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M.Sc. [Home Science – Nutrition and Dietetics]

I - Semester

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**LAB I : HUMAN PHYSIOLOGY,
NUTRITION AND HEALTH &
ADVANCED FOOD SCIENCE**

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LAB I : HUMAN PHYSIOLOGY, NUTRITION AND HEALTH & ADVANCED FOOD SCIENCE

Syllabi

HUMANPHYSIOLOGY

1. Estimation of Glucose from blood.
2. Analysis of blood Haemoglobin.
3. Determination of Cholesterol from blood.
4. Estimation of Vitamins, Minerals, Electrolytes from blood.
5. Blood cell counts, haematocrit, blood histology/ blood smears
6. Blood typing
7. Histology: cells and tissues
8. Diffusion and osmosis
9. Urine analysis - Creatinine, Total nitrogen and Urea
10. Pregnancy test

HEALTHANDNUTRITION

1. Preparation of low cost recipes for adolescents, pregnant and lactating mothers.
2. Evaluation of the ongoing public health nutrition programmes.

ADVANCED FOOD SCIENCE

1. Database management of anthropometric indices, biochemical indices, dietary recall, energy expenditure and intake.
 2. Role of portable devices in diet and health management.
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INTRODUCTION

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Human physiology can be understood as the study of the working of the human body. This includes learning about the functions of the components of the human body from the first level of chemical compounds of cell, to the second level including the tissues, to the third level inclusive of the organs ending with the coordination and workings of the different organs together. An understanding of these individual components, and the problems in them will help not only identify but also find solution to the different ailments that the individual suffers from. This is done through several different types of tests of the blood, tissues, urine, etc.

Nutrition and health go hand in hand. Diet is one of the dominating factors which affects the functioning of the human body helping the individual to ensure that all the needed nutrients are being received in adequate quantities. This field includes the knowledge of different foods and their benefits. Another important concept related to the field of food science is to learn how the different bodily features reflect the health status of the individual including indices of height, weight, fats, etc. This helps in the formulation as well as the evaluation of the health and nutrition programmes for a region.

This book, *Human Physiology, Nutrition and Health & Advanced Food Science*, deals with the practical aspects of the subjects individually.

HUMAN PHYSIOLOGY**(1) ESTIMATION OF GLUCOSE FROM BLOOD**

Introduction- The condition in which too much sugar is in the blood stream is called hyperglycemia. The blood glucose analysis is ordered to measure the amount of sugar in the blood at the time of sample collection. An ideal blood glucose estimation method should determine only glucose.

- Glucose is a monosaccharide
- It is a central molecule in carbohydrate metabolism
- It is stored as glycogen in liver and skeletal muscle

Blood collection for glucose estimation:

- No matter the source of blood, fluoride containing vials are used
- Fluoride inhibit glycolysis by inhibiting enolase enzyme
- In CSF, bacteria and other cells are also present and so are analysed immediately.
- For glucose estimation from urine, add 5 ml glacial acetic acid as preservative to inhibit bacterial growth.

Enzymatic Determination**A. GOD POD method-****Principle-**

- $\text{Glucose} + \text{H}_2\text{O} + \text{O}_2 \rightarrow \text{GOD Gluconic acid} + \text{H}_2\text{O}_2$
- $4 \text{ Amino Phenazone} + \text{Phenol} + \text{H}_2\text{O}_2 \rightarrow \text{POD} \rightarrow \text{Quinonimine - Pink colour compound.}$

Procedure-

	<i>Test</i>	<i>Stain</i>	<i>Blank</i>
(1) Glucose reagent (ml)	1.0	1.0	1.0
(2) Serum (ml)	0.01	-	-
(3) Glucose Standard (ml)	-	0.01	-
(4) Distilled water (ml)	-	0.01	-

At room temperature for 30 min.

Measure the intensity of colour at 505nm filter.

Calculation

Concentration of substance:

$$\frac{\text{O. D. of Test} - \text{O. D. of Blank}}{\text{O. D. of Std} - \text{O. D. of Black}} \times \text{Concentration of Std.}$$

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General parameter

- Reaction type: end point
- Standard concentration: 100 mg/dl
- Linearity is upto 500 mg/dl
- If sample value is 500 mg/dl, dilute the sample 1:2 with distilled water and repeat assay

B. Hexokinase Method

Principle

- Glucose + ATP ↔ Glucose 6 phosphate + ADP
- Glucose 6 phosphate + NAD ↔ 6-Phosphogluconate + NADH + H⁺
- Conversion of NADH from NAD at 340 nm, increase in O.D. is measured at blood interval.

Procedure

- Pipette 1.0 ml of Glucose reagent in cuvette and keep it in a water bath at 37°C for 1 min. (for incubation)
- Add 10 ml of sample mix well and read change in O.D. minute, upto 3 minute.

Repeat steps 1, 2 and 3 by using standard.

Calculation

$$\text{Plasma glucose} = \frac{\text{Delta O.D. / min test} \times 100}{\text{Delta O.D. / min (Std)}}$$

C. Orthotoluidine Method

Determination of Blood Glucose by the O-Toluidine Method

Principle

Proteins in blood are precipitated with trichloro-acetic acid, because they interfere with estimation. Contents filtrated obtained is known as protein-free filtrate. It contains glucose whose concentrate is to be determined. Equal volumes of protein-free filtrate and glucose solution are treated simultaneously with o-toluidine reagent (in acetic acid) and kept in a boiling-water bath. A blue-green N-glycosylamine derivative is formed. The intensity of blue-green is proportional to the amount of glucose present. The optical density values of all 3 solutions are read in a photoelectric colorimeter using a red filter (625 nm) and the amount of glucose present in 100 ml of blood is calculated.

Reagents

1. O-toluidine reagent: 90 ml of o-toluidine was added to 5 gm thiourea, and diluted to 1 litre with glacial acetic acid stored in brown bottle and the reagent was kept in a refrigerator.
2. 10% Trichloro acetic acid (TCA)
3. Glucose standard solution (0.1 mg/ml): 10 mg of glucose were dissolved in about 50 ml of distilled water in a 100 ml volumetric flask. To this 30 ml of 10% TCA was added and make up the volume to 100 ml with distilled water.
4. Blank solution: 30 ml of 10% TCA was diluted to 100 ml.

Procedure

Preparation of protein-free filtrate: 3 ml of distilled water and 0.5 ml of blood were taken in a dry test tube and mixed well. 1.5 ml of 10% TCA was added, thoroughly mixed, and allowed to stand for 10 minutes before it was filtered into a dry test tube.

Development of colour: Standard glucose solutions were taken in 6 test tubes in the range of 0.2 to 1 ml, 1 ml of protein-free filtrate was taken in a seventh test tube. To all these tubes, 5 ml of o-toluidine was added and mixed thoroughly.

The tubes were kept in boiling water bath for 10 minutes, cooled, and the optical density read at 620 nm.

Procedure

Tube no.	Tube 1	Tube 2	Tube 3	Tube 4 (blank)
O-toluidine	5 ml	5 ml	5 ml	5 ml
Test 1	0.1 ml			
Test 2		0.1 ml		
Standard (100 mg/dl)			0.1 ml	
Water				0.1 ml

Shake, then incubate in boiling water bath for 10 mins then cool under tap water.

Calculation

The concentration of glucose in the standard solution is 10 mg/100 ml

The concentration of glucose in urine is given by

$$\frac{\text{O.D. Test}}{\text{O.D. Standard}} \times 100 = \text{mg glucose/100 ml blood}$$

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D. Folin-Wu Method

Estimation of Blood Glucose level by Folin-Wu method

Aim:

To estimate Glucose level in Blood by Folin-Wu method

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Principle

When glucose or other reducing agents are treated with alkaline copper solution they reduce the copper with the result insoluble cuprous oxide is formed. The reaction depends on temperature, duration of heating, degree of alkalinity. The ratio of glucose to cuprous oxide form may be varied after heating for a period. The cuprous oxide form is allowed to react with phosphomolybdate to form molybdenum blue coloured complex which can be read colorimetrically using red filter on at 680 nm.

Reagents:

1. **1% Sugar solution:** 1 gram of sugar is added in 100 ml saturated benzoic acid.
2. **Working standard sugar solution:** 2 mg per 2 ml of the above solution.

Alkaline copper solution

1. **Solution A:** Dissolve 2% Na_2CO_3 in 0.1N NaOH.
2. **Solution B:** 5% CuSO_4 in 1% sodium potassium tartarate or Rochelle salt. Mix 50 ml of solution A with 1 ml of solution B.
3. **Phosphomolybdic acid:** To 35 gms of molybdic acid add 5 grams of sodium tungstate, 200 ml of 10% NaOH and 200 ml of water is added. It is boiled vigorously for 20-30 minutes so as to remove whole of ammonium present in molybdic acid. The solution is cooled and diluted to about 350 ml and 125 ml of 85% phosphoric acid (ortho) is added and make up to 500 ml with distilled water.
4. **10% Sodium tungstate**
5. $\frac{2}{3} \text{NH}_2\text{SO}_4$

Procedure

De-proteination of Blood

1 ml of blood is transferred to boiling tube containing 7 ml of water. Then 1 ml of 10% sodium tungstate is added and mixed well followed by 1 ml of $\frac{2}{3} \text{NH}_2\text{SO}_4$ with shaking. It is allowed to stand for 10 minutes, it is then filtered. This filtrate is called tungstic acid blood filtrate and is taken as test sample.

2 ml of tungstic acid blood filtrate is transferred to Folin-wu tube graduated at 25 ml mark and to other similar folin-vui tubes 2 ml of standard glucose solution

and 2 ml of water as Blank is added. To each of the three tubes 2 ml of alkaline CuSO_4 is added. Now the surface of the mixture is in line with 4 ml mark of the Folin-wu tube. The Folin-wu tubes are placed in boiling water bath exactly for 8 minutes. They are cooled under running water. To each of the tube 2 ml of phosphomolybdic acid solution is added. After 1 minute, it is diluted with water upto the mark. The solution is transferred to a suitable tube and OD is read at 680 nm.

Normal values

- The normal blood sugar level ranges from 8 to 120 mg / 100 ml of blood.
- In mild diabetic conditions, value of blood glucose is between 140-300 mg / 100 ml of blood and in severe diabetic conditions, the value upto 1200 mg / 100 ml of blood have been noted.
- Low blood sugar level values are formed in insulin administration, Addison's disease, hypoglycemia and hypopituitarism.

Report:

___mg of glucose is present in 100 ml of given blood sample.

Calculation:

mg of glucose / 100 ml of blood = mg of glucose in standard \times (OD of test / OD of Standard) \times 100/0.

Folin Wu method is:

- Time consuming method
- Non-specific

Glucometer

Blood is placed onto a test strip and insert into the glucometer to measure blood sugar levels.

It is only type of dry chemistry.

- **Advantage:** Can be conducted from capillary collection method. For eg. Heal pick, Pinna pick and gives result neither within seconds.
- **Disadvantage:** Costly and slightly high result than actual.

Normal Range

Blood

- Random blood sugar: < 140 ml/dl.
- Fasting blood sugar: 70 to 110 mg/dl
- Post parental blood sugar: < 140 mg/dl

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(2) ANALYSIS OF BLOOD HAEMOGLOBIN

Haemoglobin test measures the amount of haemoglobin in your blood. Haemoglobin is a protein in your red blood cells that carries oxygen to your body's organs and tissues and transport carbon dioxide from your organs and tissues best to your lungs.

Why it's done:

You may have a haemoglobin test for several reasons:

- To check your overall health
- To diagnose a medical condition
- To monitor a medical condition

How you Prepare

If your blood sample is being tested only for haemoglobin, you can eat and drink normally before the tests. If your blood sample will be used for other test, you may need to fast for a certain amount of time before the sample is taken.

Procedure

Haemoglobin may be performed as a simple bedside test on a finger pick sample of blood using a hand-held colour comparison hence.

It may also be performed as a laboratory blood test usually as part of a full blood count on ten millimetres of blood from a vein.

- Clean the skin
- Put on elastic band (tonsnignet) above the area to get the reins to swell with blood.
- Insert a needle into a vein (usually in the arm inside of the elbow or on the back of hand.
- Pull the blood sample into a vial or syringe.
- Take off the elastic band and remove the needle from the vein.

Collecting a sample of blood is only temporarily uncomfortable and can feel like a quick pinprick.

Results

The normal range for haemoglobin is-

- For men, 13.5 to 17.5 grams per deciliter
- For women – 12.0 to 15.5 grams per deciliter.

Lower than normal results

If your haemoglobin level is lower than normal, you have anemia.

- Iron deficiency
- Vitamin B-12 deficiency
- Folate deficiency
- Bleeding
- Kidney disease
- Liver disease
- Hypothyroidism
- Thalassemia

Higher than normal results

- Lung disease
- Heavy smoking

Risks

Blood tests have very few risks. You may have some bruising or swelling in the area in which the needle was inserted and, as with any opening in your skin, there's a slight risk of infection.

You may also feel dizzy, lightheaded, or even faint if you're squeamish around needles or blood. If you're on a blood-thinner such as Coumadin (warfarin), you may need a pressure bandage afterward to stop the bleeding.

Before the Test

You may have your haemoglobin test done as a part of your medical examination since there aren't any special fasting requirements beforehand. Your doctor will let you know if you're going to have any other blood tests done at the same time and what instructions you may need to follow. He may tell you if there's something specific he's looking for and whether or not you might need more tests as well.

Timing

The process of taking a sample of your blood normally takes less than five minutes, so you'll be in and out quickly.

Location

The test will most likely be done right at your doctor's office; you may even have the test done in the same room in which your doctor just examined you. However, depending on the circumstance, you may need to go to a separate part of the building in which your doctor is located, to the lab at your local hospital, or somewhere else your doctor has indicated.

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What to Wear

You don't need to wear anything special for a haemoglobin test but avoiding tight shirt sleeves is helpful since you'll need to roll up your sleeve so the technician can access your vein.

Food and Drink

If your doctor decides to do other blood tests at the same time as your haemoglobin test, you may need to go without food and drink (fast) for a specific period of time before drawing your blood. If you just have a haemoglobin test, no fasting is required. Your doctor will let you know what to do.

Cost and Health Insurance

The cost of this test varies, but it should be covered by your health insurance, especially if you have it done in the same facility as you had your doctor's appointment. If in doubt, contact your health insurance company at the number indicated on your membership identification card.

What to Bring

There isn't anything in particular that you need to bring for this test. You can bring along a book or magazine to pass the time while you wait to have your test done, if this applies.

During the Test

A lab technician will perform your haemoglobin test. This is usually a nurse or a phlebotomist—someone who is specifically trained to draw blood.

Pre-Test

You may need to fill out some forms prior to having your blood drawn. When you check in for your test, whoever is at the front desk will let you know. These may include forms that authorize your doctor to bill your insurance company or release your test results to other physicians, for example.

Throughout the Test

This test typically takes less than five minutes. Your blood sample may be drawn by a prick to your fingertip or with a needle in your arm.

If you're having a finger prick, this is quick and easy. After your fingertip is cleaned off with alcohol to remove any germs, it'll be quickly pricked with a tiny needle and the blood that results will be collected. You may feel a sharp poke, but it only lasts for a second.

For blood samples that are taken from your arm, after you sit down, the technician will have you choose the arm you'd prefer to use and roll up your sleeve if needed (many people choose their non-dominant side). Then he or she will find the best vein, often in the inside crease of your elbow, and tie a tourniquet above it to push more blood into that vein. After the area is swabbed with alcohol to disinfect it, the technician will insert a small needle into your vein and collect your blood in a tube. You may feel a small poke, but you should feel more discomfort than pain.

The technician will remove the tourniquet before removing the needle from your arm and then press a cotton ball or tissue over the entry site to stop any bleeding. If the area looks like it's not going to stop bleeding, the technician may apply a bandage to help keep the blood contained.

If your baby is the one having this test, usually his or her heel will be pricked for a blood sample.

If you have a tendency to feel lightheaded or dizzy around needles or blood, it's probably best to look away during the procedure. Tell the technician if you feel like you're going to faint and/or if you have fainted before during a medical procedure.

Post-Test

Once your arm has stopped bleeding or you have a bandage applied, as long as you aren't feeling dizzy or faint, you'll be free to go. If you're lightheaded or dizzy, you may need a little time to recover, but you'll be able to go about the rest of your day as soon as you feel up to it.

After the Test

Once you're done with the test, you can go about your normal activities.

Managing Side Effects

You may experience some bruising, swelling, or slight pain in the area the needle was, but this should be minor and should only last a few days. If it lasts longer or is getting worse, call your doctor.

Interpreting Results

The results of your haemoglobin test can take anywhere from a few minutes to a day or two to come back, depending on where your blood sample is sent.

As mentioned above, a haemoglobin test is often ordered as one part of a CBC. Haemoglobin levels in the blood are often measured as grams per deciliter

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of blood (g/dl), but other measuring units may also be used. The type of units used will depend on what's commonly used by the lab that's processing the blood samples.

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Each lab will have its own definition of a 'normal' haemoglobin range; therefore, the levels given below are only examples of what's normal and shouldn't necessarily be used to compare with any actual test results. It's also important to remember that normal levels may depend on factors such as your ethnicity and age.

Example Haemoglobin Level Reference Ranges*

Approximate Range for Women 12.0 to 15.5 gm/dl

Approximate Range for Men 13.5 to 17.5 gm/dl

Approximate Range for Children 11 to 16 g/dl

Approximate Range for Pregnant Women 11 to 12 g/dl

*Consult your lab or physician for appropriate reference ranges for your results.

