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ORNAMENTAL FISH Culture

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Nutrition of Ornamental Fish

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Overview

- Introduction
- Major group of nutrient requirements
  - Protein
  - Lipid
  - Carbohydrate
- Additives
- Types
- Feeding management

Traditionally, fish fed with live feed

Disadvantages

- Nutritional defficiency
- Transmitter of diseases (parasitic, bacterial and viral)
- Costly

Formulated feed

- Increase production efficiency
- Growth
- Propagation of ornamental fish

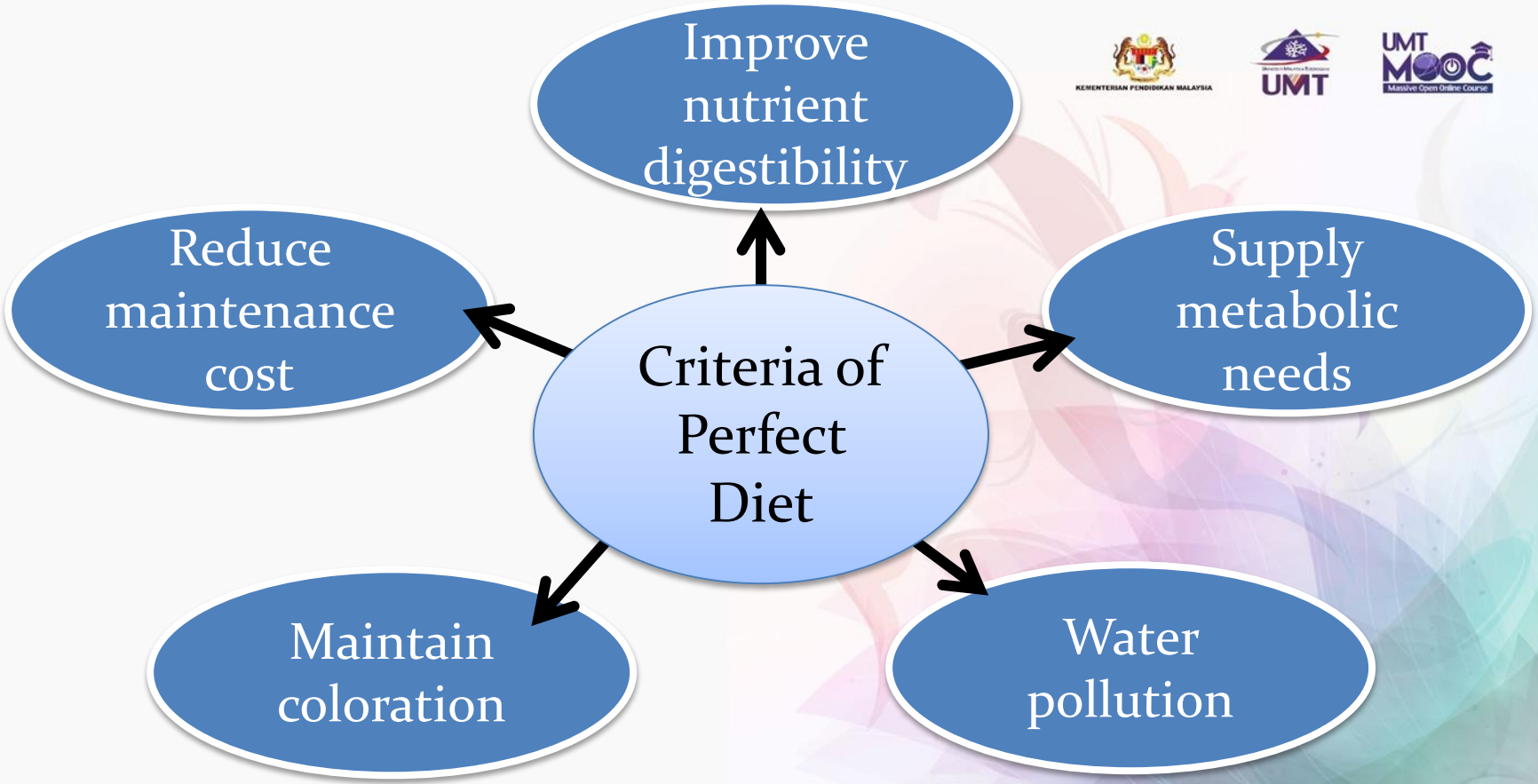
- Wide and complex area of study
  - Species
  - Production system
  - Life stages

