

# Aquatic Animal Nutrition

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FISH 7640

General Introduction

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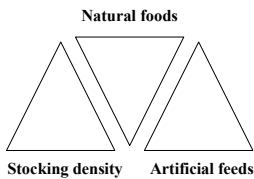
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**Aquaculture:** Conversion of “low cost” food item into a “high valued product”

Continuum of culture techniques

–Extensive: Non-supplemental feed systems, nutrients are derived from natural food sources.

–Intensive: Supplemental feed system, majority of the nutrients are provided by the culturist.



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# Aquaculture

- System must be
  - Sustainable
  - Environmentally friendly
  - Compatible with other natural resource

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Sustainable:  
 Catfish  
 Carp  
 Tilapia  
 Salmonids

Problematic  
 China's cage culture  
 Super intensive shrimp




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## General shift from extensive to intensive production systems

- Increases production yield per unit area
- Higher gross return
- Reduces site limitations
- Reduces labor cost per unit product
- Increases control of stock management
- Reduces production variability

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## Success of an intensive operation

- Infrastructure inputs
- Site limitations
- Management limitations
- Availability and quality of prepared feeds
  - Growth rates
  - Health or disease resistance
  - Cost of production (40-70% cost)
  - Nutrient loading of the culture system

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## Prepared feeds

- Nutritious
  - Formulated to provide required nutrients
  - Avoid nutrient imbalances
  - Adequate energy for metabolism
  - Digestible
- Properly processed
  - Water stable
  - Palatable: appropriate size, shape, texture and taste
- Properly applied
- Cost effective

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## Feed Processing

- Conversion of various feed ingredients into a nutritionally complete diet
  - Formulation
    - Identification of nutritional restrictions
    - Ingredient selection and restrictions
  - Processing
    - Grinding
    - Mixing
    - Forming
    - Drying

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## Development of Formulations

- Required information
  - Nutritional requirements of the culture species
  - Biological availability of nutrients from ingredients
  - Characteristics that are acceptable to the culture animal
    - Attractability
    - Palatability

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Objective:

To study current concepts in aquatic animal nutrition

- Factor effecting feed utilization
- Nutrient ingestion/digestion
- Nutrient requirements & metabolism
  - Maintenance
  - Growth
  - Reproduction
- Feed processing
- Feeding

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## Definitions

- Feed Conversion Ratio
  - Feed intake /wet wt. gain
- Feed efficiency
  - Wet weight gain/feed intake \* 100
- Protein efficiency
  - Protein gain/protein intake \* 100

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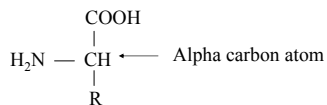
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## Amino Acid

- Short chain fatty acid that contains
  - Basic amino group (  $\text{NH}_2$  )
  - Acidic carboxyl group (  $\text{COOH}$  ).
  - 20 to 22 A. A. commonly found in proteins.



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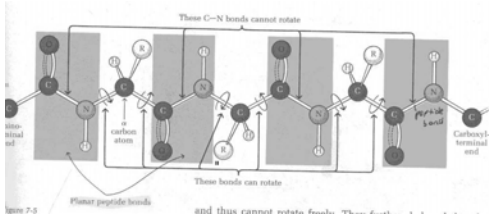
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# Protein

- Simple Protein:
  - Large complex molecules composed of various repeating units of amino acids (peptide bond).



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# Protein

- Protein structure
  - Primary structure: amino acid sequence
  - Secondary structure – near neighbor (close in linear sequence) folding or localized
    - alpha-helix
    - beta-sheet
  - Tertiary - Relationship of amino acids that are far apart. Folding of AA sequence back on itself.