(3) DETERMINATION OF CHOLESTEROL FROM BLOOD

Each day the liver manufactures upto 1gm of blood cholesterol, the fat like wax material that is a component of all cells. Blood cholesterol is also involved in the creation of and helps to make vitamin D and bile salts which aid digestion.

A cholesterol is a soft wax fat that your body needs to function properly. However too much cholesterol can lead to heart disease.

- Stroke
- Atherosclerosis, a clogging or hardening of your arteries.

If you are a man, you should get your cholesterol checked regularly, starting by age 35 or younger. If you are a woman you should begin routine cholesterol by age 45 or younger.

Who is at risk of high cholesterol:

- Have a family history of high cholesterol or have disease
- Are overweight or obese
- Drink alcohol frequently
- Lead an inactive lifestyle
- Have diabetes, kidney disease or an underactive thyroid gland

What does a cholesterol test measure?

A complete cholesterol test measures five types of lipids, or fats in your blood.

1. **Total cholesterol:** This is the total amount of cholesterol in your blood.

2. **Low-Density Lipoprotein (LDL) cholesterol:** This is referred to as ‘bad cholesterol’. Too much of it raises your risk of heart stroke and atherosclerosis.
3. **High Density Lipoprotein (HDL) cholesterol:** This is referred to as ‘good cholesterol’ because it helps remove LDL cholesterol from your blood.
4. **Triglycerides:** When you eat, your body converts the calories it doesn’t need into triglycerides, which are stored in your fat cell. People who are overweight, diabetic eat too many sweets or drink too much alcohol can have high triglyceride levels.

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Preparation for a cholesterol test

In some cases, your doctor may ask you to fast before having your cholesterol levels tested. If you are only getting your HDL and total cholesterol level checked, you may be able to eat beforehand. However, if you are having a complete lipid profile done, you should avoid eating or drinking anything other than water for nine to twelve hours before your test.

Before test, you should also tell your doctor about:

- Any symptoms or health problems you are experiencing
- Family history of heart health
- All medications and supplements that you are taking correctly

How a cholesterol test is performed

Lay testing of cholesterol levels in the blood is an increasingly popular practice, but to be certain of reliable results, testing is done under medical supervision.

To check your cholesterol levels, your doctor will need to get a sample of your blood drawn in the morning, sometimes after fasting since the night before.

A blood test is an outpatient procedure. It takes only a few minutes and is relatively painless. It’s usually performed at a diagnostic lab. In some cases, it can also be performed during a regular doctor visit or even at a home.

There are very few risks associated with having your blood drawn for a cholesterol test. You may feel slightly faint or have some soreness or pain at the site where your blood was drawn.

What do the cholesterol results mean?

- LDL: 70 to 130 mg/dl (the lower the number, the better).
- HDL: more than 40 to 60 mg/dl (the higher the number, the better).
- Total cholesterol: less than 200 mg/dl (the lower the number, the better).
- Triglycerides: 10 to 150 mg/dl (the lower the number, the better).

If your cholesterol numbers are outside of the normal range, you may be at a higher risk of heart disease, stroke and atherosclerosis. If your test results are abnormal, your doctor may order a blood glucose test to check for diabetes.

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Next Steps and Treatment

High cholesterol can be treated with lifestyle changes and medication. Lowering high levels of LDL in your blood can help you avoid problems with your heart and blood vessels.

To help lower your cholesterol levels:

- Quit smoking tobacco and limit your alcohol consumption.
- Avoid high-fat and high-sodium foods, while maintaining a well-balanced diet. Eat a wide variety of vegetables, fruits, whole-grain products, low-fat dairy products, and lean sources of protein.
- Exercise regularly. Try to do 150 minutes of moderate intensity aerobic activity per week, as well as two sessions of muscle strengthening activities.

Your doctor may put you on a ‘therapeutic lifestyle changes’ or TLC diet. Under this meal plan, only 7 percent of your daily calories should come from saturated fat. It also requires you to get less than 200 mg of cholesterol from your food each day.

Some foods help your digestive tract absorb less cholesterol. For example, your doctor may encourage you to eat more:

- oats, barley, and other whole grains
- fruits such as apples, pears, bananas, and oranges
- vegetables such as egg plant and okra
- beans and legumes, such as kidney beans, chickpeas, and lentils

Obesity is also a common risk factor for high cholesterol and heart disease. Your doctor may encourage you to lose weight by cutting calories from your diet and exercising more.

Taking medications such as statins can also help keep your cholesterol in check. These medications help lower your LDL levels.

Outlook

Overall, high cholesterol is very manageable. Ask your doctor to help you create a treatment plan that you can maintain. It may include changes to your diet, exercise routine, and other daily habits. It may also include cholesterol-lowering medications. The more proactive you are in making lifestyle changes and taking prescribed medications, the better results you will have.

(4) ESTIMATION OF VITAMINS, MINERALS, ELECTROLYTES FROM BLOOD

Vitamins have been one of the major nutritional discoveries of the 20th century and in the past three decades. Vitamin additives have been used to promote anything from mental health foods to cosmetics.

Assessing vitamin and mineral supplement use is important because supplement use is an exposure of interest for the risk of several chronic diseases and because supplements contribute a large portion of total (diet plus supplement) micronutrient intake, another important exposure in epidemiologic research unfortunately, little is known about methods for obtaining valid information about supplement use.

Electrolytes are positively and negatively charged molecules called ions, that are found within body cells and extra cellular fluids, including blood plasma. A test for electrolytes includes the measurement of sodium, potassium, chloride and bicarbonate. These ions are measured to assess renal, endocrine, acid-base function and are components of both renal function and comprehensive metabolic biochemistry profiles. Other important electrolytes routinely measured in serum or plasma include calcium and phosphorus. These are measured together because they are both affected by bone and parathyroid diseases and often move in opposite directions. Magnesium is another electrolyte that is routinely measured like calcium, it will cause uncontrolled muscle contractions when levels are too low in the extracellular fluids.

Purpose

Tests that measure the concentration of electrolytes are needed for both the diagnosis and management of renal, endocrine, acid-base, water balance, and many other conditions. Their importance lies in part with the serious consequences that follow from the relatively small changes that diseases or abnormal conditions may cause. For example, the reference range for potassium is 3.6-5.0 mmol/L. Potassium is often a STAT (needed immediately) test because values below 3.0 mmol/L are associated with arrhythmia (irregular heartbeat), tachycardia (rapid heartbeat), and cardiac arrest, and values above 6.0 mmol/L are associated with bradycardia (slow heartbeat) and heart failure. Abnormal potassium cannot be treated without reference to bicarbonate, which is a measure of the buffering capacity of the plasma. Sodium bicarbonate and dissolved carbon dioxide act together to resist changes in blood pH. For example, an increased plasma bicarbonate indicates a condition called metabolic alkalosis, which results in blood pH that is too high. This may cause hydrogen ions to shift from the cells into the extracellular fluid in exchange for potassium. As potassium moves into the cells,

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the plasma concentration falls. The low plasma potassium, called hypokalemia, should not be treated by administration of potassium, but by identifying and eliminating the cause of the alkalosis. Administration of potassium would result in hyperkalemia when the acid-base disturbance is corrected. Sodium measurements are very useful in differentiating the cause of an abnormal potassium result. Conditions such as the overuse of diuretics (drugs that promote lower blood pressure) often result in low levels of both sodium and potassium. On the other hand, Cushing's disease (adrenocortical over-activity) and Addison's disease (adrenocortical under-activity) drive the sodium and potassium in opposing directions. Chloride levels will follow sodium levels except in the case of acid-base imbalances, in which chloride may move in the opposing direction of bicarbonate. In short, diagnosis and management of a patient with an electrolyte disturbance is best served by measuring all four electrolytes.

Description

Sodium is the principal extracellular cation and potassium the principal intracellular cation. A cation is an ion with a positive charge. An anion is an ion with a negative charge. Sodium levels are directly related to the osmotic pressure of the plasma. In fact, since an anion is always associated with sodium (usually chloride or bicarbonate), the plasma osmolality (total dissolved solute concentration) can be estimated. Since water will often follow sodium by diffusion, loss of sodium leads to dehydration and retention of sodium leads to edema. Conditions that promote increased sodium, called hypernatremia, do so without promoting an equivalent gain in water. Such conditions include diabetes insipidus (water loss by the kidneys), Cushing's disease, and hyperaldosteronism (increased sodium reabsorption). Many other conditions, such as congestive heart failure, cirrhosis of the liver, and renal disease result in renal retention of sodium, but an equivalent amount of water is retained as well. This results in a condition called total body sodium excess, which causes hypertension and edema, but not an elevated serum sodium concentration. Low serum sodium, called hyponatremia, may result from Addison's disease, excessive diuretic therapy, the syndrome of inappropriate secretion of antidiuretic hormone (SIADH), burns, diarrhoea, vomiting, and cystic fibrosis. In fact, the diagnosis of cystic fibrosis is made by demonstrating an elevated chloride concentration (greater than 60 mmol/l) in sweat.

Potassium is the electrolyte used as a hallmark sign of renal failure. Like sodium, potassium is freely filtered by the kidney. However, in the distal tubule sodium is reabsorbed and potassium is secreted. In renal failure, the combination of decreased filtration and decreased secretion combine to cause increased plasma potassium. Hyperkalemia is the most significant and life-threatening complication of renal failure. Hyperkalemia is also commonly caused by hemolytic

anaemia (release from hemolysed red blood cells), diabetes insipidus, Addison's disease, and digitalis toxicity. Frequent causes of low serum potassium include alkalosis, diarrhoea and vomiting, excessive use of thiazide diuretics, Cushing's disease, intravenous fluid administration, and SIADH.

Calcium and phosphorus are measured together because they are both likely to be abnormal in bone and parathyroid disease states. Parathyroid hormone causes resorption of these minerals from bone. However, it promotes intestinal absorption and renal reabsorption of calcium and renal excretion of phosphorus. In hyperparathyroidism, serum calcium will be increased, and phosphorus will be decreased. In hypoparathyroidism and renal disease, serum calcium will be low, but phosphorus will be high. In vitamin D dependent rickets (VDDR), both calcium and phosphorus will be low; however, calcium is normal while phosphorus is low in vitamin D resistant rickets (VDRR). Differential diagnosis of an abnormal serum calcium is aided by the measurement of ionized calcium (i.e., calcium not bound by protein). Approximately 45% of the calcium in blood is bound to protein, 45% is ionized, and 10% is complexed to anions in the form of undissociated salts. Only the ionized calcium is physiologically active, and the level of ionized calcium is regulated by parathyroid hormone (PTH) via negative feedback (high ionized calcium inhibits secretion of PTH). While hypoparathyroidism, VDDR, renal failure, hypoalbuminemia, hypovitaminosis D, and other conditions may cause low total calcium, only hypoparathyroidism (and alkalosis) will result in low ionized calcium. Conversely, while hyperparathyroidism, malignancies (those that secrete parathyroid hormone-related protein), multiple myeloma, antacids, hyperproteinemia, dehydration, and hypervitaminosis D cause an elevated total calcium, only hyperparathyroidism, malignancy, and acidosis cause an elevated ionized calcium.

Serum magnesium levels may be increased by hemolytic anaemia, renal failure, Addison's disease, hyperparathyroidism, and magnesium-based antacids. Chronic alcoholism is the most common cause of a low serum magnesium owing to poor nutrition. Serum magnesium is also decreased in diarrhoea, hypoparathyroidism, pancreatitis, Cushing's disease, and with excessive diuretic use. Low magnesium can be caused by a number of antibiotics and other drugs and by administration of intravenous solutions. Magnesium is needed for secretion of parathyroid hormone, and therefore, a low serum magnesium can induce hypocalcemia. Magnesium deficiency is very common in regions where the water supply does not contain sufficient magnesium salts. Magnesium acts as a calcium channel blocker, and when cellular magnesium is low, high intracellular calcium results. This leads to hypertension, tachycardia, and tetany. Unfortunately, serum total magnesium levels do not correlate well with intracellular magnesium levels,

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and serum measurement is not very sensitive for detecting chronic deficiency because of compensatory contributions from bone. Ionized magnesium levels are better correlated with intracellular levels because the ionized form can move freely between the cells and extracellular fluids.

Precautions

Electrolyte tests are performed on whole blood, plasma, or serum, usually collected from a vein or capillary.

Special procedures are followed when collecting a sweat sample for electrolyte analysis. This procedure, called pilocarpine iontophoresis, uses electric current applied to the arm of the patient (usually an infant) in order to convey the pilocarpine to the sweat glands where it will stimulate sweating. Care must be taken to ensure that the collection device (macroduct tubing or gauze) does not become contaminated and that the patient's parent or guardian understands the need for the electrical equipment employed.

Preparation

Usually no special preparation is necessary by the patient. Samples for calcium and phosphorus and for magnesium should be collected following an eight-hour fast.

Aftercare

Discomfort or bruising may occur at the puncture site, or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Applying warm packs to the puncture site relieves discomfort.

Risks

Minor temporary discomfort may occur with any blood test, but there are no complications specific to electrolyte testing.

Measurement of Electrolytes

Electrolytes are measured by a process known as potentiometry. This method measures the voltage that develops between the inner and outer surfaces of an ion selective electrode. The electrode is made of a material that is selectively permeable to the ion being measured. This potential is measured by comparing it to the potential of a reference electrode. Since the potential of the reference electrode is held constant the difference in voltage between the two electrodes is attributed to the concentration of ion in the sample.

Electrolyte tests are performed in whole blood plasma or serum, usually collected from a vein or capillary.

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Normal consults

Electrolyte uncertain are similar whether measured in serum or plasma. Values are expressed as mmol/L for sodium potassium chloride and bicarbonate. Magnesium results are often reported as multiequivalents per litre (m/l) or in mg/dl. Total calcium is usually reported in mg/dl, and ionized calcium in mmol/L. since serum electrolyte disturbances can be associated with life threading consequences such as shock, coma alert values are used to warn physicians. Typical reference ranges are given below.

Serum or plasma sodium: 135-145 mmol/l.

Alert levels < 120 mmol/L and more than 160 mmol/L

Serum potassium – 3.6 – 5.4 mmol/l

Sweat chloride – 4-60 mmol/l

Serum calcium – 8.5 -10.5 mg/dl

Ionized calcium – 1.0 - 1.3 mmol/l

Serum inorganic phosphorus – 2.3 – 4.7

(Children – 4.0 – 7.0 mg/dl)

Serum magnesium – 1.8 – 3.0 mg/dl

Ionized magnesium – 0.53-0.67 mmol/l

(5) BLOOD CELL COUNTS

A blood cell count of CBC is an easy and very common test that screens for certain disorders that can affect health of an individual.

A CBC determines if there are any increases or decreases in the blood cells counts. Normal values vary depending on age and gender. The lab report will tell the normal value range for the test subject's age and gender.

A CBC can help diagnose a broad range of conditions, from anaemia anemia infection to cancer.

Specific types include tests for

- RBC – The number, size and types of RBC in the blood
- WBC – The number and types of WBC in the blood

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- Platelet – The number and size of the platelets
- Haemoglobin – An iron rich protein in red blood cells that carry oxygen
- Hematocrit - How much space red blood cells take up in your blood
- Reticulocyte count – How many young red blood cells are in your blood
- Mean corpuscular volume (MCV) – The average size of your red blood cells

The three basic types of blood cells

Measuring changes in blood cell levels can help your doctor evaluate your overall health and detect disorders. The test measures three basic types of cell.

(a) Red blood cells

Red blood cells carry oxygen throughout the body and remove carbon dioxide. CBC measures two components of your red blood cells.

Haemoglobin: oxygen carrying protein

Hematocrit: percentage of red blood cells in your blood

Low levels of haemoglobin and hematocrit are signs of anaemia/anemia as condition that occurs when blood is deficient in iron.

RBC are small circular, biconcave disc. There are about 5,000,000 red cells in each cubic millimeter of blood. They are pale, bluish colour when seen individually, but in masses appear red and give the colour to the blood. The average life of a red blood cell is about 120 days.

The red cells originate in the bone marrow, especially in that of the short, flat and irregular bones, in cancellous tissue at the ends of the long bones and in the narrow in the shafts of the ribs and in the sternum.

In process of development in the bone marrow, the red cells pass through several stages, at first they are large, and contain a nucleus but no haemoglobin; they are next charged with haemoglobin and finally lose their nucleus and are then passed out for circulation in the blood.

(b) White blood cells

White blood cells help your body fight infection. A CBC measures the number and types of white blood cells in your body. Any abnormal increases or decreases in the number or types of white blood cells could be a sign of infection, cancer or inflammation.

They are transparent and not coloured are larger and longer than the red.

