ENDOCRINE SYSTEM

Obesity

- Body Mass Index (BMI)
- Types of fat deposition in the body
- Metabolic changes in obesity
- Adipocytes (fat cells) and weight gain
- Hormones in obesity
- Leptin, adiponectin, ghrelin, cholecystokinin
- Treatment options

OBESITY

A disorder of body weight regulatory systems. It causes accumulation of excess body fat (>20% of normal body weight)
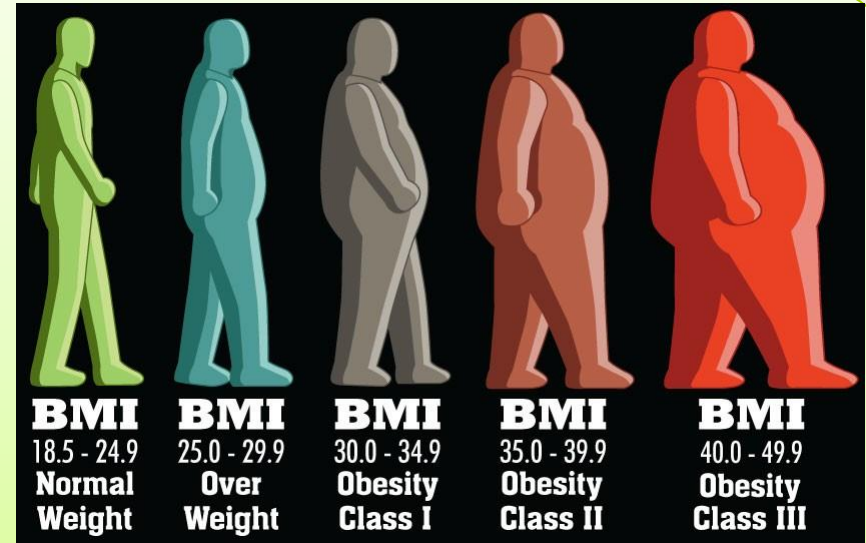
Obesity is associated with a high risk of:

- Diabetes mellitus
- High plasma triglycerides
- Heart disease
- Gallstones, arthritis, gout

- Hypercholesterolemia
- Hypertension
- Cancer
- Mortality

BODY MASS INDEX

- BMI is an indirect measure of obesity
- Correlates height, weight and amount of body fat in an individual
- High BMI is associated with increased mortality risk
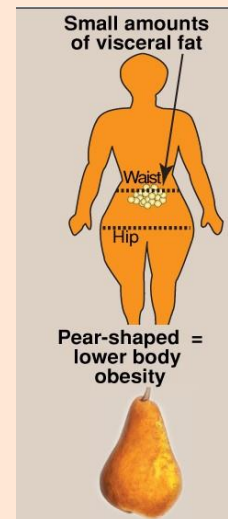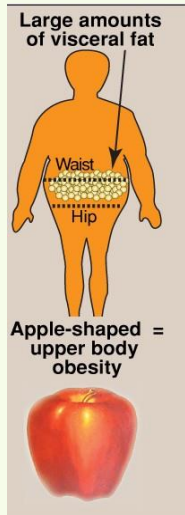
$$BMI = \frac{Weight\ (Kg)}{(Height\ in\ metres)^2}$$

| BMI 18.5 - 24.9 Normal Weight | BMI 25.0 - 29.9 Over Weight | BMI 30.0 - 34.9 Obesity Class I | BMI 35.0 - 39.9 Obesity Class II | BMI 40.0 - 49.9 Obesity Class III |

ANATOMICAL DIFFERENCE IN FAT DEPOSITION

- Android, "apple-shaped," or upper body obesity
- Excess body fat deposited in the central abdominal area
- Associated with risk of hypertension, insulin resistance, diabetes, dyslipidemia, and coronary heart disease (CHD)

- ynoid, "pear-shaped," or lower body obesity
- Fat deposited around the hips or gluteal region
- Associated risks are lower

