Nutritional diseases
Nutrition and Nutrients

Nutrients are substances that must be supplied by the diet because they are not synthesized in the body in sufficient amounts.

The need is depend:
- Age
- Physiological state
Nutrition and Nutrients

**macronutrients**
- Carbohydrates
- Fats
- Proteins

**micronutrients**
- Vitamins
- Minerals
- Water
The energy balance

The energy intake equal to energy output

The major components of energy output are:

1. resting energy expenditure (REE) (BMR) (60%) depend on FFM (total body mass - fat mass)

2. physical activity (30%)

3. Diet induced thermo-genesis (10%)
Dietary intake = food + alcohol

Current food intakes

UK
- 35% Fat
- 17% Protein
- 48% Carbohydrate

India
- 15% Fat
- 10% Protein
- 75% Carbohydrate

UK target food intakes
- 33% Fat
- 17% Protein
- 50% Carbohydrate

Energy expenditure =

Basal metabolic rate

Energy expenditure (MJ/day)

- Male
- Female

Age (years)
- 18-29
- 30-39
- 40-64

- Higher with greater fat-free mass
- Lower with ageing
- Increases with cold, heat, fever
- Higher in smokers

Physical activity

- Immobile
- Sedentary work
- Standing work
- Active leisure/sport
- Strenuous work
- Soldier
- Athlete

Physical activity level (PAL)

Total energy expenditure = Basal metabolic rate

1 megajoule (MJ) = 239 kilocalorie (kcal) = energy stored in ~ 34 g fat
The energy balance

Energy intake depend on macronutrient content

Different energy densities: carbohydrates (4 kcal/g), fat (9 kcal/g) and protein (4 kcal/g).

The average energy intake is about 2800 kcal/d (2000-3500) for men and about 1800 kcal/d (1600-2250) for women.
Response to under- and over-nutrition

Under-nutrition:
- BMR decreases
- Energy preserved
- Insulin low
- Glycogen depletion
- Triglyceride depletion
- Protein breakdown

Over-nutrition:
- BMR increases
- Energy consumed
- Insulin high
- Increase fat store as triglyceride
- Disease state
Carbohydrates

- Carbohydrates are the **sugars** and **starches** found in foods.

- There are two general types of carbohydrates: **simple** and **complex**.

- At least **55%** of total calories should be derived from carbohydrates. (100-200 g/d)

- **No** individual carbohydrate is an essential nutrient as carbohydrates can be synthesized de novo from protein.
Simple Carbohydrates

These sugars are fructose and glucose (found in fruits and vegetables, lactose (found in milk), and sucrose (table sugar).

• The most important to the body is glucose – the form of the sugar that goes directly to the bloodstream and

• provides quick energy. All other sugars must be changed into glucose by the body before the cells can use them. The cells use glucose as their primary source of energy. Glucose that is not needed immediately is converted by body to glycogen, a form of starch stored in the muscles and liver.
Complex Carbohydrates

- **Starches** are complex carbohydrates that are made up of many units of glucose. These chains must be broken down by the body into single units of glucose before they can be used. Simple sugars. **Breads, cereals, and potatoes** contain starch.

- **Dietary Fiber** is another complex carbohydrate, which comes from non-digestible part of plants. There are two types of dietary fiber: **soluble** and **insoluble**. Soluble fiber combines with waste to assist in their removal. (bran, beans, apples, carrots, and other vegetables)

- Insoluble fiber absorbs water and helps to provide needed bulk to the diet. (whole grains and the skins and seeds of fruits and vegetables).
DIETARY CARBOHYDRATES

Free sugars

Monosaccharides: Glucose, fructose
Disaccharides: Sucrose, lactose, maltose
fruits, milks, vegetables

Starch polysaccharides: Cereals (wheat, rice), root vegetables (potato), legumes (lentils, beans, peas)

Non-starch polysaccharides: (NSP, dietary fibre)
Plants Cellulose, Hemicellulose
Fats (Lipids)

- **Fats** are the nutrients that contain the most concentrated form of energy.
- **Fatty acids** have the highest energy density of the macronutrients (9 kcal/g)
- 30% of calorie should be derived from the fat

- **Fats** are part of many body tissues and are important as carriers of other nutrients, such as vitamins. Fats also carry the flavor of foods – making foods tastier.
Types of Fats

• **Saturated fats** are usually solid at room temperature. They contain maximum number of hydrogen atoms. butter, and animal fats tend to be high in saturated fats.

