

# **PHYSICAL ERGONOMICS**

**DR. ANKUR GUPTA  
IIT BHUBANESWAR**

# CHAPTER OUTLINE

- Human Physiology
- Muscular Efforts
- Work Physiology



# **HUMAN PHYSIOLOGY**

# LECTURE OUTLINE

- Introduction
- Musculoskeletal system
- Metabolism
- Cardiovascular System
- Respiratory System

# PHYSIOLOGY: AN INTRODUCTION

- A branch of biology concerned with the vital processes of living organisms and how their constituent tissues and cells function
  - Important in work because work requires expenditure of physical energy
- Much of the foundation of knowledge in human physiology was provided by animal experimentation. Due to the frequent connection between form and function, physiology and anatomy are intrinsically linked and are studied in tandem as part of a medical curriculum.

A decorative graphic on the left side of the slide, consisting of two parallel, wavy vertical lines. The inner line is a light blue color, and the outer line is white. They are set against a dark blue background.

# **SUBDIVISIONS**

# **BASED ON THE TAXA STUDIED**

- **human physiology**
- animal physiology
- plant physiology
- microbial physiology
- viral physiology



# **BASED ON THE LEVEL OF ORGANIZATION**

- cell physiology
- molecular physiology
- systems physiology
- organismal physiology
- ecological physiology
- integrative physiology



# **BASED ON THE PROCESS THAT CAUSES PHYSIOLOGICAL VARIATION**

- developmental physiology
- environmental physiology
- evolutionary physiology

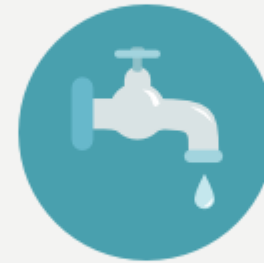



# **BASED ON THE ULTIMATE GOALS OF THE RESEARCH**

- applied physiology  
(e.g., medical physiology)



- non-applied  
(e.g., comparative physiology)





# **PHYSIOLOGY & ERGONOMICS**

# WORK & PHYSIOLOGY

- studies on physiological effects of workload (physical and mental workload) and exposure to occupational hazards (assessment of fatigue and cardiovascular response)
- assessment of adverse health effects of work performance and exposure to occupational hazards (cardiovascular abnormalities, neurovegetative system dysfunction, biological cycle and reproductive function disorders)
- experimental studies on physiological reaction to selected occupational hazards;

# WHAT DO ERGONOMIST DO WITH PHYSIOLOGY

- assessment of the impact of physical workload on the musculoskeletal system in different occupations;
- ergonomic evaluation of workposts, tools and machinery
- experimental studies on an ergonomically optimal design and construction of the workpost;
- expertise for governmental agencies setting hygienic standards for work performance, workload, design and construction of workposts as well as regulations on prophylactic examinations of workers.

# KNOW YOUR BODY

- List out the task/occasions when you feel fatigue and pain.
- Mention the particular part of the body affected and discuss the scientific explanation of internal pain arisen.
- Suggest the possible solution of the problem faced.

# PHYSICAL ERGONOMICS

# HUMAN PHYSIOLOGY

- Human musculoskeletal system
  - Primary actuator for performing physical labor and other activities requiring force and motion
  - Composed of muscles and bones connected by tendons
    - 206 bones in human body
  - Energy to perform physical activity provided by metabolism



# JOINT TYPES FOR BODY MOVEMENT

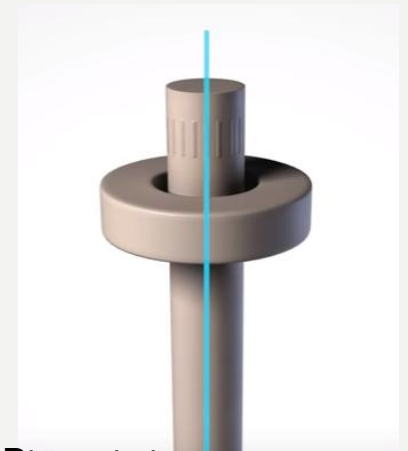
1. Ball-and-socket – shoulder and hip joints
2. Pivot – elbow and knee
3. Hinge – wrist and ankle
  - Ball-and-socket joints can apply greater force than pivot joint
    - Pivot joint can apply greater force than hinge joint



Ball and socket joint



Hinge



Pivot joint

# MUSCLE ACTIVITY

## Skeletal Muscles

- Approximately 400 skeletal muscles
- 40 percent of human body weight
- Provide power for force and motion in the musculoskeletal system
- Blood vessels and nerves distributed throughout muscle tissue to deliver fuel and provide feedback
- Skeletal muscles are connected to bones by tendons which consists of fibrous tissue that transmits force and motions exerted by muscle contraction.

