Diabetes
Diabetes Mellitus

Disease in which the body doesn’t produce or properly use insulin, leading to hyperglycemia.
What is diabetes?

Diabetes mellitus (DM) is a group of diseases characterized by high levels of blood glucose resulting from defects in insulin production, insulin action, or both.

The term diabetes mellitus describes a metabolic disorder of multiple aetiology characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.

The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs.
Diabetes mellitus may present with characteristic symptoms such as thirst, polyuria, blurring of vision, and weight loss.

In its most severe forms, ketoacidosis or a non-ketotic hyperosmolar state may develop and lead to stupor, coma and, in absence of effective treatment, death.

Often symptoms are not severe, or may be absent, and consequently hyperglycaemia sufficient to cause pathological and functional changes may be present for a long time before the diagnosis is made.
Carbohydrate Digestion

1. Starch is consumed in the mouth and初步 digested by amylase.
2. The partially digested starch (maltose) is absorbed in the duodenum and small intestine.
3. Further digestion occurs in the small intestine and large intestine by maltase.
4. The final product, glucose, is absorbed into the bloodstream.
Insulin Secretion
What goes wrong in diabetes?

- Multitude of mechanisms
  - Insulin
    - Regulation
    - Secretion
    - Uptake or breakdown
  - Beta cells
    - damage
Action of Insulin on the Cell Metabolism

- Insulin
- Insulin Receptor
- Glucose
- Closed Glucose Transporter
- Open Glucose Transporter
- Normal Cell
Action of Insulin on Carbohydrate, Protein and Fat Metabolism

- **Carbohydrate**
  - Facilitates the transport of glucose into muscle and adipose cells
  - Facilitates the conversion of glucose to glycogen for storage in the liver and muscle.
  - Decreases the breakdown and release of glucose from glycogen by the liver
Action of Insulin on Carbohydrate, Protein and Fat Metabolism

- **Protein**
  - Stimulates protein synthesis
  - Inhibits protein breakdown; diminishes gluconeogenesis
Action of Insulin on Carbohydrate, Protein and Fat Metabolism

○ **Fat**
  ○ Stimulates lipogenesis - the transport of triglycerides to adipose tissue
  ○ Inhibits lipolysis – prevents excessive production of ketones or ketoacidosis
Type I Diabetes

- Low or absent endogenous insulin
- Dependent on exogenous insulin for life
- Onset generally < 30 years
- 5-10% of cases of diabetes
- Onset sudden
  - Symptoms: 3 P’s: polyuria, polydypsia, polyphagia
Type I Diabetes Cell

- Insulin
- Insulin Receptor
- Glucose
- Closed Glucose Transporter
- Open Glucose Transporter

Type I Diabetes Cell
Type I Diabetes

- Genetic component to disease
Type II Diabetes

- Insulin levels may be normal, elevated or depressed
  - Characterized by insulin resistance,
  - diminished tissue sensitivity to insulin,
  - and impaired beta cell function (delayed or inadequate insulin release)
- Often occurs >40 years
Type II Diabetes

- Insulin
- Insulin Receptor
- Glucose
- Closed Glucose Transporter
- Open Glucose Transporter

Type II Diabetes Cell
Type II Diabetes

- Risk factors: family history, sedentary lifestyle, obesity and aging
- Controlled by weight loss, oral hypoglycemic agents and or insulin
Diabetic Metabolism

Insulin Deficiency (and glucagon excess)

- Decreased cellular glucose uptake
  - Hyperglycemia
  - Glucosuria
  - Osmotic diuresis
  - Electrolyte depletion

- Increased protein catabolism
  - Increased plasma amino acids
  - Nitrogen loss in urine

- Increased lipolysis
  - Increased plasma FFA
  - Ketogenesis
  - Ketouria
  - Ketonemia