• A diet high in saturated fats can lead to an increased chance of coronary artery disease.

• **Unsaturated fats** are those fats that are liquid at room temperature.

• Olive oil and peanut oil

• Fish oils and most vegetables oils, such as corn, soybean, and sunflower oils.
Protein

- **Proteins** are substances found in every cell. The body needs proteins to build and repair all body tissues. Proteins are made up of basic units called **amino acids**.

- There are **20 different amino acids**. Nine of them are essential, and the other eleven amino acids can be produced by the body. **10 – 15 % of energy derived from it.**

### Complete proteins
- eggs
- milk
- and meat

### Incomplete proteins
- Legumes
- cereals
- roots
Nutrients that Regulate

• **Vitamins, minerals, and water** are nutrients that work with the energy-providing nutrients to be sure that the body functions properly.

• Water is the most vital nutrient because it provides the means for all other nutrients to be carried throughout the body.

• Vitamins, minerals, are not digested by our body, and they do not provide Calories. They work with carbohydrates, fats, and proteins to promote growth and regulate body processes.
Vitamins

- **Vitamins** are organic substances with the key roles in certain metabolic pathways.

- They also help change carbohydrates and fat into energy.

- Because the body cannot make most vitamins, they must be supplied by the foods.
Water-soluble Vitamins

- **Water-soluble vitamins**: Thiamin (B1), Riboflavin (B2), Niacin, Vitamin B6, Folate (Folic acid), Vitamin B12, Pantothenic acid, biotin, choline Vitamin C (Ascorbic acid).

- **Fat-soluble vitamins**: vit A, vitD, vitE, vitK
Minerals

- Minerals are simple substances found in the environment that are essential to the body’s functioning.
- Minerals are used to regulate a wide range of body processes, from bone formation to blood clotting.
- Most minerals are either quickly used or lost in waste products, therefore we must eat mineral-rich foods daily to replenish our supply. Iron is an exception—it tends to be kept and recycled by the body.
Major Minerals: calcium, phosphorus, magnesium, potassium, sodium.

- **Calcium** keeps the nervous system working well and is needed for blood clotting. Osteoporosis is a disease caused by calcium deficiency.

- **Sodium** and **potassium** help regulate the passage of fluids in and out of cells. Too much sodium in the diet may aggravate high blood pressure or hypertension, increasing the risk of heart attack, stroke or kidney disease. Table salt is one source of sodium in the diet.
Trace Minerals:
iron, iodine, manganese, zinc, copper, and fluorine

• The majority of the minerals needed for the body to function are only required in very small, or trace amounts.

• Iron is a vital part of hemoglobin – a substance in red blood cells that carries oxygen to all parts of the body. Insufficient iron may cause anemia.

• Iodine is needed for the thyroid gland to function properly. The thyroid gland produces hormones that control how quickly chemical reactions occur in our body. Too little iodine – thyroid gland enlarged. The primary sources are seafood and iodized table salt.
Standards of Nutrition

• Dietary Reference Intakes (DRIs)
  – Quantitative estimates of nutrients collectively for proper function and health

• Recommended Daily Allowances (RDA)

• The average daily dietary intake that meets the nutrient requirement of nearly all healthy persons of a specific sex, age, life style or physiological condition.
The Food Guide Pyramid

Key:
- Fat (naturally occurring and added)
- Sugars (added)

These symbols show fat and added sugars in foods.

- Fats, Oils, Sweets (Use sparingly)
- Milk, Yogurt, Cheese (2-3 servings)
- Vegetables (3-5 servings)
- Meat, Poultry, Fish, Dry Beans, Eggs, Nuts (2-3 servings)
- Fruit (2-4 servings)
- Bread, Cereal, Rice, Pasta (6-11 servings)
Malnutrition

**Definition**: loss of the lean body mass and adipose tissue due to insufficient dietary supply

1. **primary**: inadequate or poor-quality food intake (war or famine).
2. **secondary**: from diseases that alter food intake or nutrient requirements, metabolism, or absorption.

