MODULE 1:
Fuel for Life

About the module
- Explores the role of nutrition in health and the complex systems that underpin nutrition
- Investigates the essential nutrients for life, source of energy and explores the concept of energy balance and its relationship to disease
- Examines different anatomical structures of the digestive system and the processes involved in the break down and extraction of molecules
- Introduces concept of microbiome and its role in immune and metabolic health
- Covers balance of macronutrients in the body and the storage, release and transport of molecules in response to stimuli

Lecture 1: Is nutrition a unique determinant of health?

- Human nutrition: processes whereby cells obtain and utilise necessary substances to maintain life
    - Ranges from a molecular to a societal level
- A healthy diet:
    - Satisfies energy requirements (macronutrients)
    - Provides adequate amounts of micronutrients (eg. vitamins, minerals)
    - Reduces risk of disease
    - Is safe to consume
- Refined carbs, salts, saturated fats → ↑ risk of obesity, hypertension, heart disease and energy density of the diet
- Fruits, veggies, fibre rich food → beneficial for CVD disease, ↓ energy density of the diet

Sources of information about nutrition

Animals	Humans
- Feeding domestic (farm) animals - Controlled experiments eg. rodents	- Natural experiments (famine, war) - Controlled experiments eg. clinical trials - Hunter-gatherers - Epidemiology - Case studies eg. individuals w/ rare disease - Patients reliant on intravenous feeding

Relationship between nutrition and health

Nutritional situation	Health outcomes
Optimum nutrition Food-secure individuals with adequate and balanced diets	- Normal development - High quality of life

Undernutrition Food-insecure individuals living in poverty, ignorance, politically unstable environments	- Decreased physical and mental development - Compromised immune systems - Increased infectious diseases - Cycle of undernutrition → underdevelopment → poverty
Overnutrition Overconsumption of food (esp. macronutrients) in addition to low physical activity, smoking, stress, alcohol abuse	- Chronic NCDs eg. type 2 diabetes, obesity, CVD - Metabolic syndrome
Malnutrition Nutrition transition: Individuals and communities previously food insecure → confronted with abundance palatable foods → some undernourished	- Double burden of infectious diseases and NCDs, often characterised by too many macronutrients and too few micronutrients

- Body composition: 60% H_2O, 17% protein, 17% fat, plus other
- Influences on food intake and dietary patterns:
    - Industrialisation of food production and distribution
    - Availability
    - Culture, cuisines, traditions
    - Location, environment
    - Individual preferences, knowledge, health beliefs

Overnutrition

- A form of malnutrition → overnutrition of macros and undernutrition of micros
- ↑ risk of chronic NCDs
- Consequence of nutrition transition: hunter gatherer → agriculture → industrial
- Defined by degree of overweight/obesity in an individual

→ Obesity - a condition of abnormal or excessive fat accumulation in the adipose tissue, to the extent that health may be impaired[1]

- Often measured through BMI: $\frac{weight\ (kg)}{(height\ (m))^2}$

Normal range	Overweight	Obese
18-25	25-30	>30

    - **Limitations**: does not measure body composition eg. fat, tissue, as mentioned in the definition of obesity by WHO
    - Advantages: easy, non-invasive, can be applied across populations
- General trend in obesity and changes in food intake: ↓ energy expenditure (1950s-90s) due to technological advancements eg. cars, television
- Mean BMI of adults and children ↑ worldwide (1980-2010)
    - Similarly, the number of obese men and women is increasing over time
- Visceral fat - in and around your organs, contributes to poor health

[1] World Health Organisation

- Subcutaneous fat - fat just under the skin, beneficial fat

Growth and longevity

- *Across* species, a greater adult body mass is associated with a longer lifespan than a smaller adult body mass
    - Doubling of species body mass increases lifespan by 16%
- *Within* a species, body weight is inversely associated with lifespan

Lecture 4: Nutrients

1. Two broad types of nutrients:

- Macronutrients - energy supplying nutrients eg. carbs, fat, protein
- Micronutrients - vitamins (vital to health), trace elements

1.1 Properties of nutrients

- Chemical and physical structure
- Sourced from food
    - Affected by cooking/processing → alters nutrients eg. vitamin C is heat sensitive and lost in heat
- Digestion, absorption, transport, cellular uptake and regulation of these processes
- Micronutrients → deficiency and toxicity

1.2 Classes of macronutrients

Class	Subclass	Nutrient examples
Carbs	Monosaccharides	Glucose, fructose, galactose
	Disaccharides	Sucrose, maltose, lactose
	Polysaccharide	Starch and fibre
Proteins	Plant and animal source proteins - Animal proteins → higher quality as they contain essential amino acids in similar proportion to what our body needs	Amino acids
Fats and oils (lipids)	Saturated fatty acids, Monounsaturated fatty acids, Polyunsaturated fatty acids	Palmitic and stearic acid, Oleic and elaidic fatty acids

1.3 Acceptable Macronutrient Distribution Range (AMDR)

Carbohydrate	45-65%
Fat	20-35%
Protein	15-25%

1.4 Classes of micronutrients

Class	Subclass	Nutrient examples
Minerals	Minerals & electrolytes Trace elements	Ca, Na, K, Fe, Zn, Se, Cu, Mn, phosphate, molybdenum, fluoride, chromium
Vitamins	Fat soluble Water soluble	Retinol (A), calciferols (D), tocopherols (E), vitamin K Ascorbic acid (C), thiamin (B1), riboflavin (B2), niacin (B3), B6, B12
Water	Water	Water