Large amounts of visceral fat

Waist

Hip

Apple-shaped = upper body obesity

Small amounts of visceral fat

Waist

Hip

Pear-shaped = lower body obesity

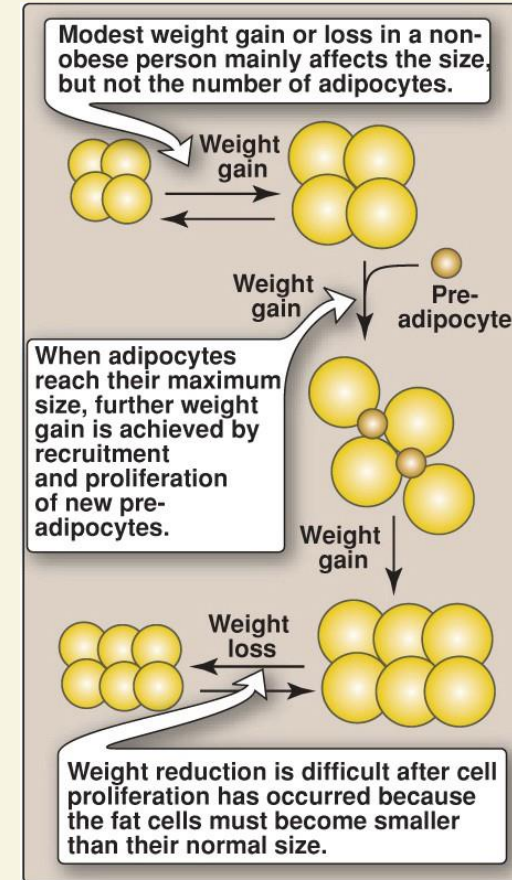| *Biochemical differences in fat deposits*	
Abdominal fat	**Gluteal fat**
Smaller in size	Larger in size
More responsive to hormones	Less responsive to hormones
Release substance via portal vein to the liver	Release substance to circulation with no effect on the liver

Adipocytes & Metabolic changes in obesity

- Adipocytes **send signals that cause abnormal metabolic changes** such as:
  1. **Dyslipidemia :** ↑ triglycerides and LDL + ↓ HDL level.
  2. **Glucose intolerance**
  3. **Insulin resistance:** High Level Of TAG Induce Inflammation that triggers Release Of Specific Adibokines.

- Triacylglycerols are deposited in adipocytes (fat cells)
  => The cells increase in size, expand and divide
- Fat cells, once gained, **ARE NEVER LOST**
- In obesity: **adipocytes increase in number and size**
- Reduction in weight causes adipocytes to reduce in size

Factors contributing to obesity		
1. Genetic	Familial tendency	
2. Environmental	i. Sex	Women more susceptible
	ii. Activity	Lack of physical activity
	iii. Psychogenic	Emotional deprivation/depression
	iv. Alcohol	Drinking Problem
	V. Smoking	Smoking cessation
3. Drugs	e.g. Antipsychotic drugs	

Modest weight gain or loss in a non-obese person mainly affects the size, but not the number of adipocytes.

Weight gain

Weight gain

Pre-adipocyte

When adipocytes reach their maximum size, further weight gain is achieved by recruitment and proliferation of new pre-adipocytes.

Weight gain

Weight loss

Weight reduction is difficult after cell proliferation has occurred because the fat cells must become smaller than their normal size.

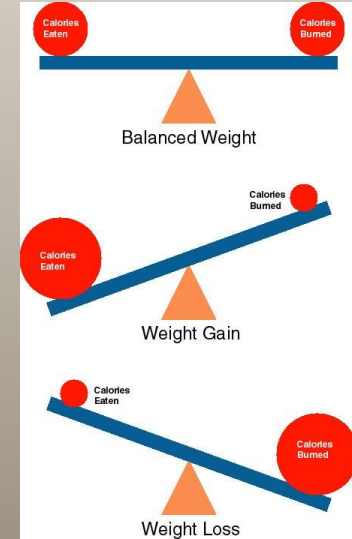Copyright © 2008 Wolters Kluwer Health | Lippincott Williams & Wilkins

Causes of weight gain

1. **Energy imbalance**: calories consumed not equal to calories used over a long period of time.