(c) Platelets

These are small cells about one third the size of a red blood cell. It helps your blood clot and control bleeding

The Normal Blood Count

Red Blood Cells	4,500,000 to 5,500,000	Average 5,000,000
White Blood Cells	6,000 to 10,000	Average 8,000
Platelets	250,000 to 500,000	Average 350,000

White Blood Cells are made up as follows –

Granulocytes	Percent	Average percent
Neutrophil cells	60-70	66
Eosinophil cells	1 to 4	3
Basophil cells	½ to 2	1
Lymphocytes (large and small)	20-30	25
Monocytes	4 to 8	5
Total		100

When is a CBC ordered –

- Evaluate your overall health
- Diagnose a health problem
- Monitor a health problem
- Monitor your treatment

Procedure

A lab technician will draw blood from a vein:

1. Cleanse your skin with an antiseptic wipe
2. Places an elastic band around your upper arm
3. Inserts a needle in back of your hand and collects a blood sample in one or more vials
4. Removes the elastic band
5. Covers the area with a bandage to stop any bleeding
6. Label your sample and send to a lab for analysis

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Normal range

Blood component	Normal levels
Red blood cell	In men: 4.32 – 5.72 million cells/mcl In women: 3.90 – 5.03 million cells/mcl
Haemoglobin	In men: 13.5-17.5 grams/dL*** (135-175 grams/L) In women: 12.0-15.5 grams/dL (120-155 grams/L)
Hematocrit	In men: 38.8 – 50.0 percent In women: 34.9 – 44.5 percent
White blood cells count	3,500 to 10,500 cells/mcl
Platelet count	150,000 to 450,000/mcl

Hematocrit Test –

A hematocrit test measures the proportion of red blood cells in your blood, red blood cells carry oxygen throughout your body. Having too few or too many red cells can be a sign of certain disease.

A hematocrit test can help your doctor diagnose you with a particular condition or it can help them determine how well your body is responding to a certain treatment. It is most often used to test for:

- Anaemia
Anemia
- Leukemia
- Dehydration
- Dietary deficiencies

If your doctor orders a complete blood (CBC), the hematocrit test is involved. Other tests in CBC are haemoglobin and reticulocyte count.

How it is performed:

A medical provider will need a small sample of blood to test your hematocrit. This blood can be drawn from a finger prick or taken from a vein in your arm.

If the hematocrit test is part of CBC, a technician will draw blood from vein, typically from the inside of your elbow or from the back of your hand. The technician will clean the surface of your skin with an antiseptic or place an elastic band, or tourniquet, around your upper arm to help the vein swell with blood.

They'll insert a needle in the vein and collect a blood sample from one or more veins.

Technician will remove the elastic band and cover the area with a bandage to stop the bleeding. A blood test can be slightly uncomfortable.

Evaluation

In the laboratory, your hematocrit is evaluated using a centrifuge which is a machine that spins at a high rate to cause the contents of your blood to separate. A lab specialist will add a special anticoagulant to keep your blood from clotting.

When the test tube is taken one of the centrifuge, it will have settled into three parts.

- Red blood cells
- Anticoagulant
- Plasma or the fluid in your blood.

Each component will settle in a different part of the tube with the red blood cells muscles to the bottom of the tube. Red blood cells are then compared to a guide that tells what problem of your blood they make up.

Normal Hematocrit level

Adult men: 38.8 – 50 percent

Adult women: 34.9 to 44.6 percent

Children ages 15 and under have a separate set of ranges, as their hematocrit levels change rapidly with age. The specific lab that analyses the results will determine the normal hematocrit range for a child of a certain age.

Low hematocrit levels may be sign of:

- Bone marrow diseases
- Chronic inflammatory disease
- Internal bleeding
- Hemolytic anemia
- Kidney failure
- Leukemia
- Lymphoma
- Sickle cell anemia

High hematocrit levels can indicate –

- Congenital heart disease
- Dehydration
- Kidney tumor
- Polycythemia vein

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Blood Smears

A blood smear is a blood test used to look for abnormalities in blood cells. The three main blood cells that the test focusses on are:

- Red blood cells, which carry oxygen throughout your body
- White cells, which help your body fight infections and other inflammatory diseases
- Platelets, which are important for blood clotting

The test provides information on the number and shape of these cells, which can help donors diagnose certain blood disorders or other medical conditions.

Irregularities in the number or shape of your red blood cells can affect how oxygen travel in your blood. These abnormalities are often caused by a mineral or vitamin deficiency, but they can also be caused by inherited medical conditions such as sickle cell anaemia anemia.

White blood cells are an integral part of your body’s immune system, which is a network of tissues and cells that help your body fight infection. Having too many or too few white blood cells can indicate a blood disorder. Disorder affecting these cells often result in the body’s inability to eliminate or control infections or other inflammatory problems.

Abnormalities in the shape or number of white blood cells may be signs of a platelet disorder. Platelet disorders affect your blood’s ability to clot which can lead to excessive or prolonged bleeding or clotting. They often occur when the body produces too many or too few platelets.

Procedure

It is a simple blood test. A phlebotomist a person specifically trained to blood, first cleans and sterilizes the infection site with an antiseptic. They then tie a band above the venous site where your blood will draw. This causes your veins to swell with blood. Once they find a vein, the phlebotomist inserts a needle directly into the vein and draws blood.

What the results mean:

A blood smear is considered normal when your blood contains a sufficient number of cells and the cells have a normal appearance. A blood smear is considered abnormal when there’s an abnormality in the size, shape, colour or number of cells in your blood. Abnormal results may vary depending on the type of blood cell affected.

Red blood cell disorders include –

- Iron deficiency anemia, a disorder in which the body doesn’t produce enough normal red blood cells due to iron deficiency

- Sickle cell anaemia anemia an inherited disease that occurs when red blood cells have an abnormal crescent shape
- Hemolytic uremic syndrome— triggered by an infection in the digestive system
- Polycythemia (rubra vein), a disorder that occurs when the body produces an excessive number of red blood cells.

White blood cell disorders include-

- Acute or chronic leukemia
- Lymphoma, a form of cancer that affects the immune system
- HIV, a virus that infects white blood cells
- Hepatitis C virus infection
- Fungal infections such as candidiasis
- Other lymphoproliferative diseases including multiple myeloma

Disorders affecting platelets include –

- Myeloproliferative disorders, a group of disorders that causes blood cells to grow abnormally in the bone marrow.
- Thrombocytopenia, which occurs when the number of platelets is very low due to an infection or other disease.

A blood smear can also indicate other conditions including –

- a. Liver disease
- b. Kidney disease
- c. Hypothyroidism

Normal and abnormal ranges can vary among labs because some use different methods to analyze the blood sample.

(6) BLOOD TYPING

Blood typing is a method to tell what type of blood you have. It is done so you can safely donate your blood or receive a blood transfusion. It is also done to see if you have a substance called Rh factor on the surface of your red blood cells.

Your blood type is based on whether or not certain proteins are on your red blood cells. These proteins are called antigens. Your blood type depends on what types your parents passed down to you.

Blood is often grouped according to the ABO blood typing system. The major blood types are –

- Type A has the A antigen
- Type B has the B antigen

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- Type AB has both A and B antigens
- Type O has neither A nor B antigens

In other words –

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O: Type O can donate blood to anyone, because their blood has no antigens. However, they can only receive blood from other type O individuals (because blood with any antigens is seen as foreign).

A: Type A individuals can donate to blood to other type A individuals and type AB individuals. Type A individuals can receive blood only from other type A individuals and type O individuals.

B: Type B individuals can donate blood to other type B individuals and type AB individuals. Type B individuals can receive blood only from type B individuals and type O individuals.

AB: Type AB individuals can give blood only to other type AB individuals. But can receive blood of any type.

Blood types are further organized by Rh factor.

Rh-positive

People with Rh positive blood have Rh antigens on the surface of their red blood cells. People with Rh positive can receive Rh positive or Rh- negative blood.

Rh- negative

People with Rh- negative blood do not have Rh antigens. People with Rh- negative blood can receive only blood that is also Rh- negative.

Together, the ABO and Rh grouping systems yield your complete blood type. There are eight possible types— O-positive, O-negative, AB-positive and AB negative. While type O negative has long been considered a universal donor.

In considering donors of blood:

Group AB may give blood AB- AB +! AB

Group A to A and AB - A- A, AB

Group B to B and AB - B- B, AB

Group O is a universal donor for all O- universal donor groups

Recipients

Group AB is a universal recipient.

Group A may receive blood from groups A and O

Group B may receive blood from groups B and O

Group O from O

Procedure

A blood sample is needed. The test to determine your blood group is called ABO typing. Your blood sample is mixed with antibodies against type A and B blood. Then, the sample is checked to see whether or not the blood cells stick together. If blood cells stick together it means the blood reacted with one of the antibodies.

The second step is called back typing. The liquid part of your blood without cells (serum) is mixed with blood that is known to be type A and type B. People with type B blood have anti-A bodies. Type O blood contains both types of antibodies.

These two steps above can accurately determine your blood type.

Rh typing uses a method similar to ABO typing. When blood typing is done to see if you have Rh factor on the surface your red blood cells, the results will be one of these:

- Rh+ (Positive) if you have this cell surface protein
- Rh- (negative) if you don't have this cell surface protein.

(7) HISTOLOGY- CELLS AND TISSUES

Histology (histo meaning tissue or 'web' in Greek) is the study of normal cells and tissues mainly with the use of microscope. It involves all aspects of tissue biology focussing on how cells structure and arrangement optimize functions specific for each organ.

The sound knowledge of these normal histologic structure is essential for understanding the histopathology or pathology of any disease, which often cause specific changes in cells and tissues.

Cells

Cells are the building blocks of all living organisms. They are the smallest units in the living body and contain all the fundamental molecules that permit life. The simplest organisms like bacteria, for examples are formed of a single cell. More complex organisms, such as humans, consist of a vast array of highly specialized cells.

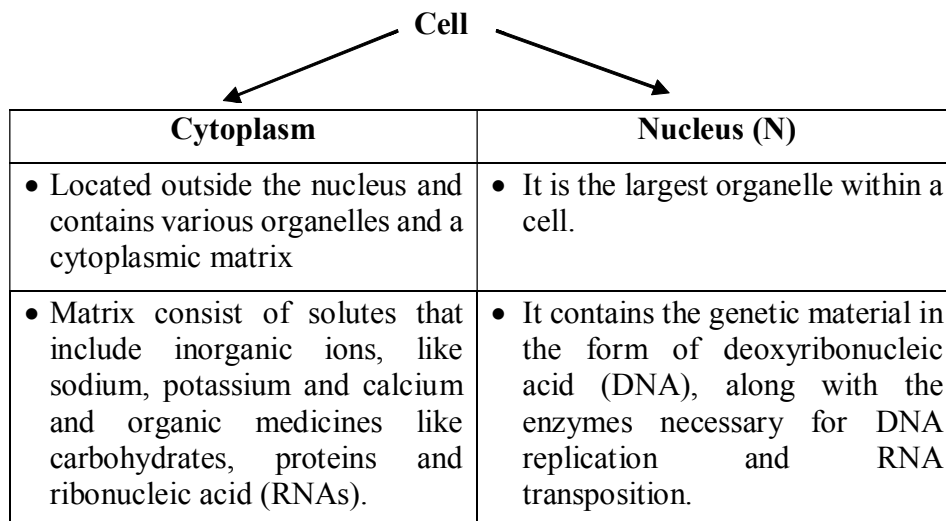
Cells perform various functions depending on their genetic blueprint. They can acquire and utilize energy perform a variety of chemical reactions, engage in mechanical activities, and overall maintain proper homeostasis.

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Cytoplasm

In general, cell can be divided in two compartments

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Tissues

Tissues are formed of cells with similar morphology, function and an extracellular matrix. Examples of tissue include matrix is a collection of extracellular molecules secreted by the cells that impart great structural and biochemical support for the tissue cells. It provides mechanical support, transport materials and carries away catabolites and secretary products.

Organs are group of tissues that act together to perform specific functions. Tissues and organs can compare integrated functional systems that form major anatomical entities. Within tissues, cells interact with each other in various ways during embryological development, growth maintenance and response to injury.

Types of Tissues

A tissue is a group of cells that have a similar shape and function. Different types of tissues can be found in different organs. In humans, there are four basic type of tissues-

- A. Epithelial tissue
- B. Connective tissue
- C. Muscular tissue
- D. Nervous tissue

A. Epithelial Tissue

It covers the body surface and forms the lining for most internal cavities. The major function of epithelial tissues includes protection, secretion, absorption and filtration. The skin is an organ made up of epithelial tissue which protects the body

from dirt, dust bacteria, and other microbes that may be harmful. Cells of the epithelial tissue have different shapes. It can be thin, flat to cubic to elongated.

It presents injury to the underlying tissue, prevents the loss of fluid from these tissues and also prevents the passage of fluid into the structures which are covered by skin. Microorganisms cannot pass through healthy skin, but they can and do pass through abraded skin.

Types of Epithelial Tissue

There are two main classes of Epithelial tissue each containing several varieties. All epithelial cells lie on and are held together by a homogenous substance called a basement membrane.

(a) Simple epithelium

This class consist of single layer of cells and subdivided into three varieties.

- **Pavement or squamous epithelium:** There are five thin plates placed edge to edge like the particles in a mosaic pattern. These formed the alveoli of the lungs. They are formed in the living of the heart, blood vessels and lymphatics.



Simple Squamous Epithelium

- **Columnar epithelium:** It forms a single layer of cells which line the ducts of most glands, the gall bladder, nearly whole of the digestive tract.



Simple Columnar Epithelium

- **Ciliated epithelium:** It is found living in the air passages and their ramifications such as the frontal and maxillary sinuses. It also lines the uterine tubes or oviducts and part of the uterus and ventricles of the brain.

Goblet Cells

Goblet cells are mucus secreting cells which lie in the walls of glands and ducts lined by columnar cells either plain or ciliated. Goblet cells secrete mucus or and express it on the surface. They act as mucus secreting glands and are most numerous where a considerable amount of mucus covers the surface as in the stomach, colon and trachea.

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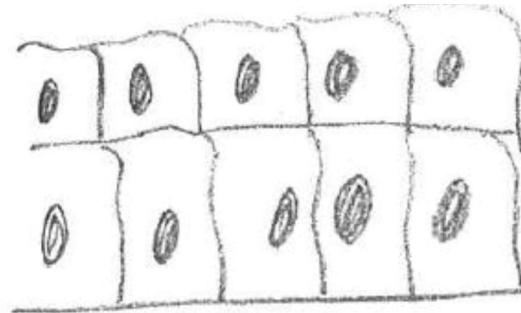
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(b) Compound Epithelium

Consists of more than one layer of cells

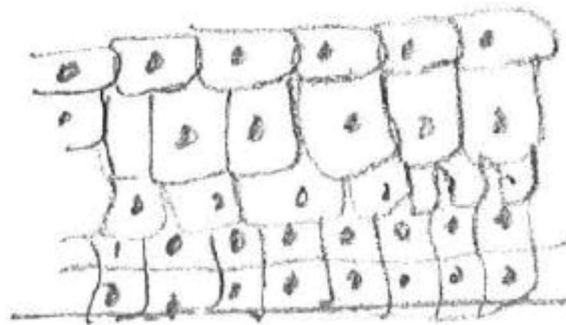
• **Stratified epithelium**

- (i) Forms the epidermal layers of skin.
- (ii) Also lines the mouth, pharynx, oesophagus, the lower part of the urethra, the anal canal and the vagina and covers the surface of the cornea.



Stratified Columnar Epithelium

- **Transitional epithelium:** It is a compound stratified epithelium consist of three layers of cells. It lines the urinary bladder, the pelvis of the kidney, the ureters and the upper part of the urethra.



Transitional Epithelium:

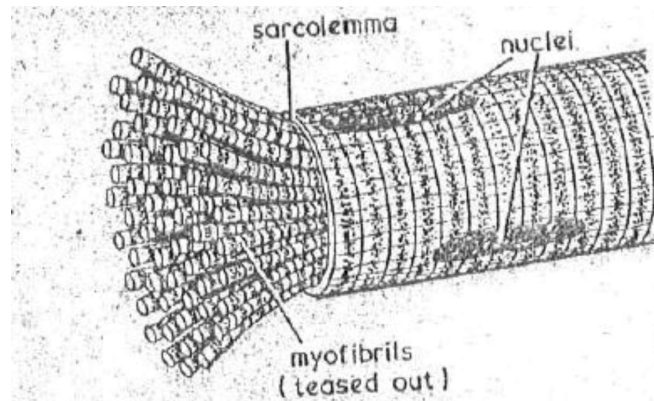
B. Muscular Tissue

It is a tissue which is specialized for contraction and means of this movements are performed. There are three types of muscles –

- (a) Skeletal muscle
 - (b) Smooth muscle
 - (c) Cardiac muscle
- **Skeletal muscle** – can be controlled by man and enable movement and carrying of objects. This tissue is present attached to the body skeletal system, especially long bones.

- **Smooth muscles** – are spindle or cone shaped in structure. They help in contraction and relaxation of main organs like lungs, stomach, uterus etc. This type will contract without nervous stimulation although in most parts of the body its activity is under the control of the autonomic hormones system.

It is found in the coats of blood and lymphatic vessels in the walls of the digestive tract and trachea, and bronchi, in the iris and ciliary muscles of the eye.



Microscopic View of a Striped Muscle Fibre

C. Connective tissue

As the name indicates, is in connecting position in between tissues. Several types of connective tissues are –

- Loose connective tissue (areolar tissue, adipose tissue)
- Dense connective tissue
- Cartilage tissue
- Bone tissue

Let's discuss these briefly.

1. Loose connective tissue (areolar and adipose)

- **Areolas connective tissue:** It is widely distributed connective tissue. It is made of fibroblasts, mast cells, macrophages and fat cells. It provides elasticity and tensile strength to almost all the part of the body. It supports and also connects other tissues like below the skin, between the muscles in the digestive tract, etc.
- **Adipose tissue:** This tissue consists of fat cells, fat globules, in the matrix of areolar tissue. It is present in all subcutaneous tissue except that of the eyelids and the penis, and inside the cranial cavity.