2. Nutrient reference values

- Set using age groups, gender, standardised body weights

Estimated average requirement (EAR)

- Nutrient level estimated to meet the requirements of 50% of healthy individuals

Recommended daily intakes (RDI)

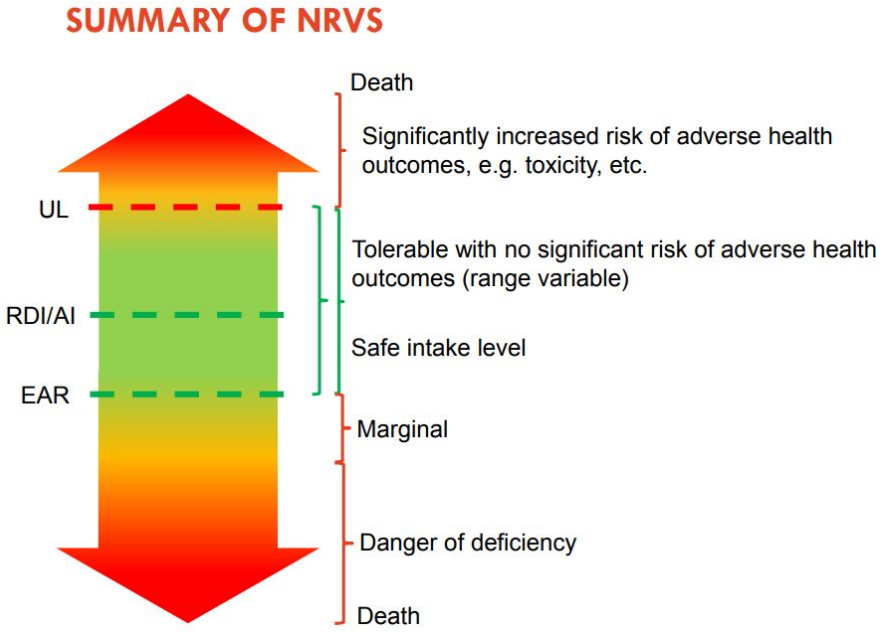
- Avg. daily intake sufficient to meet the nutrient requirements of nearly all (97.5%) healthy individuals

Upper limit (UL)

- Intakes above UL → risk of toxicity

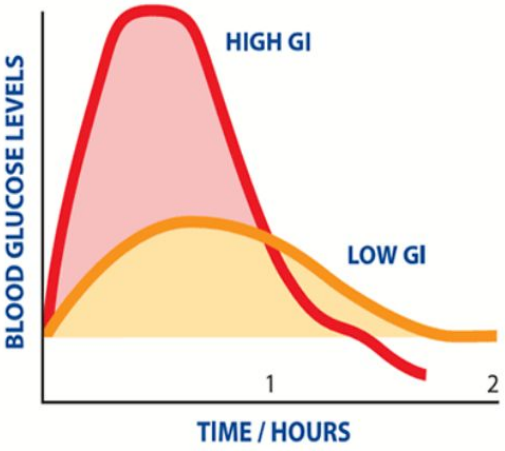
Adequate intake (AI)

- Used when RDI cannot be set (lack of evidence)
- Set using pop. intake level of an apparently healthy population or estimated based on experimental studies



3. The glycemic index

- A tool used to rate the glycemic potential of carbs in different foods and their effect on blood glucose levels
- Starchy foods → high GI
  - Eg. white bread (70), potatoes (88)
  - Few cases where starchy foods have a low GI eg. barley (25), pastas (40s)



	Glycemic Index (GI)
Low	<55
Moderate	56-69
High	>70

4. Dietary fat

- Triglycerides (>90%), phospholipids, sterols and other minor lipids from animal and plant sources
- Contributes 25-35% of energy intake
  - Saturated fat should contribute <10%
- Recommended: monounsaturated and polyunsaturated

5. Fatty acids

- Variable degree of saturation (with hydrogen)
  - Eg. saturated fats → no double bonds as they are taken up with hydrogen
  - Monounsaturated → one double bond → missing one H
  - Polyunsaturated → >1 double bond → missing >1 H
- Degree of saturation affects physical characteristics of fatty acid
  - Saturated fats → more rigid
  - Monounsaturated and polyunsaturated → more flexible

6. Protein requirement

- Diet should provide the essential amino acids and enough amino acid nitrogen to synthesise the non-essential amino acids
  - Essential amino acids are critical for our diet as our body cannot synthesise them, whereas non-essential amino acids can be synthesised
- Min. requirement is 25g/day if all amino acids are present in their optimal ratio
  - Safe level[2]: 37g for men, 29g for women
- Protein quality depends on:
  - Amino acid make-up
  - Digestibility
  - The amount present
- Some foods lack essential amino acids eg. the limiting amino acid[3] in beef is methionine/cysteine
  - Supplementary value - the capacity of a protein to make good the deficiency of another eg. soybean (low methionine) + rice

[2] According to WHO
[3] Amino acid not present → protein synthesis is limited