Dehydration
Acidosis

- Coma
- Death

Redrawn from Harper's Review of Biochemistry
# Screening for Diabetes

<table>
<thead>
<tr>
<th>Fasting Blood Glucose</th>
<th>Significance</th>
<th>Action</th>
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<tbody>
<tr>
<td>&lt; 110</td>
<td>Normal</td>
<td>Retest in 3 years</td>
</tr>
</tbody>
</table>
| >110 & <126           | IGT           | 1. Additional testing  
2. Check risk factors  
3. MNT                  |
| > 126                 | Diabetes Likely | 1. Confirm by 2\textsuperscript{nd} FBG  
2. Treat DM             |
Management of Diabetes Mellitus

- Nutrition
- Blood glucose
- Medications
- Physical activity/exercise
- Behavior modification
Medical Nutrition Therapy

- Primary Goal – improve metabolic control
  - Blood glucose
  - Lipid (cholesterol) levels
Medical Nutrition Therapy

- Maintain short and long term body weight
- Reach and maintain normal growth and development
- Prevent or treat complications
- Improve and maintain nutritional status
- Provide optimal nutrition for pregnancy
Nutritional Management for Type I Diabetes

- Consistency and timing of meals
- Timing of insulin
- Monitor blood glucose regularly
Nutritional Management for Type II Diabetes

- Weight loss
- Smaller meals and snacks
- Physical activity
- Monitor blood glucose and medications
Diabetes Control and Complications Trial

- 10 year randomized, controlled, clinical trial
- Determine the effects of glucose control on the development of long term microvascular and neurologic complications in persons with type I diabetes.
- 1441 participants, ages 13 to 39
Diabetes Control and Complications Trial

- **Conventional therapy:**
  - 1 - 2 insulin injections,
  - self monitoring B.G
  - routine contact with MD and case manager 4X/year.

- **Intensive therapy:**
  - 3 or more insulin injections, with adjustments in dose according to B.G monitoring,
  - planned dietary intake and anticipated exercise.
Diabetes Control and Complications Trial

- **Results:**
  - 76% reduction in retinopathy
  - 60% reduction in neuropathy
  - 54% reduction in albuminuria
  - 39% reduction in microalbuminuria

- **Implication:** Improved blood glucose control also applies to person with type II diabetes.
Nutrition Recommendations

- **Carbohydrate**
  - 60-70% calories from carbohydrates and monounsaturated fats

- **Protein**
  - 10-20% total calories
Nutrition Recommendations

- **Fat**
  - <10% calories from saturated fat
  - 10% calories from PUFA
  - <300 mg cholesterol

- **Fiber**
  - 20-35 grams/day

- **Alcohol**
  - Type I – limit to 2 drinks/day, with meals
  - Type II – substitute for fat calories
## 2003 Diabetic Exchange Lists

<table>
<thead>
<tr>
<th>Food Group</th>
<th>CHO (grams)</th>
<th>Protein (grams)</th>
<th>Fat (grams)</th>
<th>Calories</th>
</tr>
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<tbody>
<tr>
<td>Starch</td>
<td>15</td>
<td>3</td>
<td>0-1</td>
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<tr>
<td>Fruit</td>
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<td></td>
<td></td>
<td>60</td>
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<tr>
<td>Milk</td>
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<td></td>
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</tr>
<tr>
<td>- Skim</td>
<td>12</td>
<td>8</td>
<td>0-3</td>
<td>90</td>
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<tr>
<td>- Low-Fat</td>
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<td>120</td>
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<tr>
<td>- Whole</td>
<td>12</td>
<td>8</td>
<td>8</td>
<td>150</td>
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<td>Other Carbohydrate</td>
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<td>Varies</td>
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<tr>
<td>Nonstarchy Vegetables</td>
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<td>2</td>
<td>0</td>
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## 2003 Diabetic Exchange Lists

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<th>Fat (grams)</th>
<th>Calories</th>
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<tbody>
<tr>
<td><strong>Meat</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>○ Very Lean</td>
<td>7</td>
<td>0-1</td>
<td>3</td>
<td>35</td>
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<tr>
<td>○ Lean</td>
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<td>3</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td>○ Medium Fat</td>
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<td>5</td>
<td>8</td>
<td>75</td>
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<tr>
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<td><strong>Fat</strong></td>
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<td>5</td>
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</table>
2003 Diabetic Exchange Lists