Types of adipose tissue –

- White – makes upto 25% of body weight in healthy adults and acts as thermal insulator and also energy store.
- Brown — is found in burns and in very small amounts in adults.

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2. Dense connective tissue

Unlike the loose connective tissue, this has more of fibers and less number of cells. This is divided in two

- (i) Fibrous tissue
- (ii) Elastic tissue

3. Cartilage

It is harder and stronger than prior tissue types. It is made of cells called Chondrocytes which are embedded in a matrix of collagen and elastic fibers. There are three types of cartilage.

- (i) Hyaline cartilage
- (ii) Elastic cartilage
- (iii) Fibro cartilage

D. Nervous tissue

This tissue is mostly present in the entire nervous system including brain and spinal cord. It has two types of tissue as nervous cell and neuroglia.

The nerve cells are the longest cells in the body. They can be up to few meters. They transmit impulses from brain to other body part and vice-versa. This tissue controls the whole body by conduction of impulses across the body. The tissue operates by use of bimolecular chemical substances called as neurotransmitters.

Neuroglial tissue is a binding tissue around the neurons. It helps to protect the nerve cells from damage. Unlike other cells, these cells do not multiply. They are formed during birth and last till death. If there is any damage to them in between, it can lead to loss of their function forever.

(8) DIFFUSION AND OSMOSIS

In this section, you will study about the process of diffusion and osmosis.

Diffusion

Diffusion is the movement of particles (atoms, ions or molecules) from a region in which they are in higher concentration to regions of lower concentration. A good example of diffusion is food colouring. If you place a drop of red food colouring in a beaker of water, eventually the entire beaker of water will have a red tint. The food colouring moved through the water until it was equally distributed throughout the beaker. Diffusion takes place along a concentration gradient. A concentration gradient exists until the diffused substance is evenly distributed.

Other everyday examples of diffusion are –

1. Sugar will diffuse through tea until the entire cup of tea is sweet.
2. The colour of food cooking diffuses throughout the kitchen. If you open the kitchen door it will spread into the next room.

Osmosis

Osmosis is a special example of diffusion. It is the diffusion of a substance through a semipermeable membrane from a more dilute solution to more concentrated solution. This process is also passive since no external energy is needed.

A semipermeable membrane is a barrier that permits the passage of some substances, but not others. Some examples of osmosis are –

Absorption of water by plant roots. Reabsorption of water by the proximal and distal convoluted tubules of the nephron. Reabsorption of tissue fluid into the venule ends of blood capillaries.

Absorption water by stomach, alimentary canal, colon and small intestine.

Osmosis is the result of diffusion across a semipermeable membrane. If two solutions of different concentrations are separated by a semipermeable membrane from the less concentrated to the more concentrated solution. This process is called osmosis. At the cellular level both processes are types of passive transport.

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Comparison chart	
Diffusion	Osmosis
What is it?	
Diffusion is a spontaneous movement of particles from an area of high concentration to an area of low concentration (e.g. tea flavouring moving from an area of high to low concentration in hot water.)	Osmosis is the spontaneous hot movement of water across a semipermeable membrane from a region of low solute concentration to a more concentrated solution, up a concentration gradient. This equalizes concentrations on both sides of the membrane.
Process	
Diffusion mainly occurs in gaseous state or within gas molecules and liquid molecules. (e.g. The molecules of 2 gases are in constant motion and if the membrane separating them is removed the gases will mix because of random velocities.	It occurs when the medium surrounding the cell has a higher water concentration than the cells. The cell gains water along with important molecules and particles for growth. It also occurs when water and particles move from one cell to another.
Importance	
To create energy helps in exchange of gases during respiration, photosynthesis and transpiration.	In animals, osmosis influences the distribution of nutrients and release of metabolic waste products. In plants osmosis is partially responsible for the absorption of soil water and for the elevation of the liquid to the leaves of the plants.
Concentration Gradient	
Cross from a high concentration gradient to a low concentration gradient	Moves down concentration gradient
Water	
Doesn't need water movement	Needs water for movement
Examples	
Perfume of air freshner where the gas molecules diffuse into the air spreading the aroma.	Movement of water into root hair cells.

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(9) URINE ANALYSIS

A urine analysis is a test of your urine. A urine analysis is used to detect and manage a wide range of disorders, such as urinary tract infections, kidney disease and diabetes.

A urine analysis involves checking the appearance concentration and content of urine. Abnormal urine analysis results may point to a disease or illness.

For example, a urinary tract infection can make urine too cloudy instead of clear. Increase level of protein in urine can be a sign of kidney disease.

How does it work?

There are three ways to analyse urine, and your test might use all of them.

One is visual exam, which checks the colour and clarity. If your urine has blood in it, it might be red or dark brown. Foam can be a sign of kidney disease; white cloudy urine may mean you have an infection.

A microscopic exam checks for things too small to be seen otherwise some of the things that shouldn't be in your urine that a microscope can find include.

- Red blood cells
- White blood cells
- Bacteria
- Crystals (clump of minerals — a possible sign of kidney stone)

The third part of urine analysis is the dipstick test, which uses a thin plastic strip treated with chemicals. It's dipped into your urine and the chemicals on the stick react and change colour if levels are above normal. Things the dipstick best can check include:

- **Acidity or Ph:** If the acid is above normal, you could have kidney stones, a urinary tract infection or another condition
- **Protein:** This can be a sign your kidneys are not working right. Kidneys filter waste products out of your blood and your body needs protein.
- **Glucose:** A high sugar content is a marker for diabetes.
- **White blood cells** These are a sign of infection.
- **Bilirubin:** If this waste product, which is normally eliminated by your liver, shows up, it may mean your liver isn't working properly.
- **Blood in your urine:** Sometimes this is a sign of infections.

Reference Range

- Colour – Yellow (light/pale to dark/deep amber)
- Clarity – clear or cloudy

- Ph – 4.5-8
- Specific gravity – 1.005 – 1.025
- Glucose – 30 mg/d
- Ketones – none
- Nitrites – negative
- Leukocyte esterase – negative.
- Blood - d" 3RBCs
- Protein - d" 150 mg/d
- WBCs - d" 2-5 WBCs/hpf
- Casts – 0-6 hyaline Casts/1pf
- Crystals – Occasionally
- Bacteria – none
- Yeast – none

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A. Creatinine

Creatinine is a waste product in your blood. It comes from protein in your diet and the normal breakdown of muscles in your body. Creatinine is removed from blood by the kidneys and then passes out of the body in your urine. If you have kidney disease the level of creatinine in your blood increases.

If your kidneys aren't functioning properly, an increased level of creatinine may accumulate in your blood and provide an estimate of how well your kidneys filter (glomerular filtration rate). A creatinine urine test can measure creatinine in your urine.

Why It's done

A serum creatinine test – which measures the level of creatinine in your blood – can indicate whether your kidneys are working properly. How often you need creatinine tests depends on any underlying conditions and your risk of kidney damage. For example –

- If you have type 1 or type 2 diabetes
- If you have kidney disease
- If you have an illness that may affect your kidneys

How is the sample collected for testing?

A blood sample is drawn from a vein in the arm. A 24-hour urine sample may also be collected in which all urine produced during 24 hours is saved. Sometimes a single, random urine sample may be collected and tested.

Results

Results of the creatinine blood test are measured in milligrams per deciliter or micromoles per litre. The normal range for creatinine in the blood may be 0.84 –

1.21 milligrams per deciliter (74.3 to 107 micromoles per liter). Since the amount of creatinine in the blood increases with muscles mass, men usually have higher creatinine levels than do women.

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Generally, a high serum creatinine level means that your kidneys aren't working well.

B. Urea

Urea is a nitrogenous compound a carbonyl group attached to two amine groups with osmotic diuretic activity. In vivo, urea is formed in the liver via the urea cycles from ammonia and is the final end product of protein metabolism. Administration of urea elevates blood plasma osmolality, resulting in enhanced flow of water from tissues, including brain, cerebro spinal fluid and eye into interstitial fluid and plasma, these by decreasing pressure in those tissues and increasing urine outflow.

Urea is one of the end products of protein metabolism. It is prepared from amino acids, which are deaminated in the liver and reach the kidneys in the circulation, being excreted at the rate of 30 grams a day. The normal blood urea level is 30 mg per 100 ml of blood, but this depends on a normal intake of protein blood and the function the liver in the formation of urea.

C. Total Nitrogen

Total nitrogen is an essential nutrient for plants and animals, however an excess amount of nitrogen in a waterway may lead to low levels of dissolved oxygen and negatively alter various plant life and organisms. Sources of nitrogen include waste water treatment plant, him off from fertilized lawns and croplands, and industrial discharges that contain corrosion inhibitors.

Purpose of a urine urea nitrogen test

Your doctor will usually recommend a urea test to determine protein levels in the body. The test can determine how much protein you're eating, and if it's an adequate amount. In addition, your urea nitrogen levels may rise if you're going through heart failure or dehydration.

A common test for urea nitrogen is the blood urea nitrogen test, better known as BUN. This section refers to the urine urea nitrogen test, which is performed using a urine sample.

A urea nitrogen test can also:

- assess how well the kidneys are functioning
- determine if you have kidney disease
- monitor your kidney disease
- help diagnose a number of diseases and disorders that may affect how your kidneys function

Urine urea nitrogen test process

The urine urea nitrogen test involves analysing urine samples that you collect during a specified 24-hour period.

Follow your doctor's orders about how to collect the sample. Generally, you will maintain normal eating and drinking habits during the collection phase.

Tips

Wash your hands carefully before and after collecting each sample. Also, make sure that you cap the containers tightly. Label and return the samples to the doctor as instructed. Samples need to be refrigerated during the 24-hour period.

On the first day of collection, you won't collect a sample when you first urinate that morning. Note the time, and then collect all urine for the remaining 24 hours.

Once collected, the urine is sent to a laboratory for analysis.

Understanding total nitrogen

There are three forms of nitrogen that are commonly measured in water bodies: ammonia, nitrates, nitrites. Total nitrogen is the sum of total kjeldahl nitrogen. (Ammonia, organic, reduced nitrogen) nitrate-nitrite individually and adding the components together. An acceptable range of total nitrogen is 2 mg/l to 6 mg/l.

(10) PREGNANCY TEST

A human chorionic gonadotropin (HCG) urine test is a pregnancy test. A pregnant woman's placenta produces HCG, also called the pregnancy hormone. If you're pregnant, the test can usually detect this hormone in urine about 10 days after your first missed period. This is when the fertilized egg attaches to the uterine wall.

During the first 8-10 weeks of pregnancy, HCG levels normally increase very rapidly. These levels reach their peak at about the 10th week of pregnancy and they gradually decline until delivery.

Uses of HCG urine test

The HCG urine test confirms pregnancy about one to two weeks after your missed period. This is a qualitative test, which means that it will tell you whether or not it detects the HCG hormone in your urine. It's not intended to reveal specific levels of the hormone. The presence of HCG in your urine is considered a positive sign of pregnancy.

Method

You can take an HCG urine test at your home or at doctor's clinic with a pregnancy kit. Both will require the collection of a urine sample. An HCG urine test conducted at home is similar to the test that your doctor conducts.

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- Wait one to two weeks after your first missed period to get the most accurate results. Irregular periods or miscalculations of when a period is due can affect your test.
- Plan to use the test first time you urinate after waking up. Thus, urine is the most concentrated and will contain the highest HCG levels of the day. Your urine dilutes as you drink liquids, so HCG levels may be harder to measure later in the day.
- For some home pregnancy tests, you will hold an indicator stick directly in the urine stream until its soaked which should take about five seconds. Other kits require that you collect urine in a cup and then dip the indicator stick into the cup to measure the HCG hormone level.
- Home pregnancy test usually include an indicator that shows whether the test is being properly performed, for example, it will show if there's enough urine on the stick to get an accurate result. If the control indicator doesn't activate during your test, the results may vary.
- For most results, it only takes about 5-10 minutes for a result to appear. Typically, a coloured line or plus symbol will appear on the test stick to indicate a positive result. The absence of a coloured line or a negative sign usually indicates a negative result.

What do the result of the HCG urine test mean?

The accuracy of your HCG urine test result will depend on your ability to closely follow the instruction.

A false negative result can happen after anyone of the following:

- Using a urine sample collected after your first morning urine.
- Taking the test before there is enough HCG to produce a positive result.
- Miscalculating the timing of your missed period.

If you have a negative result, you should repeat the test in about a near to confirm the absence of pregnancy.

If you have a positive result, it means that the test detected HCG in your urine. Your next step should be to consult your doctor. They can confirm pregnancy with an exam and additional testing.

HEALTH AND NUTRITION

1. Preparation of low cost recipes for adolescent pregnant and lactating mothers.
2. Evaluation of ongoing public health nutrition programmes.

Let's have a look at each of these topics in detail.

(1) PREPARATION OF LOW COST RECIPES FOR ADOLSCENTS, PREGNANT AND LACTATING MOTHERS

Eating healthy is an important part of a healthy lifestyle and is something that should be taught at young age. Adolescence is the transition period between childhood and adulthood, a window of opportunity for the improvement of nutritional status and correcting poor nutritional practices. This is about the same period puberty sets in, typically between the ages of 10 and 13 years. Adolescence is characterized the growth spurt, a period in which growth is very fast. During this time, physical changes affect the body's nutritional needs. Adolescent nutrition is important for supporting the physical growth of the body and for preventing future health problems.

The following are some important guidelines to discuss your adolescents diet:

- Eat three meals a day, with healthy snack
- Increase fibre in the diet and reduce use of salt
- Drink plenty of water
- Take whole fruits instead of fruit juice
- Eat fruit or vegetables for a snack

A. Recipes for Adolescents

The following are some low cost, healthy and nutritious recipes for an adolescent:

(a) Groundnut chikki

(b) Vegetable toast

A 20 minutes recipe which you can make easily by moving medium size boiled potatoes,

- $\frac{1}{4}$ cup finely chopped vegetables like capsicum, carrot, onion, peas, spinach, beans, lenthil, green chilli, coriander etc.
- Add $\frac{1}{4}$ tsp of red chilli powder and chaat masala and salt according to taste.
- Now cut 4 square (any shape) pieces of a bread and spread the prepared mixture on both side of bread. Heat a pan and green lightly with oil.
- Cook on both sides, till golden brown.

(c) Chapatti wraps

- Prepare fresh *chapatti* or leftover *chapatti*.
- Make a dry stir fry vegetable out of any seasonal vegetable or can use any leftover vegetable also. Keep them crisp.

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- Take the already prepared *chapatti*, put 2 tbsp of stuffing vertically, add tomato sauce, green chutney and cabbage to it.
- Fold a little at the bottom and roll it from the side tightly. Your wrap is ready.

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(d) Stuffed Paranthas

One of the most easy, healthy and nutritive recipes for adolescent. You can make variety of parathas by using different stuffing. You can also use potatoes, bottle gourd, cabbage, cauliflower with chopped onions, green chillies to prepare different fillings for the paranthas. Add salt, rock salt, amchur, red chilli and black pepper accordingly.

Prepare dough with wheat flour and make stuff paranthas out of it.

(e) Mix veg idlis

Take idli batter prepared with urad dal and rice. Ferment it. Add chopped/grated vegetables like carrot, beans, peas, capsicums and add salt and green chilli and coriander and mix it over.

Steam it and serve hot with sambar and chutney.

You can also make with the same stuffing and serve with sambhar and chutney.

(f) Mix vegetable cutlets

Boiled vegetable likes potato, green peas, beans, carrots etc. and mash them up. Make sure the vegetables are drained well. Add ginger, garlic (optional) and green chilly optional, chaat masala, rock, salt, bread crumbs to the veggie mixture. Mix well all the aforementioned and prepare tikkis or patties of any shape. Dip these tikkis in the pre-prepared paste of maida and water and roll them in bread crumbs (or sooji) now fry them on the pan, till crisp brown on both the side.

(g) Sooji balls

Mix 1 cup sooji (semolina) with $\frac{1}{2}$ cup of yoghurt, salt black pepper powder, grated carrots, chopped veggies or anything you would like to add. Mix all the ingredients well and make balls into of them.

Try them and serve hot.

B. Recipes for pregnant and lactating mothers

A healthy pregnancy begins even before conception. A woman's diet during the few months before she conceives can be as important for her baby's well-being as what she eats during her pregnancy.

The demands pregnancy makes on a woman's body are heavy, but the vast majority of pregnant women can fulfil their own needs and those of their babies by eating a normal healthy diet. A well-balanced wholesome diet that is high in fibre-

rich complex carbohydrates, fruit and vegetables and low in saturated fats, will help a mother to stay fit and well and supply the foetus with all the essential nutrients for healthy development. Therefore, the diet of pregnant woman must provide for the additional requirements.

The increase in nutrient needs during lactation will depend mainly on the quantity of milk required. Emotional factors such as excitement, fear and anxiety can sometimes diminish the secretion of milk and may even suppress it completely, maintenance of milk secretion depends upon adequate diet.

The diet requirement of lactating mother is even greater than that of a pregnant woman because she has to feed the baby in addition to meeting her own requirements.

The diet pattern during lactation could be the same as during pregnancy, but it is advisable to increase the intake of foods like milk and those required to provide additional calories. High spicy foods or stronger flavoured vegetables may be unsuitable.

