

# Nutritional energetics: definition and forms of energy partitioning

# Introduction

- Fish requires energy for body maintenance, growth, reproduction etc.
- Aquatic animals are cold blooded- their metabolic rate depends on temperature of water.
- Fish will eat more feed in summer than in winter among different seasons
- Food requirement of different species varies according to the nature of animals, feeding habits, size, environment, reproduction state, etc.



- **Energy**

- Energy is defined as the capacity to do work, and is derived through the catabolism of dietary carbohydrates, lipid and protein within the body.
- Energy is therefore essential for the maintenance of life processes such as cellular metabolism, growth, reproduction, and physical activity.



- **Bioenergetics**

- Study of balance between energy intake and energy utilization for life sustaining processes such as

- Maintenance

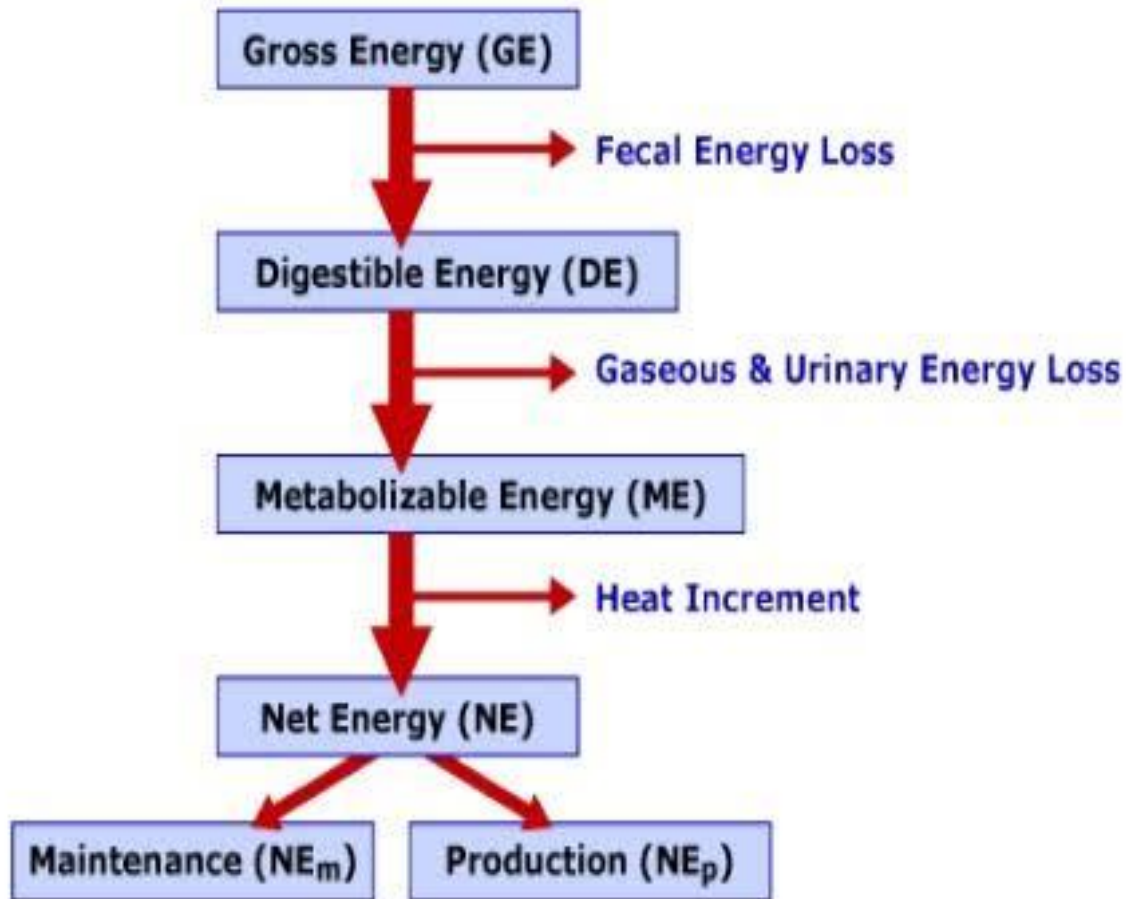
- Activity


- Tissue synthesis

- Also known as energy budget.

- Animal nutritionists are concerned primarily with two forms of energy, chemical and heat.

# FORMS OF ENERGY PARTITIONING



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- **Intake energy:** is the gross energy consumed by the animal from their food. This energy is mainly in the form of proteins, lipids and carbohydrates
  - **Faecal energy:** is the gross energy of the faeces and consists of undigested food, metabolic products and other factors, such as mucous.

- **Digestible energy:** represents the energy that the animal has absorbed from its food. It is the Intake Energy – Faecal Energy.
- **Urinary energy:** is the gross energy of the urinary products produced by the animal.
- **Gill excretion energy:** is the energy of the compounds that are excreted from the gills. This energy can be high in fish and may compose a major part of the energy budget.

- **Surface energy** is the gross energy lost in the form of scales and mucous.  $DE = IE - FE$
- **Metabolizable energy:** is the energy available to the animal to conduct the various metabolic processes.
- ME is the energy in the food less the energy lost from faeces and wastes energy.




- **Retained energy** that portion of energy contained in the feed that is retained as part of the body or voided as a useful product such as gametes.  $ME = DE - (GE + ZE + UE + SE)$   $RE = ME - HE$
- **Total heat production energy (HE):** is the energy lost from the animal in the form of heat. The heat is produced as a result of metabolism and so HE is a measure of metabolic rate in fish.


# Factors affecting Energy Partitioning

- Basal metabolic rate: Body size, oxygen availability, temperature, osmoregulation, stress
- Non-basal metabolic rate: gonadal growth and locomotion

- **Body size:** Direct relation with metabolic rate. Metabolic rate increase directly with increasing body size.
- **Oxygen Availability:** Aquatic animals consume  $O_2$  either at a rate directly dependent upon ambient oxygen tension (conformers) or at a rate independent of ambient oxygen tensions (Non-conformers or regulators).
- In Non-conformers,  $O_2$  consumption remains constant until  $O_2$  tension in the ambient water reaches a critical low level

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- **Temperature:** Direct relation with metabolic rate. Water temperature plays an extremely important role in energy partitioning.
  - Two effects of temperature can be observed in aquatic animals. When an animal is acclimated to a certain temperature and then introduced to a greater temperature, its metabolic rate will increase. If the animal is soon returned to the original temperature, its metabolic rate will return to the original rate.

- **Osmoregulation:** Salinity of an environment of fish plays an important role in energetic cost of osmoregulation. Freshwater fish live in an environment i.e. hyposaline to their body tissues and hence exchange continually, water and sequester ions. Salt water fish have exactly opposite problems and spend energy availing the loss of water and in excreting ions.

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- **Stress:** Stress results in increased basal metabolic rate and induced by several factors. Accumulation of waste products in water, low  $O_2$  crowding, handling, external disturbances, water pollution, poor quality feed.

# Factors affecting Non-basal Metabolic rate

- **Gonadal Growth:** Gonadal growth results in the diversion of large amounts of energy away from growth of muscle and other activities. At reproductive season, gonads may account 30-40% of fish weight.
- **Locomotion:** Energy cost of locomotion is a major part of total energy consumption, varies between species depending on body shape and behavioural patterns.