2. **Due to a combination of several factors**
   o Individual behavior
   o Social interaction
   o Environmental factors
   o Genetics :

   More in and less out = weight gain
   More out and less in = weight loss

3. **Hypothalamus:** A control center for hunger and satiety

4. **Endocrine disorder**: Hormonal imbalance

Hormonal control

Circulating hormones

Appetite is influenced by

Neural signals

Metabolites
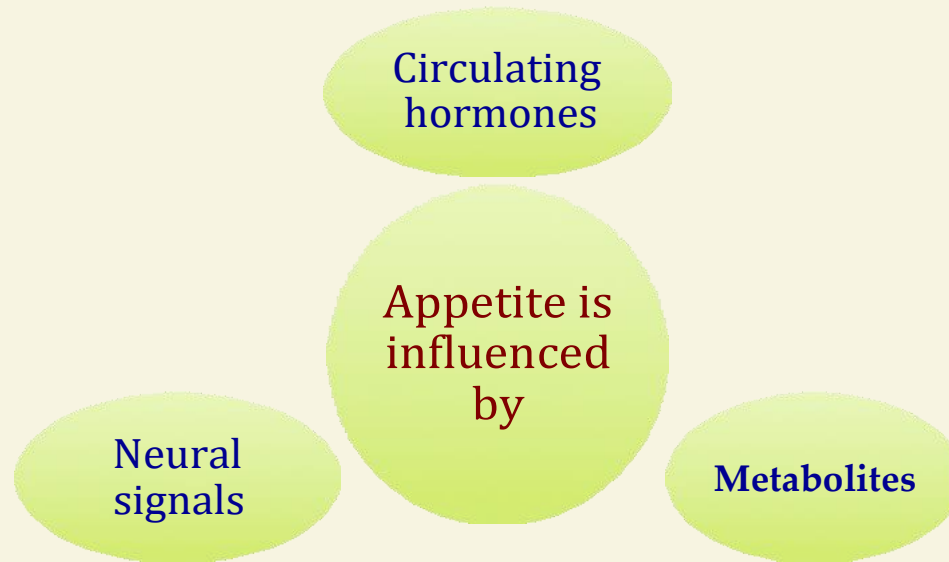
❑ These signals cause the release of hypothalamic peptides and activate neural signals

❑ Adipocytes also function as endocrine cells, they release many regulatory molecules:

1. **Leptin**

2. **Adiponectin**

3. **Resistin** (may cause insulin resistance observed in obesity)[1]

1: Low levels of adiponectin and increased levels of resistin, may cause insulin resistance observed in obesity

LEPTIN

❑ **A protein hormone produced by adipocytes,** Required to keep the body weight under control

❑ FUNCTIONS: Regulates the amount of body fat by controlling appetite and energy expenditure

1. Signals the brain about fat store levels
2. Increases metabolic rate
3. Decreases appetite in humans
4. Causes and maintain loss of weight (in overweight mice)[1]

❑ SECRETION :

↑ In well-fed state (expansion of fat stores)

↓ In starvation (depletion of fat stores)

Leptin Resistance

The receptor for leptin in the hypothalamus is produced by _db_ **gene**	Mutation in the _db_ gene causes leptin resistance in mice	It may have some role in human obesity : Dieting decreases leptin levels => **Reducing metabolism and stimulating appetite**

1: Plasma leptin level in obese humans is usually normal for their fat mass

Adiponectin	❑ A protein hormone secreted by adipocytes ❑ Adiponectin levels are ✓ **Inversely** correlated with **body fat levels** ✓ **Directly** correlated with **HDL levels** ❑ Low levels are seen in: 1) Metabolic syndrome 2) DM

Functions of Adiponectin

Promotes uptake and oxidation of fatty acids and glucose by muscle and liver	Blocks the synthesis of fatty acids and gluconeogenesis by hepatocytes	Increases insulin sensitivity / glucose tolerance

Ghrelin:

❑ **A <u>peptide</u> hormone secreted by <u>stomach</u>.**
<u>N.B: It has the complete opposite action of Leptin</u>