**Two syndrome**:
- kwashiorkor (malnutrition with edema)
- marasmus (malnutrition with marked muscle-wasting).
CAUSES OF malnutrition
Decreased the energy intake (hypo metabolism)

- **Economic**: poverty, famine
- **anorexia**: nervosa, dementia, depression, cancer, renal failure
- **Abdominal pain**: pancreatitis, intestinal ischemia
- **Impaired diet transit**: benign and malignant esoph. or gastric obstruction
- **Maldigestion**: pancreatic exocrine insufficiency, short bowel syndrome
- **Malabsorption**: small intestinal disease (celiac disease)
Causes of malnutrition

Increased energy expenditure (hyper metabolism)

• Increased BMR: (thyrotoxicosis, fever, cancer, trauma, sepsis, surgery, burn)
• Excessive physical activity (marathon runner)
• Acute and chronic inflammation: T.B, collagen diseases.
• Energy loss: (e.g. glycosuria in diabetes)

Mixed mechanisms

• Disseminated cancer
• Chronic inflammatory bowel disease (Crohn's disease)
Consequences of malnutrition

Wt loss → Weakness → Loss of cell mediated immunity → Bronchopneumonia

Too week to walk → Urinary tract infection

Too week to sit → Bed sore → death
Metabolic response to the Starvation:

First day:
- Circulating glucose and FA and TGs, liver and muscle glycogen (1200 Kcal).
- Lipolysis for the FAs production (65% of energy source).

First few days:
- Lipolysis increase and ketone body production increase.
- Gluconeogenesis begin (70 g), 15% from protein.

2 weeks-30 days:
- Energy conserved, BMR decrease, thyroids hormones decrease, sympath. system decrease.
- Lipolysis continue 150g/day (90% on fat).
- Muscle PTN breakdown decrease (20g/day).
Metabolic response to stress

- High catecholamines, glucagon, cortisol, cytokines, TNF, int 1,6
- Skeletal and visceral PTN catabolism (150 g/d)
- 50 % of body protein stores within 3 weeks
Physiological consequences

1. GIT:
   - Atrophy of small IN. mucosa
   - Gastric and pancreatic secretion
   - Volume of bile and conjugated bile acids decrease
   - Carbohydrate. and fat malabsorption decrease.

2. CVS:
   - Myocardial Mass and function decrease

3. Immune system:
   - Lymphocyte count decrease
   - Delayed skin hypersensitivity
   - Decrease production of ABs
4. Respiratory:
   • Structural and functional atrophy

5. Bone marrow:
   • Decrease lymphocyte and WBC and RBC

6. Renal:
   • Decrease mass and function

7. Skin and hair:
   • Dry, thin, wrinkled, hyperkeratosis
8. Endocrine

- Low insulin
- Increase cortisol
- Increase growth hormone
- T3 and t4 decrease
- Primary gonadal dysfunction
Clinical features:

- WT loss
- Weakness and craving for food
- Muscle wasting
- Loss of subcutaneous fat
- Leg edema and ascites
- Skin dry pale lax, easy packable thin hair
- Amenorrhea or impotence
- Bradycardia Cold cyanosed extremities, pressure sores
- Distended abdomen, with diarrhea
- Apathy, depression, loss of the initiative
- Features of associated vitamins deficiency
- Susceptibility to infections
INFECTIONS ASSOCIATED WITH PEM Patients:

• Gastroenteritis
• Gram-negative septicemia
• Respiratory infections, especially bronchopneumonia
• Viral infection: herpes simplex
• Tuberculosis
• Streptococcal and staphylococcal skin infections
• Helminthic infestation
Nutritional Assessment

• History
• Physical examination
• Anthropometric measurements
• Laboratory investigations
• Functional test
Nutritional Assessment

History

Dietary Analysis

- Dietary history Review foods eaten
- Review preparation methods
- Evaluate digestive and absorption adequacy
- Review supplements taken