FORMULATED FEEDS for Ornamental Fishes

- **Issues**
  - Nutritional information are heavily relying on non-ornamental fishes study
  - Ornamental feed production usually opt for broad type of fishes – omnivorous
    - Impractical to feed very specific diets to individuals in an aquarium environment

Essential amino acid requirements (g per 100 g protein) of goldfish (*C. auratus*) larvae (Fiogbé and Kestemont, 1995) compared to requirements of juvenile tilapia (*Sarotherodon mosambicus*) (Jauncey, 1983)

Amino acid	Goldfish	Tilapia
Arginine	7.8	2.8
Lysine	11.8	3.8
Histidine	4.1	1.1
Isoleucine	6.0	2.0
Leucine	9.1	3.4
Valine	7.0	2.2
Phenylalanine	5.6	2.5
Threonine	6.4	2.9
Methionine	3.4	–


Improve nutrient digestibility
Reduce maintenance cost
Criteria of Perfect Diet
Supply metabolic needs
Maintain coloration
Water pollution

WHAT DO WE NEED TO KNOW?

Criteria – Function - Source

Storing

Analyzing

Behavior

Animals

Digestive system

Vitamins and Minerals

Absorption

Supplementation

Origins

WHAT DO WE NEED TO KNOW?

Additives

Carbohydrate

Formulated feed

Management

Ash

Energy

Packaging

Lipid

Live Feed

Cost

Activate/Inhibit

Importance

Nutritional requirements

Protein

Calculation

Fiber

Protein and amino acids

Carotenoids

Lipids and fatty acids

Major Group of Nutrient Requirements

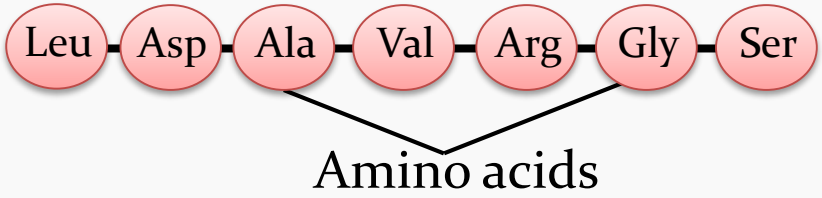
Vitamins

Carbohydrates

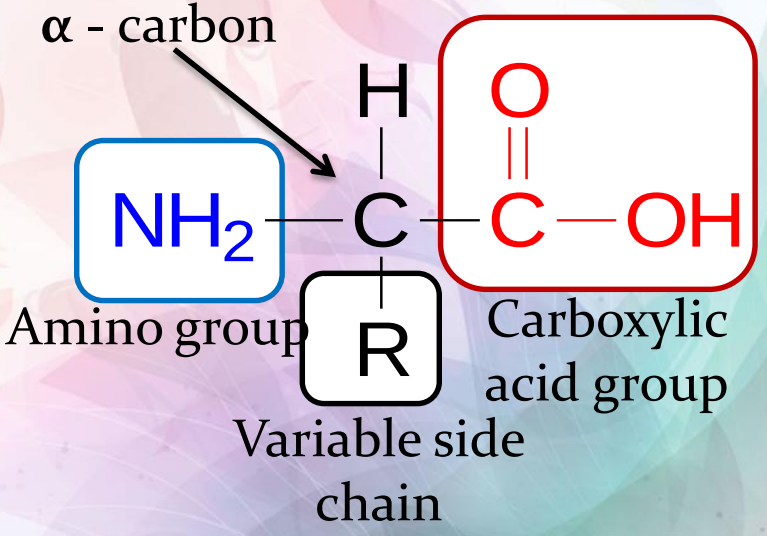
Minerals

Protein & amino acids

Protein - long chain of amino acids linked by peptide bonds



Element of protein :
Carbon, Hydrogen, Oxygen, Nitrogen