❑ FUNCTIONS:
✓ Stimulates appetite
Secretion increases just before meals and drops after meals
✓ Increases food intake
✓ Decreases energy expenditure and fat catabolism

Secreted in response to**: weight loss**
The higher the weight loss, the higher the ghrelin levels (direct correlation)

Levels in **<u>dieters are higher after weight loss</u>**

Cholecystokinin

❑ **Peptide hormone released from the gut after a meal**

❑ FUNCTION:
Sends satiety signals to the brain

Insulin:

❑ Function:
Promotes metabolism

TREATMENT OPTIONS

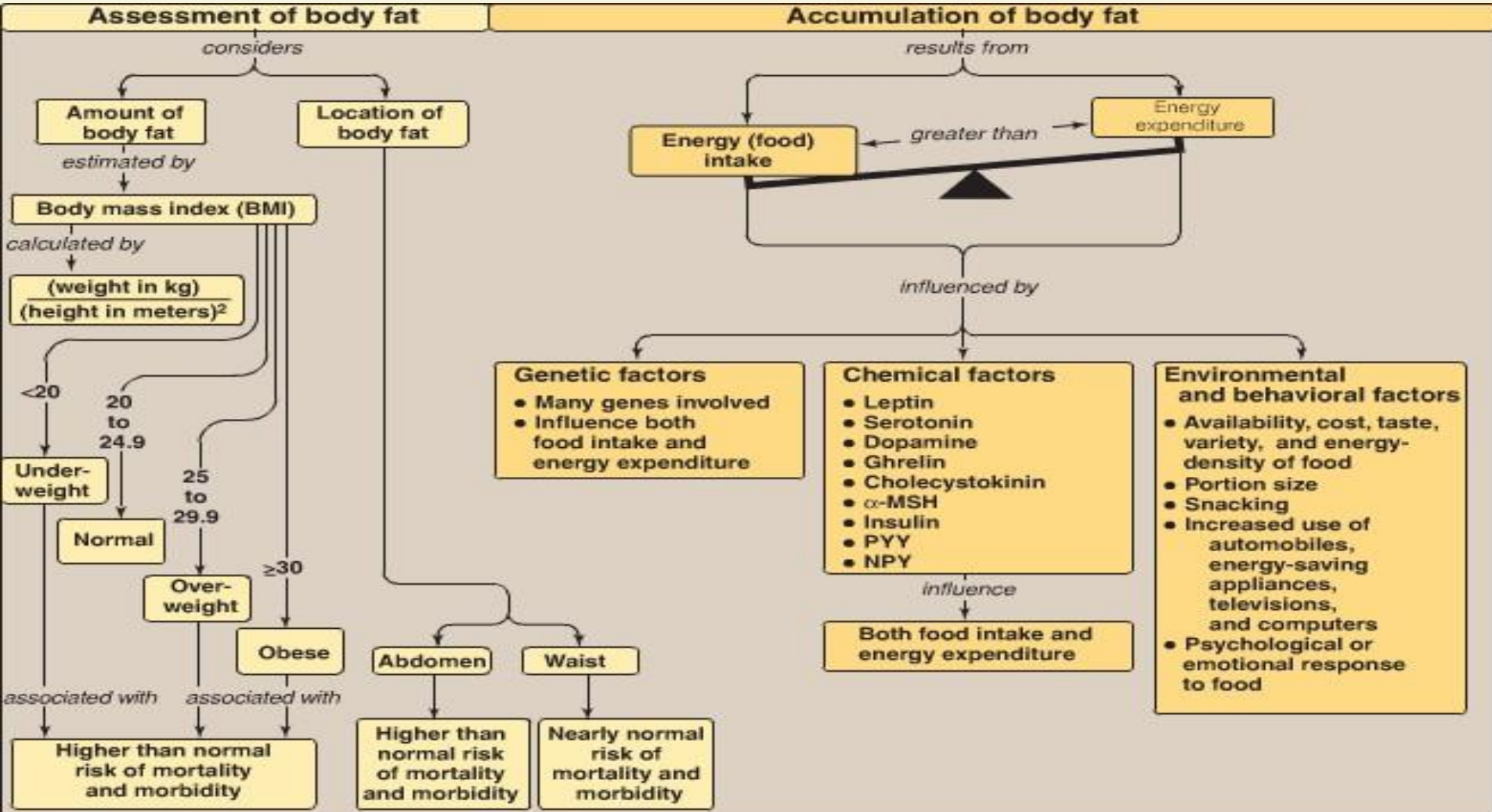| Weight loss:	Physical Activity	Dieting	Drugs	Surgery
↓ Risk factors leading to: ↓ Blood pressure ↓ Serum triacylglycerols ↓ Blood glucose levels ↑ HDL levels ↓ Mortality Beneficial changes in BMR ↓ Energy requirement **Slow weight loss is more stable**	+ healthy diet = ↓ obesity Reduces risk of heart disease and diabetes 	Use of calorie-restricted diet	**Orlistat** A pancreatic and gastric lipase inhibitor => ↓ the breakdown of dietary fat **Sibutramine** An appetite suppressant Inhibits the reuptake of both serotonin and norepinephrine	- Surgical procedures reduce food consumption in patients with BMI >40 - Used when other treatment options fail

