FUNCTION
Basic Model – the dog  (Handout fig. 1)

I. DESIGN OF ORGANS

C. HOW TO STUDY?
Basis for Comparative Physiology
1. Compare different animals
2. Compare animals of different size
   Allometry – discussed in next lecture
3. Modify the function of animals
   i.e. Training in humans

D. HISTORY –Comparative Physiology – how animals work
1. George Bartholomew

E. ASSIGNMENTS:
1. Review biochemistry – oxidative phosphorylation, electron transport chain of mitochondria
   - get a sense of where ATP formed
2. Read G.A. Bartholomew paper
LECTURE 2/3 – ANIMAL ENERGETICS

Defines animals from inanimate, organisms from objects.
   Note: organisms and environment are inseparable. Keystone species define environment, basis of natural selection/evolution – environment defining animal

I. HISTORICAL PERSPECTIVE

Kleiber – The Fire of Life – 1961
Lavoisier Theory of Combustion and Metabolism

CELLULAR ENERGY METABOLISM

   Energy is stored as Adenosine Triphosphate

   HEADLINE: The universal source of immediate energy in cellular metabolism is ATP

MEASURING – ENERGY METABOLISM OF WHOLE ANIMALS

   1. Direct calorimetry –
   2. Indirect Calorimetry.

TYPES OF METABOLISM

   1. Aerobic or anaerobic
       HANDOUT
       Fig 3.8 illustrates the two major biochemical pathways for producing energy
   2. Types of energy budgets
       ENERGY IN = ENERGY OUT
   3. Levels of Metabolism for animals
a. Minimum metabolic rate
b. Resting Metabolic Rate

c. Active metabolic rate
d. Average Daily metabolic rate

THE EFFECT OF BODY SIZE ON METABOLIC RATE

Allometry

“how does body size affect physiological function?”

A. Metabolic Rate and Body Size

DEFINITION

Allometry – deals with the structural and functional consequences of changes in size or scale among otherwise similar organisms

NOTE: difference occurs with whole animal and “mass specific” values (per gm)

HANDOUT Fig. 3.3 mass specific metabolic rate is the dotted line

VO2 = 0.676Mass^{0.75}

THIS IS THE KLEIBER CURVE DESCRIBING METABOLIC RATE IN RELATION TO BODY MASS FOR MAMMALS

AEROBIC VERSUS ANAEROBIC METABOLISM
Lectures 4 and 5 – RESPIRATION
(see physiology texts for references)

I. Structure and function of the mammalian lung
   Purpose – GAS EXCHANGE

A. AIRWAYS OF THE LUNG
   Conducting Airways - move air to gas exchange surfaces =
   ANATOMICAL DEAD SPACE

   Respiratory Zone
   Blood vessels

   HANDOUT FIG B

BUT THIS ANATOMY HAS SOME LIMITATIONS

II. VENTILATION

   Volumes (use spirometer to measure)

   Minute Volume vs. Alveolar ventilation

How does oxygen move from alveoli to blood?

HEADLINE – All gases move across the alveolar wall by PASSIVE DIFFUSION

   balance of diffusion and perfusion

   HANDOUT Fig 3.3
   Important

III. MECHANICS OF BREATHING

   1. Inspiration
   2. Expiration

   Locomotor/respiratory coupling
MECHANICAL PROPERTIES OF THE LUNG

Lungs are:

1. ELASTIC
   a. Compliance of lung tissue
   b. Surface Tension
   c. Laplace’s Law
      - SURFACTANT

2. CHEST WALLS ARE ELASTIC

3. AIRWAYS have RESISTANCE – physics of moving air

Poiseuille’s equation:

NOTE IMPORTANCE OF TUBE RADIUS

HANDOUT – Back picture very important

Note mammalian lung model: open pool model
LECURE 6 - COMPARATIVE RESPIRATION

Bird Lungs
HEADLINE -Constant Volume, Unidirectional Flow

A. STRUCTURE
Parabronchi
air capillaries

B. FUNCTION

NOTE: AIR FLOW THROUGH PARABRONCHI IS UNIDIRECTIONAL
And maintained during BOTH inspiration and exhalation

INSPIRATION

EXPIRATION

C. GAS EXCHANGE:

- actual exchange is crosscurrent

  Gill  versus  Lung

FISH RESPIRATION
Gills are the major gas exchange surface

A. ANATOMY

Secondary lamellae – equivalent to alveoli

counter current blood flow is key to respiratory efficiency in fish!

B. VENTILLATION IN FISH
ram ventilation

REPTILE RESPIRATION
suction pump

Comparison TABLE of vertebrate respiratory systems

Respiratory Efficiency

NOTE: THE MIDTERM EXAM WILL GO AS FAR AT THE LECTURE ON 1/21