D-XYLOSE ABSORPTION TEST
Objectives

1. To learn the technique of D-xylose absorption test and its relation to the function of the upper small intestine.

2. To find out whether the Malabsorption state of some patients due to intestinal diseases or pancreatic diseases.
Malabsorption

- **Malabsorption** is a state arising from abnormality in absorption of food nutrients including: vitamins and minerals from the small intestinal tract in order to secrete them into the bloodstream.

- **Malabsorption results in:**
  1. Weakness
  2. Weight loss in adults
  3. Growth failure in children

  Although these affected people are eating high – calorie and enough food.
What is the D-Xylose Absorption Test?

The D-Xylose Absorption Test is considered the best test for the upper small intestine function.

- Impaired Absorption of D-Xylose occurs in conditions where there is Flattening of the Intestinal Villi, leading to Abnormally Low Urinary Excretion of the Test Does of D-Xylose.
Purpose of the Test

1. To investigate the efficacy of absorption in the small intestine, i.e., to diagnose problems of the small intestine that prevent absorbing nutrients in food.
This test is especially useful in determining if nutrient absorption problems are due to a disease of the intestine or a disease of the pancreas.
Why do we Perform D-Xylose Test to Examine Intestinal Malabsorption?

- **D-Xylose** is a type of aldopentose sugar found in plants:

1. It is not metabolized in the body.
2. It is not normally present in significant amounts in blood.
Why do we Perform D-Xylose Test to Examine Intestinal Malabsorption?

- D-Xylose is a type of aldopentose sugar found in plants …...cont.:

3- It is normally easily absorbed by the intestine.
4- When problems in the small intestine occur and this causes defect in intestinal absorption, D-xylose is not absorbed by the intestine, and its level in blood and urine is low.
Mucosal Absorption of D-Xylose

- Pancreatic Digestive Enzymes are not needed for D-Xylose Absorption.

- When given orally, 60% of D-xylose is absorbed in the small intestine (duodenum and jejunum).
  Most is subsequently excreted by the kidneys.
Mucosal Aborption of D-Xylose.

The amount of D-xylose detected in urine or blood in a specified time interval after administration of a measured dose of D-xylose, is used to Evaluate Intestinal Absorption Ability.
Low Absorption of D-Xylose is Observed in \textit{Intestinal Malabsorption}.

- However, low values of D-xylose in urine are also observed in other than intestinal and gastric disorders:
  1. Circulatory disease
  2. Renal and other diseases.
  3. In addition, excretion decreases with age as a reflection of decreased kidney function.
The Important Role of Intestine in the Absorption of D-Xylose.

In malabsorption due to pancreatic insufficiency

The absorption of D-xylose will be normal.

>80% of patients with small intestine malabsorption (mainly jejunal malabsorption) will have abnormal D-xylose test

Main Role of Intestine in the Absorption of D-Xylose.
Objectives of the Test

Malabsorption

Due to

Intestinal Diseases

Abnormal D-Xylose Test

Pancreatic Diseases

Normal D-Xylose Test
The Important Role of Intestine in the Absorption of Xylose

• Therefore, the test is of some help in:

  (i) Distinguishing between these two types of malabsorption, whether intestinal or pancreatic.

  (ii) Evaluating the response to therapy.
There are 2 factors affect the accuracy of the D-xylose absorption test:

1. Rate of Absorption by Intestine
2. Rate of Excretion by Kidneys

Thus, patients with renal insufficiency will excrete a decreased amount of D-xylose giving False Low Results.
In order to eliminate misinterpretations as a result of renal disease

A blood determination of D-xylose after 2 hours of the oral dose is carried out along with the determination of D-xylose in urine

A normal high blood D-xylose level in the presence of decreased urine D-xylose excretion

Suggest

1. Normal Absorption due to normal intestine
2. Renal dysfunction
The Accuracy of the D-Xylose Absorption Test ..... cont.

Blood sample taken

"Clean catch" urine sample collected

D-xylose levels are measured
What are the Diseases Affect the Intestinal Absorption of D-Xylose Resulting in Limited Excretion of D-Xylose in Urine?

- Low D-xylose level in urine: Excretion of less than 25% of a measured oral dose of D-xylose occurs in patients with Gluten Sensitive Enteropathy (Celiac Disease) and in Tropical Sprue.

- The test can also be used to differentiate between two main different causes of malabsorption, the ones related to small intestine (eg, Celiac Disease etc,....) and the ones related to pancreatic insufficiency (eg, Cystic Fibrosis).
Celiac disease is an autoimmune disorder that is triggered when gluten-containing foods (such as wheat [in bread for example] and oats) are eaten. Gluten is just like a poison to people with celiac disease.
Celiac Disease ....cont.