Summary

Assessment of body fat — *considers*

- **Amount of body fat**
  - *estimated by* → **Body mass index (BMI)**
  - *calculated by* →
  $$\frac{\text{(weight in kg)}}{\text{(height in meters)}^2}$$
    - <20 → **Under-weight**
    - 20 to 24.9 → **Normal**
    - 25 to 29.9 → **Over-weight** — *associated with* → **Higher than normal risk of mortality and morbidity**
    - ≥30 → **Obese** — *associated with* → **Higher than normal risk of mortality and morbidity**

- **Location of body fat**
  - **Abdomen** → **Higher than normal risk of mortality and morbidity**
  - **Waist** → **Nearly normal risk of mortality and morbidity**

Accumulation of body fat — *results from*

- **Energy (food) intake** *greater than* **Energy expenditure**

influenced by

- **Genetic factors**
  - Many genes involved
  - Influence both food intake and energy expenditure

- **Chemical factors**
  - Leptin
  - Serotonin
  - Dopamine
  - Ghrelin
  - Cholecystokinin
  - α-MSH
  - Insulin
  - PYY
  - NPY
  - *influence* → **Both food intake and energy expenditure**

- **Environmental and behavioral factors**
  - Availability, cost, taste, variety, and energy-density of food
  - Portion size
  - Snacking
  - Increased use of automobiles, energy-saving appliances, televisions, and computers
  - Psychological or emotional response to food

Diet and eating: avoid high calorie, low nutrient foods

Eat a variety of nutritious foods. Encourage and support breastfeeding during infancy.

Emphasize:

Fruits and vegetables – at least 5 servings per day.

Whole grains – look for 100% whole grain and at least 3 grams of dietary fiber per serving.

Fat-free or low-fat milk and dairy products. If lactose-intolerant, choose fat-free lactose-free milk, or fat-free plain soy, almond, or rice milk.

Lean meats, skinless poultry, fish, beans, soy products, eggs, and nuts. Bake, broil, steam, or grill. Avoid frying foods.

Low saturated fats (look for 5% or less on the nutrition facts label). Consider using plant-based oils such as olive oil for cooking, instead of margarine or butter.

Stay within your daily calorie needs or use the plate method to control caloric intake.

Eliminate or Reduce:

Foods high in saturated fat include fatty meats (eg, bacon, sausage, deli meats, hot dogs), fried foods, full fat dairy products, donuts, cookies, ice cream.

High calorie beverages: sugar-sweetened beverages (regular soft drinks, fruit drinks, fruit punch, sweet tea, sweetened coffee drinks) and alcoholic beverages.

High calorie and low nutrient foods: sweets and junk food such as chips.

Avoid fast food, and limit eating out to rare occasions. When eating out, choose grilled or baked fish or chicken, steamed vegetables without butter, salads with low-fat dressing on the side. If eating fast food, select a grilled chicken sandwich or veggie burger and a side salad with low-fat dressing on the side. Avoid French fries and other fried food