- Significant weight loss within last 6 months
  - > 10% loss of body weight
  - <90% of ideal body weight
## Patient History of Weight Loss

<table>
<thead>
<tr>
<th>Finding</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involuntary diet restriction</td>
<td>Poverty due to inadequate income</td>
</tr>
<tr>
<td>Anorexia</td>
<td>Anorexia nervosa, severe depression, dementia, cancer, chronic renal failure</td>
</tr>
<tr>
<td>Inadequate diet selection</td>
<td>Chronic alcoholism, strict vegetarianism</td>
</tr>
<tr>
<td>Critical illness</td>
<td>trauma, burn, major surgery, sepsis</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>Esophageal obstruction</td>
</tr>
<tr>
<td>Nausea, vomiting</td>
<td>Gastric or intestinal obstruction</td>
</tr>
<tr>
<td>Chronic abdominal pain</td>
<td>chronic pancreatitis, intestinal angina</td>
</tr>
<tr>
<td>Chronic diarrhea</td>
<td>Pancreatic, intestinal mucosal</td>
</tr>
</tbody>
</table>
Nutritional Assessment

Physical Examination

- Evidence of muscle wasting
- Depletion of subcutaneous fat
- Peripheral edema, ascites
- Skin changes (easily plucked hair)
- Features of Vitamin deficiency
  - e.g. nail and mucosal changes
Nutritional Assessment

Anthropometry

- Weight for Height comparison
- Body Mass Index (BMI)
- Triceps-skin fold
  - < (6mm for the men), < (8mm for the women)
- Mid arm muscle circumference
  - < (20cm for the men), < (18.5cm for the women)
## BODY MASS INDEX (WEIGHT/HEIGHT$^2$)

<table>
<thead>
<tr>
<th>BMI (kg/m$^2$)</th>
<th>classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 25</td>
<td>obese</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>Adequate nutrition</td>
</tr>
<tr>
<td>18.5-20</td>
<td>Marginal</td>
</tr>
<tr>
<td>&lt; 18.5</td>
<td>Malnutrition</td>
</tr>
<tr>
<td>17-18.5</td>
<td>Mild</td>
</tr>
<tr>
<td>16-17</td>
<td>Moderate</td>
</tr>
<tr>
<td>&lt; 16</td>
<td>Severe</td>
</tr>
</tbody>
</table>
Nutritional Assessment

Lab investigations

1. Serum visceral protein:
   - albumin < 30 mg/dl
   - transferrin < 150 mmol/l
   - pre-albumin < 12 mg/dl
Nutritional Assessment

2. vitamin and minerals assays:
   - tests reflecting specific nutritional deficits
     e.g. prothrombin time

3. Assessment of immune function:
   - Total lymphocyte count < 1800 / mm3
   - Skin anergy testing
Nutritional Assessment

Functional test

- Hand grip dynamometry

Other

Urinary creatinine excretion:

1g of urine creatinine: 18.5g of FFM
23mg/kg of ideal body wt./men
18mg/kg of ideal body wt./women

bioelectric impedance analysis
Nutritional therapy
Nutritional therapy

• Provide a life sustained therapy for the patient who cannot take adequate food by mouth who consequently are at risk for malnutrition and its complication.
Benefits of Nutritional Support

• Preservation of nutritional status

• Prevention of complications of protein malnutrition

• ↓ Post-operative complications
Nutritional therapy given when

1. improve the quality of life.
2. improve the ability to recover from the disease.

Don’t forget it depend: disease outcome, severity of the malnutrition, any additional stress.
Who Requires Nutritional Support?