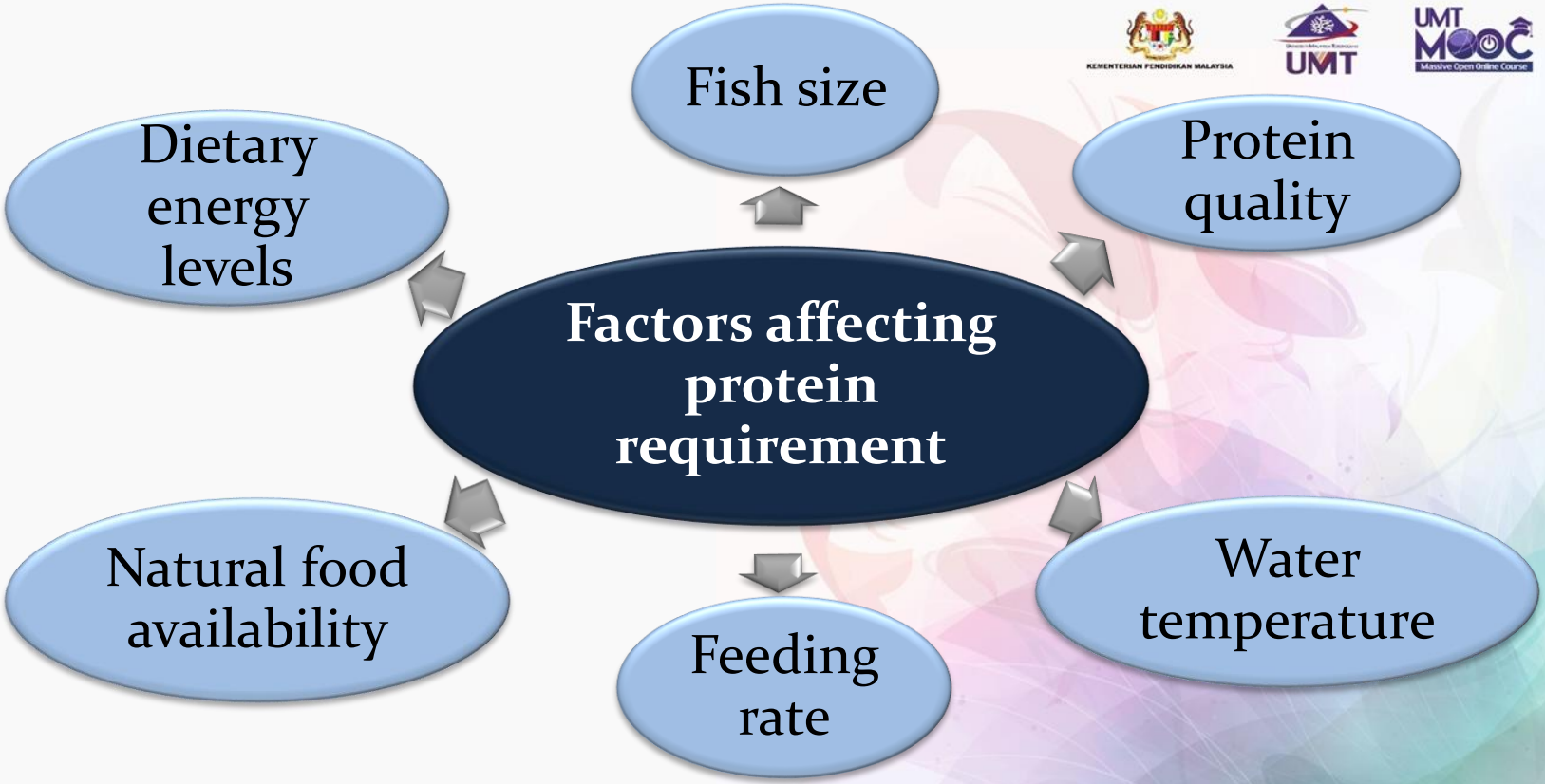
Amino acid structure

Essential and non-essential amino acids

Essential/ Indispensable	Non-essential/ Dispensable
Arginine	Alanine
Histidine	Asparagine
Isoleucine	Glutamic acid
Leucine	Glycine
Lysine	Aspartic acid
Methionine	Serine
Phenylalanine	
Threonine	
Trytophan	
Valine	

What needed by fish???

- **Indispensable** amino acids are needed first as they cannot be synthesized. Can be gained from the diet
- Then **dispensable** amino acids can be made to enable the synthesis
- Requirement of dietary protein for ornamental fish are at utmost efficiency
- Breakdown product of protein metabolism (ammonia) can pollute fish living environment


Fish size
Protein quality
Dietary energy levels
Factors affecting protein requirement
Natural food availability
Water temperature
Feeding rate

The protein requirements for growing some ornamental fish under captive conditions are presented in Table 1.

Table 1
Protein requirements of ornamental fish species

Common name	Species name	Initial size (g)	Energy	Protein source	Parameters	Dietary requirements (%)	Reference
Guppy	*P. reticulata*	0.10	13.10 kJ g^{-1} ME	Fish meal, casein	Weight gain, feed conversion, gonadal development	30–40	Shim and Chua (1986)
Goldfish	*C. auratus*	0.20	11.72 kJ g^{-1} DE	Fish meal, casein	Weight gain, feed conversion, protein efficiency ratio	29	Lochmann and Phillips (1994)
		0.008	20.3 kJ g^{-1} GE	Fish meal, casein	Specific growth rate, feed efficiency, nutrient retention	53	Fiogbé and Kestemont (1995)