Carbohydrate Exchanges – 3 g. protein, 0-1 g. fat and 80 calories

- Bread: bagel, bread, English muffin, tortilla
- Cereal: cold and hot cereal, pasta, rice
- Starchy vegetables: corn, peas, potato, squash
- Crackers and snacks
- Dried beans
- Starch prepared foods with fat: biscuits, muffins
2003 Diabetic Exchange Lists

- **Fruit Exchanges**
  - 15 grams carbohydrate and 60 calories
  - Fruit and fruit juice

- **Vegetables**
  - 5 g. carbohydrate, 2 G protein and 25 calories
2003 Diabetic Exchange Lists

- Other Carbohydrates
  - Exchanges and Serving size vary
  - Angel food cake – 2 carbohydrates
  - Cake, frosted – 2 carbohydrates, 1 fat
  - Donut, plain cake – 1 ½ carbohydrates, 2 fats
  - Potato chips – 1 carbohydrate, 2 fats
2003 Diabetic Exchange Lists

- **Milk** – 12 g. carbohydrate, 8 g. protein and 0-8 g. fat
- **Meat and Meat Substitutes**
- **Very Lean Meat** (7 g protein, 0-1 g. fat and 35 calories)
  - Chicken, turkey – white meat
  - Shellfish (clams, crab, lobster, shrimp)
2003 Diabetic Exchange Lists

- Lean Meat (7 g protein, 3 g fat and 55 calories)
  - Select or choice beef, trimmed of fat
  - Lean pork
  - Poultry, turkey – dark meat
2003 Diabetic Exchange Lists

- **Medium Fat Meat** (7 g protein, 5 g. fat and 75 calories)
  - Most beef products – corned beef, ribs, prime grades
  - Ground turkey
  - Chicken – dark meat with skin

- **High Fat Meat** (7 g protein, 8 g. fat and 75 calories)
  - All cheeses
  - Processed meats, hot dogs
<table>
<thead>
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<th>Time</th>
<th>Exchanges</th>
<th>Menus</th>
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<tbody>
<tr>
<td>8 AM</td>
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<tr>
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<td>Starch exchanges</td>
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<td>Meat exchanges</td>
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<tr>
<td></td>
<td>Milk exchanges</td>
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<td>Fat exchanges</td>
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<tr>
<td>10 AM</td>
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<td>12:30 PM</td>
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<td>6:30 PM</td>
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<td>Starch exchanges</td>
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<td>Fat exchanges</td>
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<tr>
<td>8 PM</td>
<td></td>
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</tbody>
</table>
Carbohydrate Counting

- A serving of carbohydrate is considered 15 grams
- A serving of fruit or starch or 3 servings of vegetable is equal to 1 carbohydrate
- One milk serving is considered equal to one carbohydrate
Carbohydrate Counting

- Example: Meal plan = 9 carbohydrate servings
  - 4 fruit and 5 starches or
  - 3 fruit + 4 starches + 3 vegetables and 1 milk or
  - 2 fruit + 4 starches + 3 vegetables and 2 milk
## Daily Meal Plan

<table>
<thead>
<tr>
<th>Time</th>
<th>Grams of Carbohydrate</th>
<th>Menus</th>
</tr>
</thead>
</table>
| 8 AM  | ___ Carbohydrate choices  
       | ___ Meat exchanges  
       | ___ Fat exchanges | |
| 10 AM | ___ Carbohydrate Choices |       |
| 12:30 PM | ___ Carbohydrate choices  
       | ___ Meat exchanges  
       | ___ Fat exchanges | |
| 6:30 PM | ___ Carbohydrate choices  
       | ___ Meat exchanges  
       | ___ Fat exchanges | |
| 8 PM  | ___ Carbohydrate Choices |       |