# SKELETAL MUSCLE CONTRACTIONS

- *Concentric* muscle contraction – muscle becomes shorter when it contracts
- *Eccentric* muscle contraction – muscle elongates when it contracts
- *Isometric* muscle contraction – muscle length stays the same when it contracts

Muscle contraction is enabled by the conversion of chemical energy into mechanical energy.  
The conversion process is known as metabolism

# METABOLISM

Sum of the biochemical reactions that occur in the cells of living organisms

- Functions:
  1. Provide energy for vital processes and activities, including muscle contraction
  2. Assimilate new organic material into the body

Metabolism can be viewed as an energy rate process.

# TYPES OF METABOLISM

- *Basal* metabolism – energy used only to sustain the vital circulatory and respiratory functions
- *Activity* metabolism – energy associated with physical activity
- *Digestive* metabolism – energy used for digestion
- Daily metabolic rates:

$$- TMR_d = BMR_d + AMR_d + DMR_d$$

For a 20 year old male:  $BMR_h/kg = 1.0$  kcal per hour per kg of body weight.

For a 20 year old female,  $BMR_h/kg = 0.9$  kcal/hr per kg of the body weight.

(As a person ages, his or her basal metabolism rate declines slowly, so the age correction is simply to subtract 2% from the preceding values for each decade above 20 years)

# NUMERICAL BASED ON DAILY BASAL METABOLISM RATE

- Calculate the **daily basal metabolism rate** for a 35 year old woman who weighs 130 lb.

Ans: The hourly basal metabolism rate must be adjusted for woman's age.

Given that she is 1.5 decades older than 20 years, the age correction would be  $1.5 (.02) = 0.03$

Adjusted  $BMR_h/kg$  value is  $0.9 (1 - 0.03) = 0.873$  kcal/hr/kg of body weight.

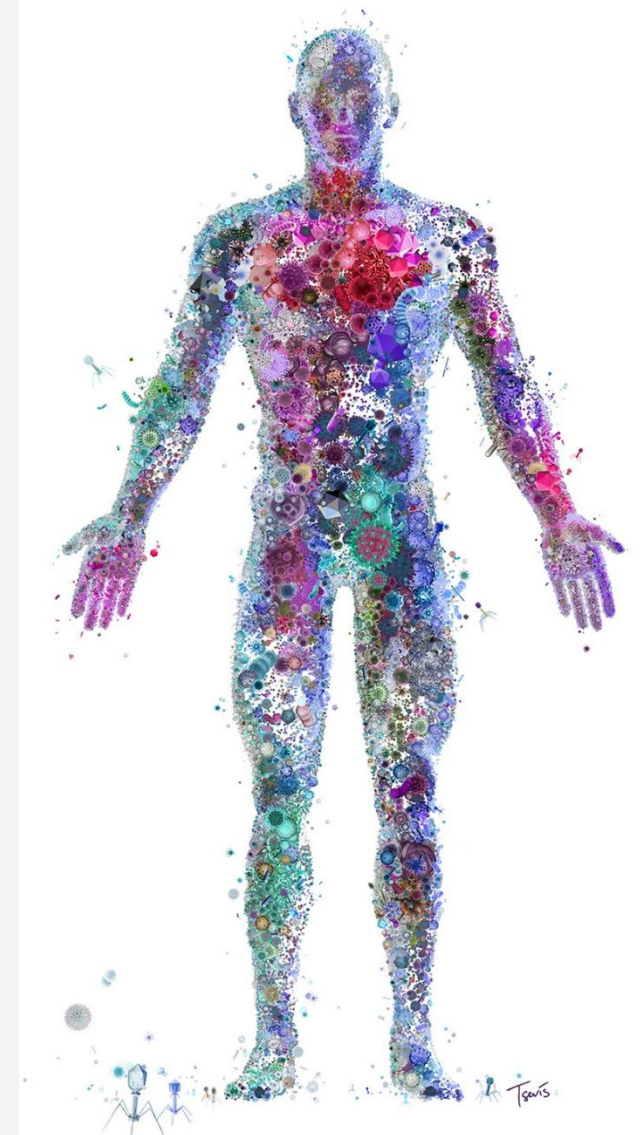
# BIOCHEMICAL REACTIONS IN METABOLISM

- Food categories:
  - Carbohydrates (4 kcal/g) – converted into glucose ( $C_6H_{12}O_6$ ) and glycogen
    - Primary source of energy muscle, brain, nervous system and RBC, helps in regulating fat metabolism.
  - Proteins (4 kcal/g) – converted into amino acids
    - Helps in body tissue growth and maintenance of hormones, enzymes and antibody protection
  - Lipids (9 kcal/g) – converted into fatty acids (acetic acid and glycerol)
    - Use in energy source for body surrounds and cushions vital organs, helps in maintaining body temperature. Essential in vitamins A, D, K E.