Tin foil barb	*Barbodes altus*	0.81	20.38 kJ g^{-1} GE	Casein	Weight gain	41.7	Elangovan and Shim (1997)
Discus	*S. aequifasciata*	4.45–4.65	21.65 kJ g^{-1} GE	Fish meal, casein	Specific growth rate	44.9–50.1	Chong et al. (2000)
Redhead cichlid	*Cichlasoma synspilum*	0.28	1.55 kJ g^{-1} DE	Fish meal	Specific growth rate	40.81	Olvera-Novoa et al. (1996)

GE, gross energy; ME, metabolisable energy; DE, digestible energy.

- Fish ingest food, to gain enough energy and protein and energy should be balanced
- Although fish utilize energy sufficiently, excessive nutrients may restrict protein consumption and subsequent growth

At least **45%** **protein** at 6% lipid level

= ✓ Specific growth rate
↑ Feed conversion ratio

- Current approached of protein source with used of soybean meal as an alternatives to replace fish meal in diet

Lipids & fatty acids

Class of lipids

- Fats
- Oil
- Waxes
- Phospholipid

Element of lipid:
Carbon, Hydrogen, Oxygen

Saturated fatty acids (SAFA)

Palmitic acid, stearic acid

Monounsaturated fatty acids (MUFA)

Oleic acid

Poly and highly unsaturated fatty acids (PUFA/HUFA)

Ecosapentaenoic, docosahexaenoic, arachidonic, linoleic, linolenic

- Low energy demand by fish compared to terrestrial animals caused deposition of excessive lipid

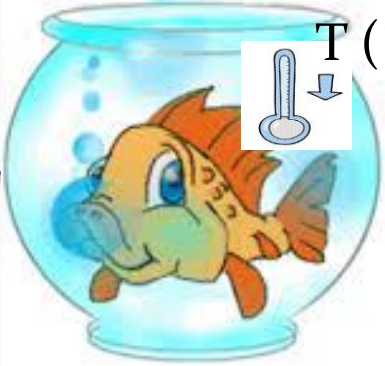
Main function of lipids

- Provide energy
- Serve as structural components of biological membranes
- Provide essential fatty acid
- Serve in regulatory function – carriers for fat, fat soluble vitamins and sterols

- Importance for normal **growth** and **survival of fish**

Fish needs...