Here are some recipes for pregnant and lactating mothers:

(a) Stuffed besan roti-

- 1 cup methi
- Atta 1 cup
- Besan 40 gm

Prepare dough of the ingredients and make chapattis and eat with chutney and jaggery.

(b) Bajra dosa and Bajra roti-

High in fibre and iron, bajra replenishes a nursing mother's iron level and prevents constipation.

Ingredients –

- 1 cup bajra
- ¼ cup par-boiled idli rice
- ¼ cup whole urad dal
- 1 tsp methi seeds
- Salt to taste

Method

- Soak all the ingredients together for 6-7 hours or overnight.
- Grind it to a smooth paste in a blender, add salt and mix well.
- Allow it to ferment for 5-6 hours.

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- Heat a tawa. When it is hot, pour a idli of butter and spread it in a circular motion. Drizzle a 1sp of oil around the dosa. Flip over once the edges start curling upwards.

Can make bajra roti also and have it with any seasonal vegetable.

c) Ajwain halwa – This recipe makes use of dry ginger and ajwain both known to facilitate digestion and lactation. Use jaggery to sweeten the halwa.

Ingredients

- 1 cup whole wheat flour
- Ajwain (carom seeds)
- ½ cup ghee/oil
- ½ cup jaggery
- ¼ tsp dry ginger powder
- A pinch of cardamom powder
- Water

Method

- Heat ghee/oil in a thick bottomed pan. Add whole wheat flour and roast on medium flame until it turns golden brown and the ghee starts to separate. Be sure to separate all the lumps.
- Now add in powdered carom (ajwain) seeds and dry ginger (saunth). It is the mixture for a few minutes. Add jaggery and mix well.
- Pour the water and stir the mixture. Cook till it thickens in consistency. Remove from the stove. Garnish halwa and serve hot.

Note: - You can also make gajar halwa, sooji halwa, etc.

(d) Mix vegetable porridge

Ingredients

- Daliya – 1 small cup
- Seasonal – vegetables – 1 cup
- Spices according to taste
- Oil – 1-1 ½ tsp

Method

- Dry roast daliya till golden brown, cook daliya in pressure cooker with water.
- Put oil in a pan and add green chillies, jeera, curry leaves and all vegetables. Cook them.
- Add all spices, and then add cooked daliya in that add little water if needed.
- Garnish with coriander and serve hot.

(e) Multi seed Mukhwas

Ingredients –

- ¼ cup flaxseeds (alsi)
- ¼ cup black sesame seeds (kala til)
- ¼ cup white sesame seeds (til)
- ¼ cup saunf
- ¼ cup pumpkin seeds
- 1 tsp lemon juice
- ½ tsp salt

Method

- Combine all the ingredients in a bowl, add lemon juice, salt and mix well. Cover and keep aside for an hour.
- Dry roast in a non-stick pan for 2 to 3 minutes till it starts giving a good aroma
- Cool slightly and mix well
- Cool completely and store in air tight container

(f) Til Ladoo

- Roast til (sesame), keep aside
- Melt jaggery and add roasted til and mould the mixture to make small balls.

Note: Take little water in palm and wet your hands and make ladoos, it will be easy to make.

(h) Dhokla

Ingredients

- Dal (besan) 2 cups
- Sour curds – ½ cup
- Water – 2 cups
- Ginger/green chilli
- Coriander leaves/ curry leaves
- Oil – ½ cup
- Hing – 1 pinch
- Cooking soda – 1 tsp

Method

- Soak it in curd and water for four hours.
- Take besan add curd, turmeric powder, salt and cooking soda and pour on a greased tray or any suitable vessel.

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- Steam till it is done.
- Heat oil, add hing (asafoetida), mustard seeds, ginger, green chillies and coriander leaves and garnish the dhokla.

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(2) EVALUATION OF ONGOING PUBLIC HEALTH NUTRITION PROGRAMMES

The international and national agencies involved in different nutrition programmes in India are listed below:

International agencies –

- World health organization (WHO)
- Food and Agricultural organization (FAO)
- United nations international children's educational fund (UNICEF)
- United Nations International Education and cultural organization (UNESCO)
- World food programme
- Cooperative for American relief everywhere (CARE)

National Agencies –

- Ministry of Health and Family Welfare
- Ministry of Food and Agriculture
- Ministry of Education and Social Welfare
- Ministry of Community Development
- Indian Council of Medical Research (ICMR)
- National Institute of Nutrition
- Council of Scientific and Industrial Research
- Central Food Technological Research Institute (CFTRI), Mysore
- Indian Council of Agricultural Research (ICAR), Delhi
- Food Corporation of India (FCI)

The various National nutrition programmes in operation in India are –

- Applied Nutrition Programme (ANP)
- Special Nutrition Programme
- School lunch Programme
- Integrated child development scheme (ICDS)
- Vitamin A deficiency Programme
- Goitre control Programme
- Nutritional anaemiaanemias Programme
- Rural health plan

The three-fold objectives of the present programmes –

- As welfare schemes (e.g. Feeding Programmes) undertaken as relief measures under scarcity conditions.
- Supplementary feeding to certain vulnerable sections of population (e.g. special nutrition programmes)
- Provide nutrition education (e.g. Feeding scheme under the applied nutrition programme)

Evaluation: What is it?

- A process of data collection designed to assess the effectiveness of the project in attaining its originally stated objectives and the extent to which observed changes are attributable to the project.
- Done at the end of the project but could be planned at strategic periods during the life of the projects. Inform of various of midterm reviews or biennial reviews.
- Evaluation happens only after the decision to implement a certain intervention has been made.
- Evaluation needs
 - (i) Clarity scaled goals
 - (ii) Clarity scaled objectives

Programme managers and planners needs to be accountable to funding agencies and policy makers. They must therefore distinguish useful current programmes from ineffective to inefficient ones, and plan, design and implement new efforts that effectively and efficiently have the desired impact on the target group. To do so they must obtain answers to a range of such questions –

- Is the strategy based on priorities from a broad analysis of the nutrition situation, needs assessment and cultural and behavioural aspects?
- Are the interventions selected likely to ameliorate significantly the nutrition problems?
- Is the most appropriate target population selected?
- Is the intervention being implemented in the ways envisioned?
- Is it effective?
- How much does it cost?
- If the nutrition education programme is one of several interventions, how can its effect or impact be separated from the impact of other inventions.

Evaluation theory and procedures are basically the same in various interventions such as health, education, welfare and other services and policies.

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Purpose of evaluation

Evaluation of educational programmes are undertaken for several reasons –

- To judge how the programme personnel have performed.
- To judge how the nutrition education programs are planned and executed and to increase the effectiveness of programme management and administration; to possess the utility of new programmes.

The functions of evaluation

Evaluation of nutrition education programmes includes not only collection of qualitative and quantitative data but also their analysis and interpretation for the purpose of making judgement and decisions. In this context, evaluation is seen to have two main functions –

Formative and summative

Formative evaluation is used to improve and develop programme activities as they are carried out and is therefore continuous.

Summative evaluation measures the outcome of an activity or set of activities.

Evaluation may have psychological or socio-political functions as it is used to increase the awareness of educational activities or promote public relations.

Another function is to facilitate supervision. In an organization responsible for a nutrition education programme, it is the responsibility of a manager to evaluate personal and programme activities under her or his responsibility.

Reasons for evaluating nutrition education programmes to assess –

Impact or effect

- How programme is planned and executed
- How programme personnel perform
- How effectiveness can be improved
- The utility of a programme, and
- To satisfy the programme sponsors

Components of evaluation

Usually four components are considered –

1. Inputs
2. Processes
3. Outputs
4. Outcomes

Inputs –

Inputs are the set of resources dedicated to a programme.

They include human and financial resources, physical facilities, equipment and operational policies that enable services to be delivered i.e.–

- Personal
- Facilities
- Space, storage, room for admitting children
- Equipment

Process

Process refers to the set of activities in which programmes inputs are utilized in pursuit of the results from the programme.

Process refers to multiple activities that are carried out to achieve the objectives of the projects

- Service delivery operations
- Management oriented activities
- Training, research, etc.

Output

Outputs are the results obtained at the programme level through education of activities using its resources:

- Could be staff performing better as a result of having been trained
- As a result of clear policy environment
- Staff better informed about policies – better in taking decisions

Output classified into three levels –

1. Functional outputs: - Number of nutrition IEC tasks, food preparation demonstration, people trained.
2. Service outputs: - member benefiting/accessing, quality of service, acceptability image.
3. Service utilization, member using the service.

Outcome

The set results expected to occur at the population level due to the programme output. The immediate effects are often behavioural and results directly from the project outputs. They may be necessary to achieve a desired effect.

Outcomes may be divided into two components—

- (i) Intermediate outcomes and (ii) long term outcomes.

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Immediate outcomes are set of results at the population level that are closely and clearly linked to the programme activities.

Long term outcome refers to set of results at the population level that are long term in rather and are produced through action of immediate outcomes.

Six key outcomes for nutrition:

1. Exclusive breastfeeding
2. Appropriate complementary feeding
3. Adequate iron intake
4. Adequate vitamin A intake
5. Adequate iodine intake

Elements of Evaluation

Indicators –

Indicators are variables that measure the different aspects of a given programme.

The inputs, processes, outputs and outcomes.

An indicator can be assigned a numeric value, a percentage, a mean value, a ranking, an absolute number of yes/no score, e.g., presence vs absences

Selection of indicators

Indicator must be selected to provide evidence that defines the extent to which project interventions are successful in achieving the set objective.

Criteria for selection of indicators

- Validity – it measures what it is intended to
- Sensitivity – its changes reflect desired changes.
- Reliable – it produces the same results then repeated.
- Un-dimensional- it is measurable.
- Operational – it is measurable.
- Objective - it is not subject to measurer's biases.
- Practical – its data collection is reasonable feasible.
- Comparability (from time to time/place to place)

Components of evaluation plan

- Introduction – the country region and background of what the project is addressing
- Conceptual framework – maps the linkages inputs – process – outputs and outcomes
- Data types

Mechanism for M & E

- Data collection methods
- Establishing baseline
- Data storage/analysis
- Management of collection, who collects and when
- Routine review of data

Indicators of evaluation

- Uses of data
- Work plan needed to implement the plan
- Work plan lists:
 - (i) Activities
 - (ii) Time they shall be conducted
 - (iii) Target numbers
 - (iv) Milestones e.g., by after 18 months
 - (v) Implementations

Evaluation of National Nutrition Programmes

The Government of India has been a pioneer in initiating national programmes to combat macro-and micro-nutrient undernutrition. These programmes have been evolved on the basis of research studies in the country, on the ecological factors responsible, the magnitude of the nutritional problems and feasible interventions, that could be implemented within the existing infrastructure.

At the request of the concerned departments, NFI had undertaken independent third-party evaluation of these programmes at the National or State level, identified lacunae in ongoing programmes and recommended remedial measures to improve performance. A summary of some of the evaluations undertaken by NFI are given in the following pages.

(a) National Goitre Control Programme

Iodine deficiency disorders (IDD) continue to be a major public health problem in India even though the National Goitre Control programme has been in operation since 1962.

NFI carried out an evaluation of the on-going Goitre Control Programme in 1980 to:

- (i) assess reasons for failure of control programmes so far
- (ii) identify newly emerging dimensions of this problem and
- (iii) set out practical recommendations for future action, based on detailed consideration of causes of earlier failures.

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The study showed that the existing salt iodisation facilities were inadequate to meet the country's needs and even they were working far below their installed capacity. Quality control at the production site was inadequate and iodine loss during transport and storage was very high. Awareness about the need to use iodised salt was low even among the population groups with high IDD prevalence.

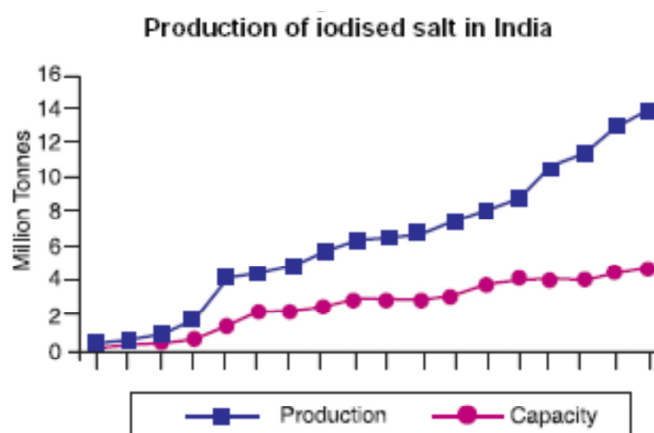
NFI made the following recommendations for ensuring universal access to iodised salt:

- i. opening up iodisation of salt to private sector to ensure adequate production to meet national needs
- ii. ensuring quality control at production site
- iii. packing salt in poly packs to reduce iodine loss during transport and storage
- iv. testing iodine content of salt at consumer level
- v. improving awareness about the need to consume only iodised salt.

Over the next two decades many of these recommendations have been implemented. Iodisation of salt has been opened to private sector and production capacity has increased many folds. Quality control both at production and consumer levels is improving. Surveys in the 1990s showed that utilisation of iodised salt is high in erstwhile goitre prone states; but in spite of ready availability consumption of iodised salt is low especially in the areas where IDD is not perceived as a problem by the population (Figure 1).

The Tenth Plan had recommended the following steps to achieve the elimination of IDD as a public health problem by 2010:

- i. improve access to iodised salt through TPDS, if necessary, with subsidy to cover cost differential between iodised salt and uniodised salt
- ii. improve awareness in areas where use of iodised salt is low



Lathyrism

- *Lathyrus sativus* (*kesari dal*) is a hardy crop grown easily on unirrigated land. Till the sixties, this inexpensive pulse was given as wages to bonded labourers in Madhya Pradesh who consumed it in the form of *chappatis*. The toxin from the pulse, β -ox-allyl aminoalanine (BOAA) caused neurolathyrism characterised by spastic paraplegia. In the 1950s, the reported prevalence of lathyrism was 1.5 per cent but studies carried out at NFI in 1981-82 showed that there was a steep reduction in the prevalence of lathyrism (Figure 2).

NFI recommended that:

- cultivation of *Lathyrus* should be prevented
- payment of wages to workers in the form of *Lathyrus sativus* must be prohibited
- ban on inter-state movement of *Lathyrus* must be strictly enforced
- laboratory facilities for detection of BOAA in pulse flour must be made freely available in food testing laboratories to detect the adulteration of other pulses with *Lathyrus*.
- research to develop low toxin strains of *Lathyrus sativus* should be encouraged.

Agricultural scientists were not very successful in developing low toxin (BOAA) strains of *Lathyrus* and the other recommendations were not implemented effectively. Subsequent studies in the nineties have shown that lathyrism has become rare. The decline was due to the fact that cost of *kesari dal* had increased several folds and so it was no longer given to labourers as 'wages'. Lathyrism is an example of the 'nutritional' problem, which was solved by 'market forces'.

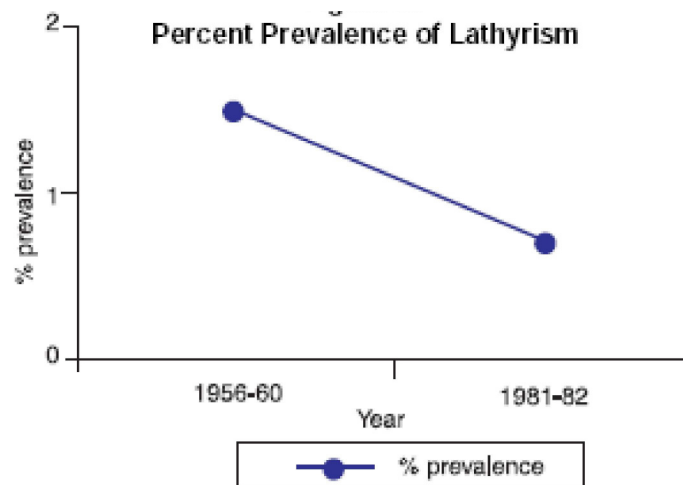


Fig. 2

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Integrated Child Development Services (ICDS)

- The ICDS programme, initiated by the Government of India in 1975, is the largest and perhaps one of the most imaginative, progressive and ambitious programmes for ‘human resource development’ to be attempted by any developing country. The programme is designed to facilitate and promote the ‘total development’ of the child by making available, at the doorstep of poor communities, a coordinated package of mutually reinforcing child development services health, nutrition and education. The emphasis is on the most crucial stages of child development the intrauterine phase and early childhood (0-6years). In response to a request from the Ministry of Social Welfare and Women’s Affairs of the Government of India, the Foundation undertook an evaluation of the ICDS programme.

The evaluation showed that:

- training received by the Anganwadi Workers (AWWs) is inadequate
- the AWW’s knowledge regarding some basic concepts about vaccines, diseases and treatment was incomplete and inaccurate
- AWWs needed better training about nonformal preschool education, supplementary nutrition, immunisation, health check-up and referral services, growth monitoring and record keeping
- there were no functional linkages between the ICDS and PHC set-up either for providing primary health care or referral services.