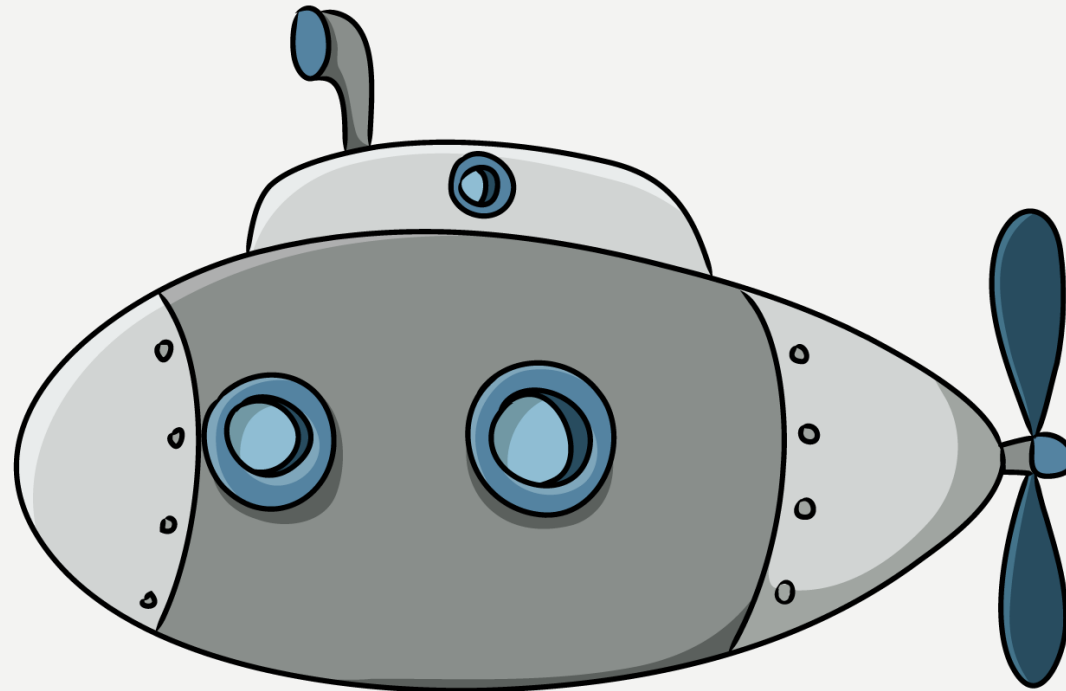
# DID YOU KNOW.....?????

- Not that all microorganisms are bad. You have between 2 and 5 pounds of bacteria living inside you, much of it in the intestines. As scientists have begun to understand what that microbial life is up to, it has become clear that your internal “microbiome” is a big part of what keeps you healthy.



# IF YOU WERE.....?????

- If you were a NAVY commander, how would you train your subordinates to make them adapt to the environment in the submarine for months.....???



# A BRIEF HISTORY OF HUMAN PHYSIOLOGY

- Walter Cannon and Hans Selye used animal studies to establish the earliest scientific basis for the study of stress. They measured the physiological responses of animals to external pressures, such as heat and cold, prolonged restraint, and surgical procedures, then extrapolated from these studies to human beings.
- Subsequent studies of stress in humans by Richard Rahe and others established the view that stress is caused by distinct, measureable life stressors, and further, that these life stressors can be ranked by the median degree of stress they produce (leading to The *Holmes and Rahe Stress Scale*). Thus, stress was traditionally conceptualized to be a result of external insults beyond the control of those experiencing the stress. More recently, however, it has been argued that external circumstances do not have any intrinsic capacity to produce stress, but instead their effect is mediated by the individual's perceptions, capacities, and understanding.

# GRAFFITI





# THANK YOU ...



PLEASE READ FROM RECOMMENDED  
REFERENCE BOOKS FOR A BETTER  
UNDERSTANDING OF NEXT LECTURE