Longer chain fatty acids **(CFAs) = >12 carbons**



Degree of unsaturation

Melting point

- To support cell membrane flexibility at **low** temperature

High degree of unsaturation = **multiple rings/bonds**

- Generally…
  - Freshwater fish needs either dietary linoleic acid (18:2n-6), or linolenic acid (18:3n-3), or both
  - Marine fish needs dietary eicosapentaenoic acid (20:5n-3) and/or docosahexaenoic acid (22:6n-3)
- Supplemental phospholipids are not essential for survival of small (0.3 g) juvenile goldfish
- About 1% of linolenic acid (18:3n-3) is required in the diet of carp to keep lipogenesis low and to prevent overproduction of oleic acid

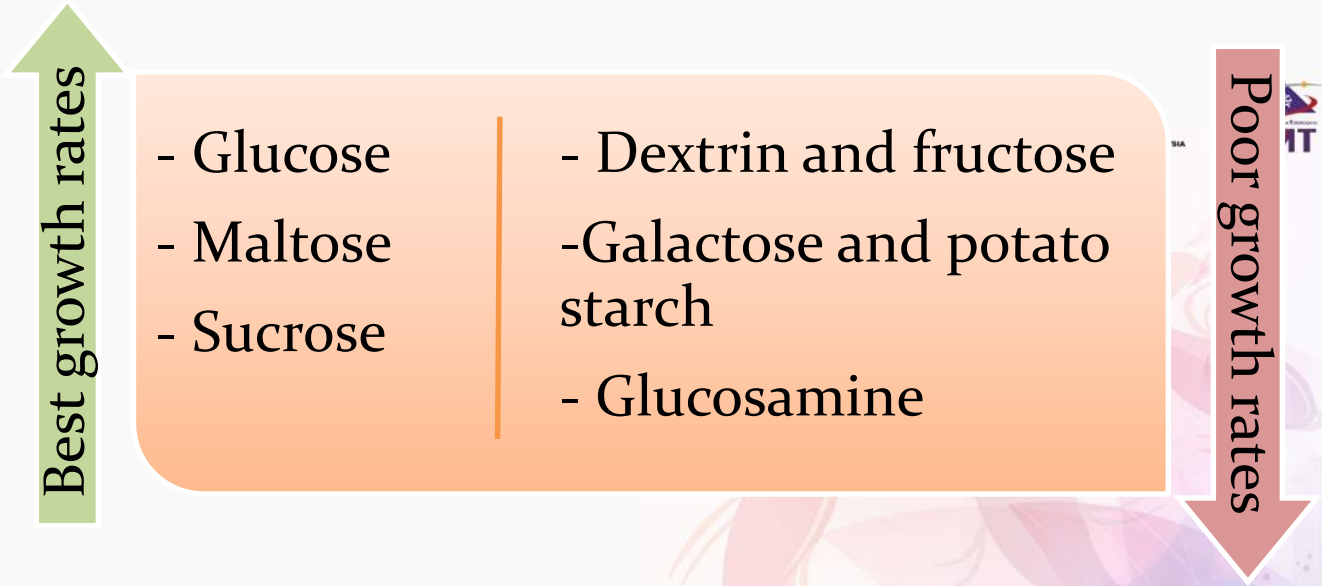
Carbohydrates

Class of carbohydrate

- Monosaccharides
- Oligosaccharides
- Polysaccharides

Element of carbohydrate:
Carbon, Hydrogen, Oxygen

- **Organic compound** with cheap energy source for sparing the catabolism of other nutrients such as protein and lipids
- Warm water fish can use much greater amounts of dietary carbohydrate than cold water and marine species