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# Protein

- Conjugated Protein
  - Simple proteins combined with a non-protein radical (prosthetic group) e.g. nucleoproteins (ribosomes: RNA), phosphoprotein (casein of milk: phosphate) metaloproteins (cytochrome oxidase: iron and copper), lipoproteins (VLDL: phospholipid, fat, cholesterol) etc

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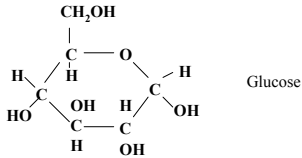
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## Carbohydrates

- Chemically, carbohydrates are polyhydroxy aldehydes and ketones, or substances which yield them on hydrolysis.
- $(\text{CH}_2\text{O})_n$
- Sugar, starch, cellulose, gums and related substances
- < 1% vertebrates (glucose and glycogen)
- Up to 75% in plants



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## Carbohydrates (CHO)

- Plants:
  - Soluble forms serve in plant systems in energy transformation and for tissue synthesis
  - The less soluble ones such as starch serve as reserve energy
  - Relatively insoluble fractions (cellulose, hemicellulose) structural.

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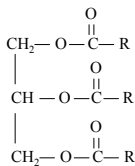
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## Lipids

- Organic compounds that are insoluble in water, but soluble in organic solvents. e.g. glycerol and 3 fatty acids.
- Energy source
- Component of membranes



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- Vitamins
  - A trace organic substance required in the diet of some species; most vitamins function as components of certain coenzymes.
- Minerals
  - Inorganic constituent. Not all inorganic elements found in the body have a dietary essentiality. A dietary need for 23 minerals has been identified.

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### **DEFICIENCY SYMPTOMS**

- Nutritional deficiencies result from the improper balance with respect to protein (gross or EAA), carbohydrates, lipids (EFA), energy, vitamins and minerals or due to anti-nutrients.
- Nutritional deficiencies range in severity and may not be displayed until a secondary stress (low D.O., disease challenge etc.) is encountered.

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Deficiencies or imbalances can result in

- Poor growth and feed conversion
- Decreased survival
- Decreased immunocompetence
- Skeletal abnormalities
- Skin and fin hemorrhages and lesions
- Nervous disorders
- Poor hatch rate
- Lack of reproduction etc. etc.

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## Feeding behavior and culture



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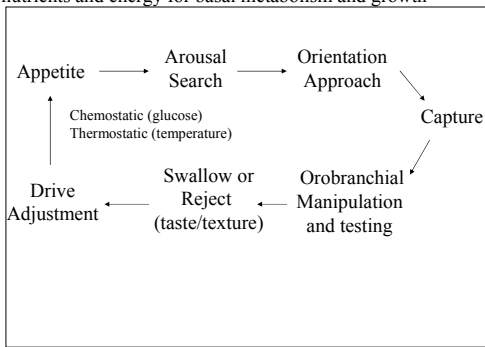
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**Nutrient intake:** Driven by a need to obtain nutrients and energy for basal metabolism and growth



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## Common thread

- Optimum forage theory
  - Natural selection favors a animal whose foraging strategy provides the highest possible rate of energy intake relative to energy expended in feeding.
  - Energy costs are determined by encounter rate (time spent locating and identifying food which is dependent on prey abundance and the predator's perceptual abilities) and a handling time cost (the energy and feeding time expended in capture, manipulation and test).
  - Energy intake is dependent on the assimilation efficiency of the food.

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## Practical implications for culture

- Encounter rate need to be maximized by concentrating food availability in time and space
  - Reduce search energy
  - Reduce competition or aggression
- Food supply must be matched to appetite or demand
  - Overfeeding – waste food
  - Underfeeding – does not waste food may cause aggression
  - Predator – large stomach tend to overfeed
  - Grazer – small or no stomach need to eat on a continual basis (shrimp)

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- Chemical and physical characteristics (especially size) of food particles need to be related to species, size and sensory abilities to aid location, identification and capture.
  - Very important in shrimp and larvae
- Chemical and physical characteristics should be designed to minimize handling time and wastage.
  - Very important in salmonids, tend to handle the food
  - Palatability
    - Texture
    - pH
    - Taste
      - absence of attractants
      - presence of feeding deterrents

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