The Foundation recommended that:

- apart from the three-month preservice training, AWW should receive refresher orientation courses and in-service training. It was suggested that different training modules suited for various regional conditions may be used.
- effective system of referrals from anganwadis should be worked out through joint consultations between the health system and the ICDS system and arrangements formalized
- it will be useful if officers-in-charge of ICDS, and health officers periodically attend joint orientation programmes. The National Institute of Public Cooperation and Child Development (NIPCCD), with its regional centres and network of Home Science colleges in the country, could be entrusted the task of organizing such orientation programmes.
- During the 1980s and 1990s, ICDS has undergone substantial expansion. The GOI- World Bank reviews in 1997 and 2001, showed that the content and quality of resources under ICDS remain suboptimal because of gaps in training and supervision of anganwadi workers, and there was a lack of intersectoral coordination and community support.

- The Tenth Plan envisages that there will be improvements in coverage, content and quality of services provided by ICDS for reducing macro and micronutrient undernutrition, so that the goals set in the Tenth Plan are achieved.

Nutrition Health Education and Environmental Sanitation (NHEES)

- India has a vast infrastructure of rural schools offering primary education to poor children. It is estimated that in spite of poor enrolment and high dropouts, the total number of children in rural primary schools is nearly 60 million. Practically, every village in the country has a school within a radius of 1 km.
- In recognition of the enormous potential of the rural school system, the Government of India launched the Nutrition Health Education and Environmental Sanitation (NHEES) Project in 1975. This project was coordinated by the National Council of Education Research and Training (NCERT) and funded by UNICEF.
- The NHEES project attempted to provide a more intensive focus and purposeful direction to the health/nutrition component in the primary education system. Perhaps the most daring and innovative part of the NHEES project was the attempt to reach the community through the rural school system.
- Between 1975 and 1983, the Project was developed and expanded in two stages. In the first stage (1975-79), the project was confined to school children. In the second phase it was extended to the entire school community, namely, the pupils, the parents and the village community as a whole.

Government of India (Ministry of Education), NCERT and UNICEF (the international agency funding the project) requested the Nutrition Foundation of India (NFI) to undertake an evaluation of the programme.

- NFI found that the curriculum at the primary education level had an urban elitist bias. A few statements were found to have no scientific validity. Some instructions in the curriculum were unimaginative, complicated and repetitive. The curriculum was rather weak on information with information with regard to the effects of poor diets on health, which is perhaps one of the most important areas.
- ‘Population education’, even in a very elementary form, did not find a place in the curriculum; coverage of important community health problems related to poor environment, such as diarrhoea in children, and communicable diseases received inadequate coverage.
- The Foundation recommended that an expert group consisting of experts in home science, child health and preventive medicine, with practical experience

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and first-hand knowledge of rural health problems and education may be convened for the purpose of reviewing and modifying the curriculum and the syllabus.

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The community contact programme was initiated in the second phase when it became clear that nutrition/health education confined to pupils within the four walls of the schools had not made any significant impact on their health/nutrition behaviour. The communication strategy for the delivery of the messages adopted in the project included the following two approaches:

- (i) periodic door-to-door home visits by the teachers
 - (ii) organisation of periodic meetings and exhibitions, group discussions on community problems and groups singing in the school where the same messages were to be explained to the village community.
- The community contact programme had ceased for nearly two years before NFI's evaluation study. Despite the two-year gap, many community members could still offer useful comments and reactions. It was found that the programme had, in fact, promoted better awareness of nutrition/health problems among some sections of the community. The Foundation recommended that every attempt must be made to develop this part of the project, not as an isolated activity of the Department of Education, but as the common concern and responsibility of all departments engaged in rural development in the village, with the rural school system acting as a focal point and playing a coordinating role.

Evaluation of health and nutrition interventions in Madhya Pradesh

- Anaemia and Vitamin A deficiency are major public health problems in pregnant women, lactating women, and children under five years of age. Dietary inadequacies and malaria aggravate anaemia. To combat these problems, the Ministry of Health and Family Welfare, Government of India, has initiated various steps to facilitate procurement, storage, supply and distribution of the needed micronutrient supplements, antihelminths, and antimalarials. However, it has been reported that the programme is not being implemented well. The Nutrition Foundation of India undertook an evaluation to identify bottlenecks, so that programme managers, health administrators and health care providers take steps to improve implementation of these programmes.
- The evaluation was carried out in the Bhopal Division of Madhya Pradesh in two districts; 505 pregnant women, 395 lactating women and 900 children under the age group of five years living in 24 remote villages were interviewed.

Health care providers in four Primary Health Centres (PHC) and 24 sub centres (SC) were interviewed about their knowledge and practices; pharmacists were interviewed about the availability of drugs. Focus group discussions were undertaken at the district, PHC, SC and village level.

- The supply of antihelminths, antimalarials and micronutrients was not regular. Supervision and monitoring of the supply of the supplements and their distribution was poor. Though health care providers were found to have knowledge regarding the programme, their actual performance was poor. The number of pregnant and lactating women receiving IFA tablets showed an increase in comparison to previous years. However, a similar increase was not seen in children up to five years of age. Actual levels of consumption of IFA tablets were low. It is possible that the health care providers do not effectively communicate the importance of the regular consumption of IFA tablets. Massive dose Vitamin A coverage had increased in comparison to previous years. However there was no change in number of persons taking antihelminthic and antimalarial drugs. The focus group discussions revealed that greater attention was needed towards educating the community regarding the beneficial effects of these programmes. If these problems are sorted out, the vulnerable groups can get the expected benefits from these programmes.

Mid-day Meal Programme

- Primary school children (6-14 years) form about 20 per cent of the total population. Free and compulsory education up to the age of 14 years is the constitutional commitment. However, even now school enrolment is not universal and about 40 per cent of the children drop out of primary school. Poor enrolment and high school dropout rate are attributed to poor socio-economic conditions, child labour, lack of motivation and poor nutrition status of the children. Data from the National Nutrition Monitoring Bureau (NNMB) Surveys (2000) indicate that majority of children in the school-going age are undernourished and anaemic.
- Mid-day meal programme (MDM) also referred to as 'Nutrition Support to Primary Education' is considered as a means of promoting improved enrolment, school attendance and retention. Simultaneously, it may improve the nutritional status of primary school children. With children from all castes and communities eating together, it is also a means of bringing about better social integration.
- The MDM scheme, initiated in 1995s aims to provide each school child roughly a third of the daily nutrient requirement. The Central government supplies food grains for the programme. The Supreme Court of India's Interim Order dated 28 November 2001 directed the State Governments/

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Union Territories to implement the Mid-day meal scheme by providing every child in every Government and Government assisted schools with a hot cooked Mid-day meal with a minimum of 300 Kcals and 8-12 grams of protein on each school day for a minimum of 200 days. In compliance with this Order, the Government of Delhi, in July 2003, initiated the programme in 410 schools for serving hot meals to the children. The programme is being extended in a phased manner to cover all the schools. At the request of MCD, NFI undertook a third-party evaluation of the programme being carried out in schools run/aided by MCD.

The objectives of the evaluation were to assess

- (i) the infrastructural facilities available at the food supplier level
 - (ii) the hygienic aspects of the food prepared by the food suppliers
 - (iii) the system for receiving, storage and distribution of the meals at the schools
 - (iv) overall quality (with special emphasis on nutritional quality) of the food served.
- In addition, an attempt was made to obtain the feedback from children and teachers on the MDM programme through focus group discussions.

NFI helped MCD in standardisation of the food items to be given to the children in MDM, taking into account nutritional adequacy (calories and protein), variety and taste. Initially in the mid-day meals, 18 dishes were being served. Subsequently, most of the schools started serving one of the following seven items: *chhole rice*, *rajma rice*, *puri sabji*, vegetable *pulao*, *dal rice*, *sambhar rice* and stuffed *paranths*.

- The Nutrition Foundation of India (NFI) carried out surprise visits to 79 kitchens of suppliers of MDM and visited 316 schools to assess distribution of the MDM at school level. Evaluation of the kitchens was done on the basis of the 'Code for Hygienic Conditions for Establishment and Maintenance of the Mid-Day Meal School Programmes' laid by the Indian Standards Institution (1972). Kitchens were rated on the basis of their infrastructure facilities, procurement and storage of raw material, pre-preparation and preparation activities, management of the leftover food, personal hygiene of the food handlers, sanitary conditions of the cooking area, kitchen waste disposal, and transportation of the cooked food.
- There was wide variation in the infrastructure facilities. Some of the kitchens had a big multipurpose room where all the activities were carried out. Only a few kitchens had well demarcated areas for different activities. There were no special pest control measures in most of the kitchens. The hygiene of cooks/food handlers was not up to the mark. They were not provided

with aprons/headgears or gloves. Management of kitchen waste disposal in most kitchens was not satisfactory. None of the kitchens could be graded as good; majority were graded as fair and some as poor.

- Some of the kitchens were located in very unhygienic environments, with open drains in front of the kitchens or the garbage dumps in close proximity. The choice of location of the kitchen seems to have been made on the basis of availability of space without due consideration to hygiene and sanitation of the location.
- The schools were evaluated on the basis of their organization, personal hygiene of food handlers, cleanliness and hygienic condition of receiving, storage and distribution area and utensils, evaluation of food quality and drinking water facility. NFI also evaluated the personal hygiene of the children, quantity of food served per child, and consumption pattern of children at class level. Focus group discussion was held with school teachers as well as children to find their views about the MDM programme in their schools.
- It was observed that some schools were functioning without proper buildings, drinking water facilities, toilets, furniture and staff. Most of the afternoon shift schools were not as clean as the morning shift schools. The toilet facilities provided were generally in poor condition. Some children never took mid-day meals; others took the food when they liked the preparation. Many children did not completely eat all the food provided. The schools were maintaining records of children who took MDM; but they should also maintain written records of the number of children who do not avail MDM and the reasons for not availing the MDM.
- Personal hygiene of the children was graded on the basis of cleanliness of their nails, hair, uniform and general appearance. It was observed that majority of the children did not wash their hands before eating their meals, even though they used their hands to eat. In terms of hygiene, majority of the children were rated as fair, but about a third were rated as poor.

Based on the findings, NFI recommended that:

- the MCD may have to look into availability of space and environmental hygiene in the vicinity of the kitchen.
- there is a need to provide orientation and training to the suppliers chosen for supplying MDM on the basic principles laid by the Indian Standards Institution in 1972.
- NFI suggested that the suppliers should be trained in large scale institutional catering and should be oriented regarding the parameters for qualitative assessment of the various areas in the kitchens preparing

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MDM, so that they themselves can assess the shortfalls and make necessary modifications

- public health personnel and the MCD officials should carry out continuous monitoring of preparations, transport and distribution of MDM and make appropriate mid-course corrections.
- the school should develop a system in which the teachers play a key role in:
 - i. Monitoring and ensuring quality and quantity of food served
 - ii. Persuading children to consume all the food provided
 - iii. Observing hygienic practices such as washing hands before eating and ensuring that utensils are clean
 - iv. Ensuring that left over food is not thrown in and around the school to prevent environmental deterioration.

Evaluation: What is it?

- A process of data collection designed to assess the effectiveness of the project in attaining its originally stated objectives and the extent to which observed changes are attributable to the project.
- Done at the end of the project but could be planned at strategic periods during the life of the projects. Inform of various of midterm reviews or biennial reviews.
- Evaluation happens only after the decision to implement a certain intervention has been made.
- Evaluation needs
 - i. Clarity scaled goals
 - ii. Clarity scaled objectives

Programme managers and planners needs to be accountable to funding agencies and policy makers. They must therefore distinguish useful current programmes from ineffective to inefficient ones, and plan, design and implement new efforts that effectively and efficiently have the desired impact on the target group. To do so they must obtain answers to a range of such questions –

- Is the strategy based on priorities from a broad analysis of the nutrition situation, needs assessment and cultural and behavioural aspects?
- Are the interventions selected likely to ameliorate significantly the nutrition problems?
- Is the most appropriate target population selected?
- Is the intervention being implemented in the ways envisioned?

- Is it effective?
- How much does it cost?
- If the nutrition education programme is one of several interventions, how can its effect or impact be separated from the impact of other inventions.

Evaluation theory and procedures are basically the same in various interventions such as health, education, welfare and other services and policies.

Purpose of evaluation

Evaluation of educational programmes are undertaken for several reasons –

- To judge how the programme personal have performed.
- To judge how the nutrition education programs are planned and executed and to increase the effectiveness of programme management and administration; to possess the utility of new programmes.

The functions of evaluation

Evaluation of nutrition education programmes includes not only collection of qualitative and quantitative data but also their analysis and interpretation for the purpose of making judgement and decisions. In this context, evaluation is seen to have two main functions –

Formative and summative

Formative evaluation is used to improve and develop programme activities as they are carried out and is therefore continuous.

Summative evaluation measures the outcome of an activity or set of activities.

Evaluation may have psychological or socio-political functions as it is used to increase the awareness of educational activities or promote public relations.

Another function is to facilitate supervision. In an organization responsible for a nutrition education programme, it is the responsibility of a manager to evaluate personal and programme activities under her or his responsibility.

Reasons for evaluating nutrition education programmes to assess –

Impact or effect

- How programme is planned and executed
- How programme personnel perform
- How effectiveness can be improved
- The utility of a programme, and
- To satisfy the programme sponsors

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Components of evaluation

Usually four components are considered –

1. Inputs
2. Processes
3. Outputs
4. Outcomes

Inputs –

Inputs are the set of resources dedicated to a programme.

They include human and financial resources, physical facilities, equipment and operational policies that enable services to be delivered i.e.–

- Personal
- Facilities
- Space, storage, room for admitting children
- Equipment

Process

Process refers to the set of activities in which programmes inputs are utilized in pursuit of the results from the programme.

Process refers to multiple activities that are carried out to achieve the objectives of the projects

- Service delivery operations
- Management oriented activities
- Training, research, etc.

Output

Outputs are the results obtained at the programme level through education of activities using its resources:

- Could be staff performing better as a result of having been trained
- As a result of clear policy environment
- Staff better informed about policies – better in taking decisions

Output classified into three levels –

- Functional outputs: - Number of nutrition IEC tasks, food preparation demonstration, people trained.

- Service outputs: - member benefiting/accessing, quality of service, acceptability image.
- Service utilization, member using the service.

Outcome

The set results expected to occur at the population level due to the programme output. The immediate effects are often behavioural and results directly from the project outputs. They may be necessary to achieve a desired effect.

Outcomes may be divided into two components—

(i) Intermediate outcomes and (ii) long term outcomes.

Immediate outcomes are set of results at the population level that are closely and clearly linked to the programme activities.

Long term outcome refers to set of results at the population level that are long term in rather and are produced through action of immediate outcomes.

Six key outcomes for nutrition:

1. Exclusive breastfeeding
2. Appropriate complementary feeding
3. Adequate iron intake
4. Adequate vitamin A intake
5. Adequate iodine intake

Beauate nutritional care during illness and severe malnutrition.

Elements of Evaluation

Indicators –

Indicators are variables that measure the different aspects of a given programme.

The inputs, processes, outputs and outcomes.

An indicator can be assigned a numeric value, a percentage, a mean value, a ranking, an absolute number of yes/no score, e.g., presence vs absences

Selection of indicators

Indicator must be selected to provide evidence that defines the extent to which project interventions are successful in achieving the set objective.

Criteria for selection of indicators

- Validity – it measures what it is intended to
- Sensitivity – its changes reflect desired changes.
- Reliable – it produces the same results then repeated.

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- Un-dimensional- it is measurable.
- Operational – it is measurable.
- Objective - it is not subject to measurer’s biases.
- Practical – its data collection is reasonable feasible.
- Comparability (from time to time/place to place)

Components of evaluation plan

- Introduction – the country region and background of what the project is addressing
- Conceptual framework – maps the linkages inputs – process – outputs and outcomes
- Data types

Mechanism for M & E

- Data collection methods
- Establishing baseline
- Data storage/analysis
- Management of collection, who collects and when
- Routine review of data

Indicators of evaluation

- Uses of data
- Work plan needed to implement the plan
- Work plan lists:
 - i. Activities
 - ii. Time they shall be conducted
 - iii. Target numbers
 - iv. Milestones e.g., by after 18 months
 - v. Implementations

ADVANCE FOOD SCIENCE

1. Database management of anthropometric indices, biochemical indices, dietary recall, energy expenditure and intake.
2. Role of portable device in diet and health management.

Let's discuss these topics in detail.

Aerobic Respiration

1. Database Management of Anthropometric Indices Biochemical Indices, Dietary Recall, Energy Expenditure And Intake

The effect of diet on health is measured by an assessment of nutritional status. Nutritional assessment procedures were used as early as in 1932 in survey designs to describe the nutritional status of population on a national basis.

Nutritional assessment can be defined as the interpretation of information obtained from anthropometric, dietary, biochemical and clinical studies. The information obtained is used to determine the health status of individual or population groups as influenced by their intake and utilizations of nutrients. Nutritional assessment is done for survey, surveillance, screening and monitoring.

Methods used in Nutritional assessment

Nutritional assessment system involves four types of method, which are used either alone or in combinations. These methods are-

- A. Anthropometric assessments
- B. Biochemical assessments
- C. Clinical assessments.
- D. Dietary methods.

These are commonly known as ABCD. For the assessment of nutritional status in a community, generally dietary and Anthropometric measurements are used, since they are simple, less time consuming and do not require any kind of expensive instruments.

A. Anthropometric assessment- Anthropometric assessment means physical measurements of body weight and dimensions. Body composition may be estimated from anthropometric measurements.