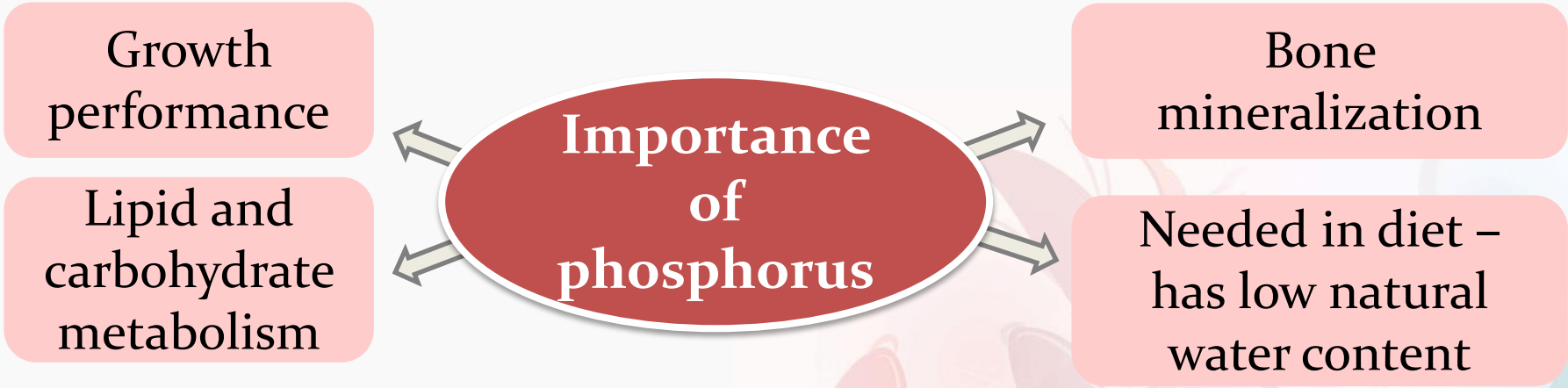
- Most herbivorous fish, such as goldfish and koi carp, use the microflora in their hind gut to digest complex carbohydrates
- Carbohydrate digestibility can vary from 70% in goldfish to as low as 50% for moonlight gourami (*Trichogaster microlepis)*

Minerals

Class of minerals

- Macrominerals – required in **large** amounts – calcium, chloride, magnesium
- Microminerals – required in **small** amount – chromium, cobalt, copper

- **Inorganic element** found in ash when a food or body tissue is burnt
- Fish utilize minerals for tissue formation and various functions in metabolism and regulation
- Ornamental fish can absorb some water soluble minerals from the water, complicating studies in determining dietary mineral requirements.



- In accordance to results obtained with food fishes dietary calcium was found to be non-correlated to fish growth in guppies
- Similar as with food fishes, depressed appetite, scoliosis and lordosis have been reported in guppies fed phosphorus deficient diets

Mineral requirements of ornamental fish species

Table 3
Mineral requirements of ornamental fish species

Mineral	Common name	Species name	Initial size (g)	Parameters	Dietary requirements (%)	Reference
Phosphorus	Tiger barb	*Barbus tetrazona*	0.33	Weight gain	0.52[a]	Elangovan and Shim (1998)
Phosphorus	Guppy	*P. reticulata*	0.24	Weight gain, mineralisation	0.53–1.23	Shim and Ho (1989)
Iron	Guppy	*P. reticulata*	4 weeks	Prevention of hypochromic, microcytic anaemia[b]	0.008	Shim and Ong (1992)
Magnesium	Guppy	*P. reticulata*	0.17	Weight gain	0.054	Shim and Ng (1988)
Zinc	Guppy	*P. reticulata*	0.25	Weight gain, feed conversion	0.01	Shim and Lee (1993)

[a] Originating from potassium phosphate monobasic (KH_2PO_4).