- The autoimmune antibodies that are triggered by the gluten-containing food attacks the small intestine villi (the structure that the cells lining the small intestine form to increase the area of absorption of the intestine), which destruct the villi of the small intestine.

- Symptoms of Celiac Disease are mainly due to malabsorption: (1) abdominal pain, (2) diarrhea, (3) weight loss (4) anemia and (5) deficiencies of many nutrients especially folic acid, vitamin B12, and fat.

- Treatment is simply a gluten-free diet.
How do the Villi Look Like in the Small Intestine Normally?

• (The structure that the cells lining the small intestine form to increase the area of absorption of the intestine)
What Happens to the Villi and Intestine Structure in Celiac Disease.....?

A. In a healthy person, nutrients get absorbed by villi in the small intestine and go into the bloodstream.

B. In a person with Celiac Disease, the villi have been damaged by inflammation, so fewer nutrients pass into the bloodstream.

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Tropical sprue is a disorder of unknown cause (infection..?) affecting people living in tropical areas who develop abnormalities of the small intestine structure (destruction of the villi), leading to malabsorption and deficiencies of many nutrients especially folic acid, vitamin B12, and fat.
Tropical Sprue ....cont.

- Typical symptoms include anemia, chronic diarrhea, and weight loss.
- A doctor bases the diagnosis on symptoms in a person who lives in or has recently visited one of the areas in which the disorder commonly occurs.
- What’s the treatment? Tetracycline antibiotic.
Cystic fibrosis (CF) is an inherited disease that affects secretory glands, including the glands that make mucus and sweat. CF mostly affects the lungs, pancreas, liver, intestines and other organs that contain mucus. The Mucus lines the inner surface (the lumen) of certain organs like the lungs, pancreas, liver and intestines. Normally mucus is a slippery and a watery substance to prevent the organs from drying out or getting infected. However, if you have CF, your mucus becomes thick and sticky.
The thick, sticky mucus block the tubes, or ducts, in the pancreas. As a result, the digestive enzymes that your pancreas makes can't reach your small intestine where they are needed for digestion and, of course, their absorption, then, by intestinal cells.

Treatment: Enzyme supplements for CF patients can replace natural enzymes in them so that fat and proteins can be absorbed properly, which improves nutrition. People with cystic fibrosis who receive enzyme replacement therapy can eat the same foods as anyone else.
Principle of the Test

• **D-xylose** is a pentose which produces a brown color with o-toluidine in the presence of acetic acid and heat, a brown compound will be formed with maximum absorption at **475 nm**.

• **Hexoses** also react with o-toluidine but produce a different complex with an absorption peak at **622 nm**, this ensures that interference with glucose is minimum.
1. O-toluidine reagent: Dissolve 3g of thiourea in 1900 ml of glacial acetic acid, and add 100 ml of O-toluidine. The reagent should be stored in a dark bottle at room temperature.

2. Stock standard D-xylose solution: 1.0 g of D-xylose per 100 ml distilled water.

3. Working standard (0.5g/l) D-xylose solution: 5.0 ml of stock standard is diluted to 100 ml with distilled water.

4. Urine sample.

5. Test tubes and test tube rack.


7. Water bath.
Method

1. The patient should keep an over night fast, in the morning empties the bladder and discard the urine.

2. 25g of D-xylose in 250 ml water should be taken by mouth, the patient then should drink plenty of water at one and two hours after drinking the dose. All urine passed within the next five hours is collected.
3. Label 6 test tubes T1 and T2 (test a), T3 and T4 (test b), S (standard), and B (blank), add the following:

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>S</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine &quot;a&quot;</td>
<td>0.1 ml</td>
<td>0.1 ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine &quot;b&quot;</td>
<td></td>
<td></td>
<td>0.1 ml</td>
<td>0.1 ml</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1 ml</td>
<td></td>
</tr>
<tr>
<td>Distilled H2O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1 ml</td>
</tr>
<tr>
<td>O-Toluidine Reagent</td>
<td>7.0 ml</td>
<td>7.0 ml</td>
<td>7.0 ml</td>
<td>7.0 ml</td>
<td>7.0 ml</td>
<td>7.0 ml</td>
</tr>
</tbody>
</table>
4. Mix the contents of each tube thoroughly, Cover with aluminium foil and place them in a boiling water bath for ten minutes.

5. Remove the tubes and cool them under a tap for 1-3 minutes.

6. Measure the absorbance of each tube against the blank at 475 nm using the spectrophotometer.
The concentration of D-xylose =

\[
\text{Mean absorbance of test} \times \text{Concentration of Standard (5g/L)}
\]

= g/L.