Anthropometric evaluation is an essential feature of human body whether it is child, woman, man, adult etc. It is important for determining malnutrition, being overweight, obesity, muscular mass loss, fat mass gain and adipose tissue redistribution. The field of anthropometry encompasses a variety of human body measurement like weight, height, length, skinfold thicknesses, circumferences (head, wrist, limb etc.) lengths and breadths (shoulder, wrist etc.) are examples of anthropometric measures.

The measurement varies with age and degree of nutrition and are useful in assessing imbalances of protein and energy. They can be used to detect moderate as well as severe degree of malnutrition.

The technique also provides information on previous nutritional history which is not possible in other assessment techniques. Anthropometric measurements are

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of two types—growth and body composition measurements. The latter can be sub-divided into measurement of body fat free mass.

Anthropometric indices can be derived directly from a single one measurement, i.e., weight for age, height for age, head circumference for age or combination of raw measurements, such as weight and height, skinfold thickness at various sites or limb circumference. Some combinations, i.e., triceps, skinfold and mid upper arm circumference are used to derive prediction equation to estimate mid upper arm muscle area and mid upper arm fat area.

Advantages of Anthropometric assessment

- The procedures used as simple, safe and how invasive and can be used for majority people.
- Equipment are not very expensive.
- An untrained person can also do the measurement.
- The methods are precise and accurate.
- Mild to moderate malnutrition can be detected.
- Any changes in nutritional status can be watched closely.

Equipment for anthropometric assessment

- Calibration weights
- Digital weight scale
- Portable scale
- Sitting box
- Stadiometer
- Calibration
- Infantometer
- Skinfold calipers
- Knee caliper
- Head circumference take
- Steel measuring tape
- Height adjustment ruler

Parameters of anthropometry

Age dependent factors-

- (a) Weight
- (b) Height

- (c) Head circumference
- (d) Chest circumference

Age independent factors

- (a) Mid arm circumference (1-5 yrs)
- (b) Weight for height
- (c) Skinfold thickness
- (d) Mid upper arm/height ratio.

Let's study these techniques in detail.

Techniques for assessment of malnutrition in children

(a) Weight

The measurement of weight is most reliable criteria of assessment of health and nutritional status of children. Here child's weight is compared with reference weight value for his age. This is easy to assess if the child age is known.

The weight can be recorded using a beam type weighing balance
Electronic weighing scale for infants and children.

The periodic recording of weight on a growth chart is essential for monitoring the growth of under five children

Growth velocity

- | | | |
|--------------------------|---|-------------------------------|
| i. 0-4 months | - | 1.0 kg/month (30 g/day) |
| 5-8 months | - | 0.75 kg/month (20 g/day) |
| 9-12 months | - | 0.50 kg/month (15 g/day) |
| 1-3 yrs. | - | 2.25 kg/yr. |
| 4-9 | - | 2.75 kg/yr. |
| 10-18 years | - | 5.0-6.0 kg/yr. (0.5 kg/month) |
| ii. Weight at 4-5 months | | 2 × birth weight |
| weight at 1 yr | | 3 × birth weight |
| weight at 2 yr | | 4 × birth weight |
| weight at 7 yr | | 7 × birth weight |

The most widely used method is of Gomez and co-workers. The observed weight of child is expressed as a percentage of expected weight of a child of that age using the 50th percentile (median) of Howard standards.

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The Gomez classification

% of expected weight for age	Classification	Category of nutritional status
> 90 %	Normal	Normal
76 – 90 %	Mild malnutrition	1 st degree malnutrition
61 – 75 %	Moderate Malnutrition	2 nd degree malnutrition
< 60 %	Severe malnutrition	3 rd degree malnutrition

Classification of malnutrition by Indian Academy of Paediatrics.

% of expected weight	Classification
> 80 %	Normal
71 – 80 %	Grade I
61 – 70 %	Grade II

(b) Height for age

It is used as an indicator of nutritional status of groups of population for estimating past and electronic malnutrition but not necessarily the present nutritional status.

Height measurement technique

Upto 2 yrs. of age length is measured with the help of an infantometer.

In older children standing height is recorded. It is convenient to use an inbuilt stadiometer affixed on the wall which provides a direct read out of height with an accuracy of +/-snuggly - 0.1 cm.

Technique of length measurement

The infant is placed supine on the infantometer.

Assistant or mother is asked to keep the vertex or top of the head snugly touching the fixed vertically plank.

The legs are fully extended by pressing over the knee, and feet are kept vertical at 90°, the movable pedal plank of infantometer is snugly opposed against soles and length is read from scale.

Steps for taking accurate weight measurements

- Set the measuring board vertically on a stable level surface.
- Remove the child's shoes and any head covering.
- Place the child on the measuring board, standing upright in the middle of the board.
- Head should be kept in frankfurt plane.
- Read and announce the measurement to the nearest 0.1 cm.

Height Velocity

Age	Approximate rate of increase in stature
Birth to 3 months	3.5 cm/month
3 – 6 month	2.0 cm/month
6 – 9 month	1.5 cm/month
9-12 month	1.3 cm/month
2-5 years	6 – 8 cm/yr.
5 – 12 years	5 cm/yr.
At birth	50 cm
Gain during 1 st yr.	25 cm
Gain during 2 nd yr.	12.5 cm
Gain during 3 rd yr.	7.5 to 10 cm
Adolescence	8 cms/yr. for girl during 12 to 16 years. 10 cms/yr. for girls during 14 – 18 years.

NOTES**(c) Head Circumference**

1. Brain growth take place 70% during fetal life, 15% during infancy and remaining 10% during pre-school years.
2. Head circumferences are generally recorded until 5 years of age.
3. If scalp edema or cranial moulding present measurement of scalp edema may be not accurate until fourth or fifth day of life.
4. The head circumference is measured by placing the tape over the occipital protuberance at the back and just over the supra-orbital ridge and glabella infant.

Expected head circumference in children

Age	Head circumference
At birth	34-35
2 months	38
3 months	40
4 months	41
6 months	42-43
1 year	45-48
2 years	47-48
5 years	50-51

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Head circumference growth velocity

Till 3 months	2 cm/month
3 months- 1 year	2 cm/3 months
1-3 year	1 cm/6 months
3-5 year	1 cm/year.

During the first year, there is 12 cm increase in head circumference, while 1-5 years age, only 5 cm gain occur in head size.

Adult head size is achieved between 5 to 6 years following formula (Bine's formula) is used for estimating the head circumference in the first of life:

$$\frac{(\text{Length in cm} + 9.5) + 2.59}{2}$$

(d) Chest Circumference

It is usually measured at the level of nipples, preferably in mid inspiration

Xiphisternun

In children

- < 5 years – lying down position
- > 5 years – standing position.

Relationship between head size with chest circumference

At birth: head circumference > chest circumference by upto 3 cm.

At around 9 months to 1 year of age: head circumference = chest circumference.

But after that chest grows more rapidly compared to the brain.

Age independent criteria for assessment of nutritional status

- Mid upper arm circumference
- Thickness of subcutaneous fat
- Body ratios
- Weight for height
- Body mas index
- Upper segment/ lower segment
- Arm span
- Obesity

Mid upper arm circumference

During 1-5 yrs. age it remains static between 15-17 cm among healthy children.

It is measured over the left upper arm at a point marked midway between shoulder and elbow with arm bent at right angle.

The child is asked to stand or sit with the arm hanging loose at the side.

MUAC is measured with a fiber glass or steel tape.

If it is less than 12.5 cm it is a suggestion of severe malnutrition.

If it is between 12.5-13.5 cm it is indicative of moderate malnutrition.

Bangle test

It is a very quick assessment of arm circumference. A fibre glass ring of internal diameter of 4 cm is slipped up the arm, if it passes above the elbow, it suggests the upper arm is less than 12.5 cm and child is malnourished.

Shakir tape

It is a fibre glass tape with —red— less than 12.5 cm, Yellow- 12.5 – 13.5 cm and green- greater than 13.5 cm— shading so that paramedical workers can assess nutritional status without having to remember the normal limits of mid arm circumference.

QUAC stick- Quaker upper arm circumference stick

It is developed on the principle that acute starvation severely affects mid arm circumference while height is not affected.

It is a height measuring rod, calibrated in MAC

Values of 80% MAC for Ht., are marked on stick at corresponding height levels.

The malnourished child would be taller than the anticipated height.

MAC(cm)	Ht(cm)
16.5	133.0
13.5	103.5
12.5	70.0

The cut off points to define malnutrition are

AC > 14.0 cm - normal nutritional status

AC 14-12.5 cm - mild/moderate undernutrition

AC < 12.5 cm - severe undernutrition.

Skinfold thickness

The most widely used direct measure of fatness in people is measurement of skinfold thickness using skinfold calipers. These spring loaded calipers exert a constant pressure on a fold of a skin; the thickness of skin is indicated on a meter.

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The skinfold with subcutaneous fat is picked up with thumb and index finger, and caliper is applied beyond the pinch. The thickness of the skinfold will largely depend upon the amount of fat stored subcutaneously in the region of the skinfold. Skinfold thickness is measured at several sites, and the assumption is made that the amount of fat stored subcutaneously at these sites (as measured by the skinfold thickness) will be representative of the total amount of body fat.

Typically, skinfold thickness is determined at four sites:

- Over the triceps muscle
- Over the biceps
- In the subscapular region
- And in the supra-iliac region

The single triceps muscle skinfold thickness is sometimes used in nutritional surveys – it can be measured quickly to not take a skinfold measurement reading if you cannot consume a that has two thickness of skin and underlying fat.

Body ratios

- Rao and Singh's weight – height index:

$$= [\text{weight (kg)} / (\text{height})^2 \text{cm}] \times 100$$

Normal index is more than 0.15

- Kanawati index: (during 3 m to 4 years)

$$= \text{mid-arm circumference} / \text{head circumference}$$

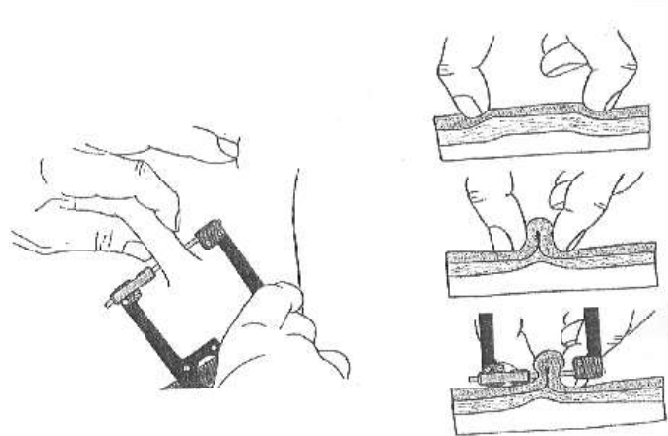
Normal 0.331

Mild 0.310-0.280

Moderate 0.279-0.250

Severe <0.250

Skin fold measurement method



Weight for height

Weight for height can be expressed as a percentage of the reference median weight for median height at each age. The advantage for using weight for height as an index of nutritional status is its apparent age independence. Its age independence allows its use in populations where ages are uncertain or unknown. Marked decrease in weight for height is a more reliable finding in the finding of Protein energy malnutrition (PEM).

Researches have pointed out that weight may be used in all age groups for detection of PEM.

If no endocrinological factor is responsible for the impaired development of a child's height, then it is highly probable that there was a history of prolonged malnutrition during early childhood, a period associated with a rapid growth spurt in terms of height.

The limitation in using of weight for height criteria is the difficulty in measuring body length in young infants, which may make it difficult or same. Hence impossible to obtain adequate data in this age group.

Weight for height = $\frac{\text{Weight of the patient (kg)}}{\text{weight of normal child of same height}}$

Weight for height	Nutritional status
>90%	normal
85-90%	borderline malnutrition
75-80%	moderate malnutrition
< 75%	severe malnutrition

Source: Ref- Standard NCHS data.

Classification-

When malnutrition has been *chronic*, the child is *stunned*.

- Weight for age is low/normal.
- Height for age is low
- Weight for height is normal

In *acute* malnutrition, the child is *wasted*

- Weight for age is low.
- Height for age is normal
- Weight for height is low

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Assessment of nutritional status

Water low classification

Malnutrition

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	Normal	Mild	Moderate	Severe
Height for age (s)	95	90-95	85-90	85
Weight for age (w)	90	80-90	70-90	70

Assessment of duration of malnutrition

Children with poor linear growth but adequate weight for height may be classified as normal but this conclusion is not justified. These children can however, be identified if height for age is also taken into consideration along with weight for height. The extent of height deficit in relation to age may be regarded as a measure of the past duration of malnutrition. Seoane and Lythan proposed this concept and as classification based on weight for height, weight for age and they have suggested height for age. The advantage of this classification is that it helps to find out the type and duration of malnutrition.

Nutritional status	Ht. for age	wt. for age	wt. for ht.
Normal	normal	normal	normal
Past chronic malnutrition (nutritionally dwarf)	low	low	normal
Current short duration malnutrition	normal	low	low
Current long duration malnutrition	low	low	low

Reference body weights and heights of children and adolescents according to NCHS

NCHS				
Age (Years)	BOYS		GIRLS	
	Height (cm)	Weight (kg)	Height (cm)	Weight(kg)
0	50.5	3.3	49.9	3.2
¼ (3 m)	61.1	6.0	60.2	5.4
½ (6 m)	67.8	7.8	66.6	7.2
¾ (9 m)	72.3	9.2	71.1	8.6
1.0	76.1	10.2	75.0	9.5
1.5	82.4	11.5	80.9	10.8
2.0	85.6	12.3	84.5	11.8
3.0	94.9	14.6	93.9	14.1
4.0	102.9	16.7	101.6	16.0

5.0	109.9	18.7	108.4	17.7
6.0	116.1	20.7	114.6	19.5
7.0	121.7	22.9	120.6	21.8
8.0	127.0	25.3	126.4	24.8
9.0	132.2	28.1	132.2	28.5
10.0	137.5	31.4	138.3	32.5
11+	140	32.2	142	33.7
12+	147	37.0	148	38.7
13+	153	40.9	155	44.0
14+	160	47.0	159	48.0
15+	166	52.6	161	51.4
16+	171	58.0	162	53.0
17+	175	62.7	163	54.0
18+	177	65.0	164	54.4

NOTES**Reference body weights (kg) of Indians of different age groups**

	Age(years)	Male	Female
Infant	0-1/2	5.4	5.4
	½-1	8.6	8.6
Children	1-3	12.61	11.81
	4-6	19.20	18.69
	7-9	27.00	26.75
	10-12	35.54	37.91
Adolescents	13-15	47.88	46.66
	16-18	57.28	49.92
Adults	20-50	60	50

Body mass index

The body mass index (BMI) is a value derived from the mass (weight) and height of an individual. The BMI is defined as the body mass divided by the square of the body height and is expressed in units of kg/m², resulting from mass in kilograms and height in meters.

In adults, low weight, for height may indicate malnutrition, whereas high weight for height may indicate overweight and obesity. If the recent nutritional adequacy of an individual (e.g. a hospital patient) is being assessed the recent weight change may be a more sensitive indicator than absolute weight for height.

Weight for height tables listing acceptable ranges for given heights have traditionally been used as anthropometric standards to assess the nutritional status and fitness of adults.

In recent years, the body mass index (BMI) has been used widely-

$$\text{BMI} = \text{body weight (kg)} / \text{height}^2(\text{m}^2)$$

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The normal range for the BMI is set at 18.5-25kg/m², any values significantly below this range is taken to indicate varying degrees of overweight or obesity.

BMI	17-18.5	First degree malnutrition
	16-17	Second degree malnutrition
Below	16	Third degree malnutrition
	18.5-22	normal
	23-25	slightly overweight
	> 25	obese

Ponderal index

It is another parameter which is similar to BMI and is used for defining newborn babies with instantaneous growth retardation

$$P1 = (\text{body weight in grams}) / \text{Length}(\text{cm})^3 \times 100$$

In malnourished small for date babies (asymmetric IUGR), ponderal index is < 2, while it is usually more than 2.5 in term appropriate for gestation babies and hypoplastic small for date babies.

Arm span

It is the distance between the tips of middle fingers of both arms outstretched at right angles to the body, measured across the back of the adult.

In under 5 children, arm span is 1 to 2 cm smaller than body length.

During 10-12 years of age, arm span height.

In adults, arm span is more in adults by 2 cm.

Abnormally large arm span is seen in patients:

- Marfan syndrome
- Eunuchoidism
- Klinefelter's syndrome
- Coarctation of aorta

Atorm span is short compared to height in patients with:

- Short limbed dwarfism
- Cretinism
- Achondroplasia

(B) Biochemical Analysis

The biochemical evaluation of nutritional status involves quantitative determinations of nutrition or related metabolites in such tissues as blood and urine. Low blood

levels of a nutrient may reflect a low dietary intake defective absorption, or increased utilization, destruction or excretion.

Biochemical data either serve to confirm findings from clinical observations and dietary studies or to identify subclinical deficiencies before clinical symptom are evident. They can be used for some nutrients to assess the range from frank deficiency levels through adequate, optimal and excessive levels of nutritive intake.

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Biochemical analysis techniques

- Spectrophotometry
- Chromatography
- Electrophoresis
- Radioimmuno assay
- Hybridoma
- ELISA
- Centrifugation

Biochemical analysis techniques refer to a set of methods, arrays and procedures that enable scientist to analyse the substances found in living organisms and the chemical reactions underlying life processes. The most sophisticated of these techniques are reserved for speciality research and diagnostic laboratories.