[b] A condition characterised by a reduced blood cell count, haemoglobin content, haematocrit, and erythrocyte values.

Vitamins

- Organic compounds that required in relative small quantities, but essential for growth, health, reproduction and maintenance
- Frequently fish could not synthesize at all, or can only synthesize insufficient quantity

Types of vitamins

- Fat soluble - Vit A, D, E, K
- Water soluble – Biotin, choline, folic acid, niacin

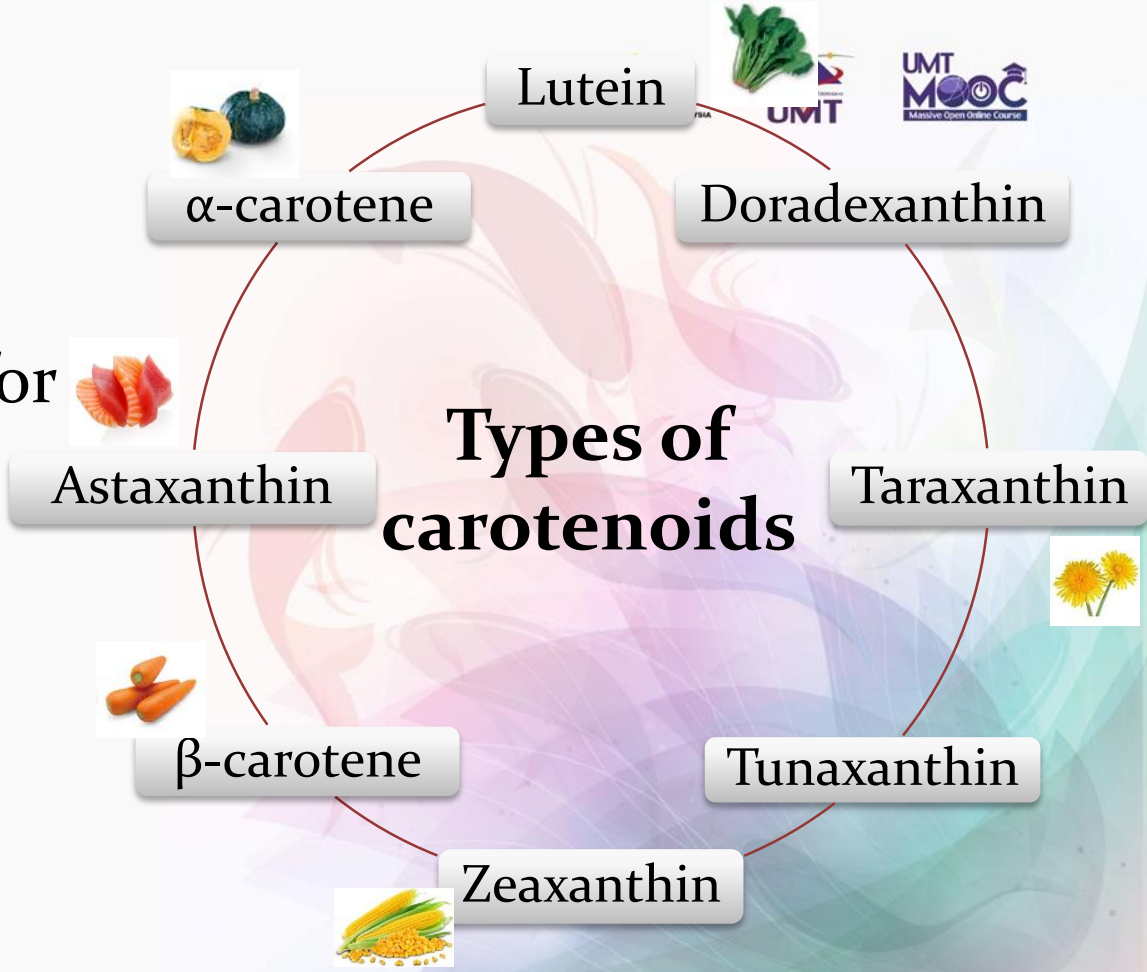
- Water-soluble vitamins are most vulnerable to nutrient leaching. A large percentage of vitamin C, vitamin B12, choline, and panthothenic acid are lost in water within 30 s of feeding some commercial flake diets