• Patients already with malnutrition – surgery / trauma/sepsis

• Patients at risk of malnutrition
Patients at Risk of Malnutrition

- **Cannot eat for >9 days**
  - Vomiting: acute pancreatitis, hyperemesis gravidarum
  - GIT obstruction: malignancy
  - Neurological: coma, swallowing dis.
  - Abdominal pain: A. pancreatitis

- **Can not absorb**: intestinal fistula, short bowel syndrome

- **Should not eat**: bowel rest in
• Others

  nutritional support in patient with malignancy
  nutritional support in malnourished patient
  before surgery
Type of the nutritional rehabilitation

- Normal diet  mild malnutrition and treatable disease
- Supplement  high energy and protein content used if normal diet can't give sufficient nutrition
- Specific Nutritional support

Enteral feeding
Types of Nutritional Support

- Enteral Nutrition
- Parenteral Nutrition
Enteral Feeding Is Best

• More physiologic
• Less complications
• Gut mucosa preserved
• No bacterial infection
• Cheaper
Enteral Feeding Is Indicated

• When nutritional support is needed
• Functioning gut present
• No contra-indications
  – no ileus, no recent anastomosis, no fistula
Types of Feeding Tubes

*Tubes inserted down the upper GIT, following normal anatomy*

- Naso-gastric tubes
- Naso-duodenal tubes
- Naso-jejunal tubes
Types of Feeding Tubes

Tubes that require an invasive procedure for insertion (feeding for long time)

• Gastrostomy tubes
  – Percutaneous Endoscopic Gastrostomy (PEG)
  – Open Gastrostomy

• Jejunostomy tubes
What Can We Give in Tube Feeding?

Blenderised feeds

Commercially prepared feeds
  • *e.g.* Vivonex
Complications of Enteral Feeding

12% overall complication rate

• Gastrointestinal complications
• Mechanical complications
• Metabolic complications
• Infectious complications
Complications of Enteral Feeding

Gastrointestinal

- Distension
- Nausea and vomiting
- Diarrhoea
- Constipation
Complications of Enteral Feeding

Infectious

- Aspiration pneumonia
- Bacterial contamination
Complications of Enteral Feeding

**Mechanical**

- Malposition of feeding tube
- Sinusitis
- Ulcerations / erosions of nasal and esoph
- Blockage of tubes
Parenteral Nutrition
Parenteral Nutrition

Allows greater caloric intake

**BUT**

- Is more expensive
- Has more complications
- Needs more technical expertise
Who Will Benefit From Parenteral Nutrition?

Patients with/who

– Abnormal gut function
– Cannot consume adequate amounts of nutrients by enteral feeding
– Are anticipated to not be able to eat orally by 5 days
– Prognosis warrants aggressive nutritional support
Two Main Forms of Parenteral Nutrition

• Peripheral Parenteral Nutrition
• Central (Total) Parenteral Nutrition
Peripheral Parenteralal Nutrition

Given through peripheral vein

- Short term use
- Mildly stressed patients
- Low caloric requirements
- Needs large amounts of fluid
- Contraindications to central TPN
What to Do Before Starting TPN

- Nutritional Assessment
- Venous access evaluation
- Baseline weight
- Baseline lab investigations
Baseline Lab Investigations

- **Daily**: urea, electrolytes, glucose
- **Twice weekly**: LFT, calcium, phosphate, magnesium
- **Weekly**: CBC, zinc, triglycerides
- **Monthly**: copper, selenium, manganese
Formula of the TPN

- Dextrose 10%, 20% glucose
- Intralipid 10%, 20% fatty acid
- Vamine (amino acid) 8%, 14%
- Vitamins
- Minerals
- Trace elements
Complications Related to TPN

• Mechanical Complications
• Metabolic Complications
• Infectious Complications
Mechanical Complications

Related to vascular access technique

- pneumothorax
- air embolism
- arterial injury
- bleeding
- brachial plexus injury
- thoracic duct injury
Mechanical Complications

Related to catheter in situ

Venous thrombosis
Catheter occlusion
Metabolic Complications

Abnormalities related to excessive or inadequate administration

– hyper / hypoglycemia
– Fluid and electrolyte: Refeeding syndrome
  hypomagnesemia, hypokalemia, hypophosph

Congestive heart failure

– acid-base disorders
Metabolic Complications

Hepatic complications

• Biochemical abnormalities
• Cholestatic jaundice
• Hepatic steatosis
• Gall stones
• Acalculous cholecystitis
Infectious Complications

- Insertion site contamination
  - improper insertion technique
  - use of catheter for non-feeding purposes
  - contaminated TPN solution
  - contaminated tubing

- Secondary contamination
  - *septicaemia*