To perform a comprehensive biochemical analysis of a biomolecule in a biological process or system, the biochemist typically needs to design a strategy to detect that biomolecule, isolate it in pure form from among thousands of molecules that can be found in extracts from a biological sample, characterize it, and analyse its function.

(C) Dietary Assessment Methods

Various classification have been devised and suggested for collection of dietary data. However, there are two major categories of methods. The first is a group method and the second is based on dietary intake of an individual. This is determined by record or recall of all foods consumed over a specified period of time. This is the most common used methods.

Dietary Recall

The purpose is to detailed information all foods and beverages consumed on a given day.

This is a frequently used method to obtain current dietary intake information from individuals. This is based on the principal that, food consumption for a specified period of time prior to the survey can be recalled as accurately as possible. It is often referred to as the “24 hour recall method.”

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A 24 hour dietary recall (24Hr.) is a structured interview intended to capture detailed information about all foods and beverages (and possible, dietary supplements) consumed by the respondent in the past 24 hours, most commonly from midnight to midnight the previous day.

The respondent recalls what and how much food was consumed and when it was consumed. The ingredients recalled are recorded in household standardised volumetric measures. In addition to other detailed descriptors such as time of day and source of food, portion size of each food and beverage is captured. Volume of cooked food is also recorded. For example, a respondent reporting sandwich for lunch would be asked about the preparation method and type of bread. This open-ended response structure is designed to prompt respondents to provide a comprehensive and detailed report of all foods and beverage consumed.

Dietary recalls typically ask about foods and beverages first, before questions on dietary supplements.

Standardized vessels are used mainly to aid in recapitulating the amount of food stuff used and distribution of food to family members. From the raw weight of food stuffs, their nutritive value is calculated.

$$\frac{\text{Individual Intake (in volume)}}{\text{Total Cooked Quantity (in volume)}} \times \text{Raw Amounts} = Y$$

Advantages

- Useful method in quick recapitulation of one's habitual diet.
- It is helpful in revealing extreme daily variations in diet.
- The 24 hours yields detailed information on foods and beverages consumed on a given day. The total amount of each specific food and beverage is consumed.
- If information such as name of eating occasions, timing and location of meals and snack, sources of food and beverages and other activities such as TV and computer use during meals is collected, the 24 hours can yield contextual information, such as meal and snack, patterns consumption of foods and beverage from home away from home and activities during meals.

Limitations

- Because a single administration of a 24 hours is unable to account for day to day variation, two or more non-consecutive recalls are required to estimate usual dietary intake distribution. Multiple administrations are also recommended when 24 hours are used to examine diet and health or health variable.

- Respondent recall depends on short term memory.
- Subject must be willing and able to recall diet.
- Some subjects have little awareness of what they eat.
- Portion size is difficult to estimate accurately.

Practical aspects

USDA 5 step multiple pass method

1. Quick list: an interrupted listing by the subject of foods and beverage consumed.
2. Forgotten foods list: queries subject on categories of foods that frequently are forgotten.
3. Time and occasion of which foods were consumed.
4. Detail cycle elicits descriptions of food and amounts eaten, aided by the interactive use of a sheet containing pictures of sample portion sizes.
5. Final probe review.

(D) Energy Expenditure and Intake

The body needs energy for maintaining body temperature, metabolic activity, supporting growth and for physical work. The energy allowances recommended are designed to provide enough energy to promote satisfactory growth in infants and children and to maintain constant body weight and good health in adults. Among the factors which influence energy needs are age, body size, activity and in a limited way climate and altered physiological status such as pregnancy and lactation.

Energy expenditure is the amount of energy (or calories) that a person needs to carry out a physical function such as breathing, circulating blood, digesting food or physical movement. Your total daily energy expenditure (TDEE) is the total number of calories you burn each day, to prevent weight gain, energy intake must be balance with energy expenditure.

To understand what energy expenditure is, you need to understand how your body creates energy. To provide free for movement and daily functions, your body creates energy in the form of heat. The energy is measured in the form of kilocalories or calories. The total number of calories you burn for energy each day is your total daily energy expenditure or TDEE.

Total daily expenditure can vary from person to person depending on body size, gender, body composition, genetics and activity level. The total energy expenditure for a small sedentary woman may be 1800 calories or less per day. But the TDEE for a large man be 2000 calories or more.

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Key Points

- Energy is needed by the body to stay alive, grow, keep warm and more around.
- Energy is provided by food and drink. It comes from the fat, carbohydrate, protein the diet contains.
- Energy requirements vary from one individual to the next, depending on factors such as age, sex, body composition and physical activity level.
- Energy expenditure is the sum of the basal metabolic rate (the amount of energy metabolic rate) the amount of energy expended while at complete rest), the thermic effect of food (TEF, the energy required to digest and absorb food) and the energy expended in physical activity.
- To maintain body weight, it is necessary to balance the energy derived from food with that expended in physical activity. To lose weight energy expenditure must exceed intake and to gain weight, energy intake must exceed expenditure.

Three components of energy expenditure

Energy expenditure concerns calories burned versus calorie consumed. Imbalances between the two determine weight loss, gain or maintenance. Bodies that store too much energy become overweight. Components of energy expenditure are:

- Basal metabolic rate (BMR)— the energy you burn when inactive. The other two components are activity thermogenesis, which are the calories burned during activity, and the thermic effect of foods, which concerns calories used to digest foods you eat.
- Regulatory thermogenesis, which is categorized into obligatory and facultative components and includes the metabolic response to food ingested, i.e., the use of energy in digesting, absorbing, storing and disposing of ingested nutrients as well as the response of the body to stimuli such as cold, stimulants and drugs.
- Physical activity, which includes both the cost and quantum of the activity as well as the type of activity, viz,
 - (a) Essential economic or occupational activities and
 - (b) Discretionary activities, which include household tasks, socially desirable activities and activities aimed at maintenance of physical fitness.

A regular supply of dietary energy is essential for life and is required to fuel many different body processes. However daily energy requirements vary widely from one individual to the next. This is due to factors such as sex, body size, body weight, climate and physical activity levels.

Energy is obtained from the food and drink we consume, by oxidation of carbohydrate, fat, protein known as macronutrients.

Energy requirement of reference Indian man and woman (Kcals/day)

Sex	Body wt. (kg)	Activity		
		Sedentary	Moderate	Heavy
Man	60	2425	2875	3800
Woman	50	1875	2225	2925

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A comparison of dietary allowances of energy for a man (55 kg) and woman (45 kg) recommended in 1958 and in 1989

Activity	Man		Woman	
	1958	1989	1958	1989
Sedentary	2400	2300	1900	1760
Moderate	2800	2750	2200	2100
Heavy	3900	3600	3000	2800

Values computed from the suggested BMR factors and BMR computed for 55 kg man and 45 kg woman.

Energy requirements of adult— males and females aged 18-30 years with different body weights (Kcal/24hr)

Body weight (kg)	Male				Female			
	BMR	Activity			BMR	Activity		
		Sedentary	Moderate	Heavy		Sedentary	Moderate	Heavy
35					960	1536	1824	2400
40	1225	1960	2328	3063	1030	1648	1957	2575
45	1300	2080	2470	3250	1100	1760	2090	2750
50	1370	2192	2603	3425	1170	1872	2223	2925
55	1445	2312	2746	3612	1240	1984	2356	3100
60	1515	2424	2879	3788	1310	2096	2489	3275
65	1590	2544	3021	3975	1380	2208	2622	3450
70	1660	2656	3154	4150	1450	2320	2755	3625
75	1755	2806	3335	4388				

Energy requirement of children

Age group	Boys	Girls
1-3 years	1287	1193
4-6 years	1752	1630
7-9 years	2075	1833
10-12 years	2194	1965
13-15 years	2447	2056
16-18 years	2642	2064

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Energy requirement of infants

Age	Kcal/kg	
0-3 months	116	
3-6 months	99	Average during the first
6-9 months	95	year = 103 kcal/kg
9-12 months	101	

Energy requirement of children (Kcal/d)

Age (yrs)	Boys	Girls
1+	1096	1078
2+	1301	1190
3+	1463	1310
4+	1531	1458
5+	1778	1643
6+	1948	1750
7+	2030	1858
8+	2034	1792
9+	2160	1848
10+	2140	1907
11+	2193	1956
12+	2248	2032
13+	2340	2037
14+	2468	2066
15+	2354	2065
16+	2586	2070
17+	2662	2061
18+	2677	2061

Observed energy intakes of well-nourished Indian preschool children

Age (yrs)	Energy intake (Kcal)	
	Per day	Kcal/kg
2-3	1223± 24	107
3-4	1467 ± 397	93
4-5	1530 ± 370	93
5-6	1500 ± 378	98

Mean ± SD

Basal metabolic rate (BMR)

The basal metabolic rate (BMR) is the rate at which a person uses energy to maintain the basic functions of the body—breathing, keeping warm, keeping the heart beating when at complete rest. An average adult will use around 1.1 Kcal each minute just maintaining. These functions and BMR differs from one person to the next. Infants and young children tend to have a high BMR for their size due to their rapid growth and development. Men usually have a higher BMR than women since they tend to have more muscles. Older adults usually have a lower BMR than younger people since their muscle mass tends to decrease with age. The

The ICMR committee had used energy expenditure per kg body weight per hour for computing the energy requirements of Indian reference man and women. First the energy cost of rest and physical activity is expressed as multiples of BMR which is called the physical activity ratios (PAR). The physical activity ratio expresses the energy cost of an individual activity per minute as ratio of the cost of BMR per minute.

Energy requirement at different ages of adult males and females with different body weights (Kcal/24hr)

		Age 30+ to 59+ yrs				Age 60 + yrs.	
			Activity				Activity
Sex	Body Weights (kg)	BMR	Sedentary	Moderate	Heavy	BMR	Sedentary
Males	45	1325	2120	2518	3313	1040	1664
	50	1380	2208	2622	3450	1105	1768
	55	1435	2296	2727	3588	1170	1872
	60	1485	2376	2822	3713	1235	1976
	65	1540	2464	2926	3850	1295	2072
	70	1595	2552	3031	3988	1360	2176
	75	1650	2640	3135	4125	1425	2280
Females	40	1120	1792	2128	2800	965	1544
	45	1160	1856	2204	2900	1015	1624
	50	1200	1920	2280	3000	1065	1704
	55	1240	1984	2356	3100	1115	1784
	60	1285	2056	2442	3213	1165	1864
	65	1325	2120	2518	3313	1215	1944
	70	1365	2184	2594	3413	1265	2024

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NOTES**Physical activity level**

In addition to their BMR, people also use energy for movement of all types. The amount of energy a person uses to perform daily tasks depends on his or her weight and their physical activity level. An estimate of the amount of energy an individual will need can be calculated by multiplying their BMR by a factor appropriate to the amount of activity that person does, known as the physical activity level (PAL). A PAL of 1.4 is associated with a very low level of physical activity at work or during leisure time. In contrast, a PAL of 1.6 for women or 1.7 for men represents moderate intensity activity and values of 1.8 for women or 1.6 for men represent high levels of physical activity.

$$\text{Energy expenditure} = \text{BMR} \times \text{Physical activity level (PAL)}$$

Using this approach, estimates of different energy requirements for different groups have been established.

Recommended BMR factors for computing energy requirement of Indians

Recommending Body	Sex	Activity Category		
		Sedentary	Moderate	Heavy
ICMR 1989	Man/Woman	1.6	1.9	2.5
FAO/ WHO/ UNU 1985	Man	1.55	1.78	2.10
	Woman	1.56	1.64	1.82

Comparison of energy cost of some common activities in terms of BMR units

Activity	Energy cost of activities in BMR units	
	Indian data	International data
Sitting quietly	1.20	1.25
Standing quietly	1.40	1.33
Sitting at desk	1.30	1.36
Standing and doing lab work	2.0	1.95
Harvesting	3.6	3.5
Hand saw	7.4	7.5
Typing (sitting)	1.58	1.69
Walking 3 MPH	3.71	3.77

Computation of Energy Requirements of Indian Adults in Terms of BMR Units

Aerobic Respiration

Activity	Duration (hr)	Rate of energy expenditure in terms of BMR units		
		Sedentary Activity	Moderate Activity	Heavy Activity
Sleep	8	1.0	1.0	1.0
Occupational activity	8	1.7	2.8	4.5
Non-occupational activity	8	2.2	2.0	
Average for 24 hr.		1.6	1.9	2.5
Computed 24 hr energy expenditure				
Reference Man, 60 kg		2424	2882	3788
Reference Woman, 50 kg.		1872	2223	2925

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Equations for Predicting BMR (Kcal/24 hr)

Sex	Age (yrs)	Prediction equation		Correlation coefficient	S.D.
		Proposed by FAO/WHO/UNU	Proposed by ICMR expert group for Indians		
Male	18-30	$15.3 \times \text{B.W. (kg)} + 679$	$14.5 \times \text{B.W. (kg)} + 645$	0.65	151
	30-60	$11.6 \times \text{B.W. (kg)} + 879$	$10.9 \times \text{B.W. (kg)} + 833$	0.60	164
	>60	$13.5 \times \text{B.W. (kg)} + 587$	$12.8 \times \text{B.W. (kg)} + 463$	0.79	148
Female	18-30	$14.7 \times \text{B.W. (kg)} + 496$	$14.0 \times \text{B.W. (kg)} + 471$	0.72	121
	30-60	$8.7 \times \text{B.W. (kg)} + 829$	$8.3 \times \text{B.W. (kg)} + 788$	0.70	108
	>60	$10.5 \times \text{B.W. (kg)} + 596$	$10.0 \times \text{B.W. (kg)} + 565$	0.74	108

5% lower than that proposed by FAO/WHO/UNU (1985)

(2) ROLE OF PORTABLE DEVICES IN DIET AND HEALTH MANAGEMENT

NOTES

Integrating technology is an important but daunting task for some providers. Smaller practices in particular way not have the bandwidth or budget to bring in new devices or systems. Fortunately, the rise of mobile devices has made a dramatic impact in removing the barriers to health information access as well as given patients new tools for taking responsibility for personal health.

The use of mobile devices by health care professionals (HCPs) has transformed many aspects of clinical practice. Mobile devices have become common place in health care settings, leading to rapid growth in the development of medical software applications for these platforms. There are currently at least 10,000 health related apps that could be downloaded to a mobile electronic device that are increasingly being used by consumer and health care providers to manage various aspects of health maintenance and healthcare.

Numerous apps are now available to assist HCPs with many important tasks such as information and time management, health record maintenance and access; communication and consulting; reference and information gathering, patient management and monitoring clinical decision making and medical education and training.

The adoption of mobile

At present, 25 percent of physicians use smartphones, tablet and other mobile devices to deliver care to patients. Personal health apps are also driving a mobile resolution in health care. A whopping 93 percent of physicians believe that fitness tracking and weight loss apps can contribute to improved patient health, and there is the possibility that these may be shared with a physician for greater coordination of care. Patient portal apps and other developments only serve to reinforce how powerful mobile can be in healthcare.

Type and prevalence of devices used

The introduction of mobile computing devices (personal digital assistants) followed by smartphones and tablet computers has greatly impacted many fields. Health care professionals now use smartphone or tablet computers for functions. Smartphones and tablets combine both computing and communication features in a single device allowing easy access and use at the point of care. In addition to voice and text, new mobile devices are more advanced features, such as web searching, global positioning systems (GPS), high quality cameras and sound recorders with large memories.

Need for mobile devices at the point of care

One major motivation driving the widespread adoption of mobile devices by HCPs has been the need for better communication and information resources at the point of care. HCPs require to access many types of resources in a clinical setting including.

- Communication capabilities- voice calling, video conferencing, text and email.
- Hospital information systems (HISs)- electronic health records, electronic medical records, clinical decisions support systems, picture archiving and communication systems and laboratory information systems.
- Informational resources- textbooks, guidelines, medical literature, drug references.
- Clinical software applications- disease discuss diagnosis and medical calculators.

Benefits of mobile health apps

Uses of smartphones, mobile devices and mobile apps for medical and healthcare purposes is a growing trend, which is also known as *m* health. Use of mobile technology, health apps and services by patients and providers alike is rapidly increasing. Here are few examples of benefits of mobile health apps-

a) Tracking personal health data on smartphones and health apps.

Many doctors believe in the benefits of *m* health and health apps. 93 percent of physicians think mobile health apps can improve patient health.

The food and drug administration (FDA) encourages the development of mobile apps that improve healthcare professionals with valuable health information. Mobile applications can help people uses their own health and wellness, personal healthy living and gain access to useful information when and where they need it.

Goals are reflected in the health app categories which are weight loss, exercise and fitness, and women's health. Health apps on smartphones: mobile devices, wearable and fitness trackers have become an ideal way for people to fit from *m* health by collecting personal health data that is easy to understand.

Include among the uses of mobile health apps:

- Mobile medical 2D information
- Mobile fitness tracker
- Heart rate and vitals monitor

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- Mobile emergency health communication— certain health apps or mobile features allow you to get in touch with the help of you need when you are facing an emergency.
- Calorie counter and nutrition planner- monitor what you eat and learn more about your diet with nutrition and diet apps
- Manage healthcare on mobile
- Prescription medication reminder

b) Connected care between doctor’s office visits

If your doctor visit currently using mobile to connect with you, they probably will take advantage of mobile technology to better communicate with you in near future.