- Case study of juveniles Amazonian ornamental fish, the Oscar (*Astronotus ocellatus*) showed that, lowest level of ascorbic acid (25 mg kg–1 diet) was sufficient to :-

    - Prevent growth reduction
    - Ascorbic acid deficiency signs (opercula and jaws deformities, haemorrhage in the eyes and fins, lordosis)

Carotenoids

- Oxygenated molecule that important as natural pigmentation for skin and flesh of fish
- Common occur in freshwater



- Fish cannot synthesize pigments, thus rely on dietary supply of carotenoids to achieve their natural skin pigmentation

- Pigmentation is important quality criteria addressing the market value of ornamental high value species such as Koi carp (*Cyprinus carpio*) and goldfish

Goldfish

Red coloration by astaxanthin metabolize from yellow pigment zeaxanthin

Koi carp

- Goldfish metabolised very little beta-carotene and no lutein to astaxanthin

Accumulate secondary carotenoids

Well culture condition:
- ✓ Nitrogen depletion
- ✓ High salinity
- ✓ Light intensity

Algae *Chlorella* sp., Spirulina

=

replace costly synthetic colorings in ornamental fish feed

Other dietary components

Water	• Easily storage and handling with minimal amount in diet
Fiber	• Plant material - cellulose • Indigestible and do not crucial in nutrition
Hormones	• Growth, thyroid hormones, gonadotropin, androgens, estrogens
Antibiotics	• Sulfadimethoxine/ormetoprim and oxytetracyline
Antioxidants	• Ethoxyquin – used in fish meal

Type of formulated feeds

Pellets		Floats pellet for top feeders, and sink pellet for bottom feeders
Flakes		Suitable for all types of fish. Flakes will float first, then gradually sink to bottom
Tablets and granular food		Suitable for bottom dwellers. They sink quickly to bottom
Freeze-dried food		Most of nutritional value of food is retained, has long shelf life and does not need refrigeration
Vacation food		In tablets or compacted into molded forms. Slowly dissolve into water over several days

Others

Freeze-dried food

Eg: tubifex worms, blood worms, krill and brine shrimp

- Needs look up into more manageable bits for small fish

Frozen food

Eg: brine shrimp, plankton, krill, and bloodworms

- One of the best alternative food as it is good source of protein
- Excellent to stimulate fish that loss appetite

Live food

Eg: worms, insects and larvae

- Good deal of nutritional value
- Stimulate hunting instinct for carnivorous fish
- Encourage finicky, new or sick fish to eat
- Potential of poisonous and contaminations

Feeding requirements in some ornamental fishes

Maintenance feeding requirement of five popular species of ornamental fish (Pannevis and Earle, 1994b)

Common name	Species name	Initial size (g)	Maintenance feeding requirement (mg feed per day)	Maintenance energy requirement (J DE per day)
Goldfish	*C. auratus*	3.59	14.36	239
		4.78	11.47	191
		8.06	25.79	429
		11.66	18.33	306
Neon tetra	*P. innesi*	0.18	3.8	68
Leopard danio	*Brachydanio rerio*	0.30	<7.2	<128
Kribensis	*Pelvicachromis pulcher*	1.02	<10.2	<182
Moonlight gourami	*T. microlepis*	1.87	<28.5	<508

DE, digestible energy; GE, gross energy. Goldfish diet, 19.38 kJ g^{-1}; GE, 16.65 kJ g^{-1} DE. Diet for other species, 19.66 kJ g^{-1} GE; 17.83 kJ g^{-1} DE. Water temperature at 20 °C for goldfish and 26 °C for other species.