

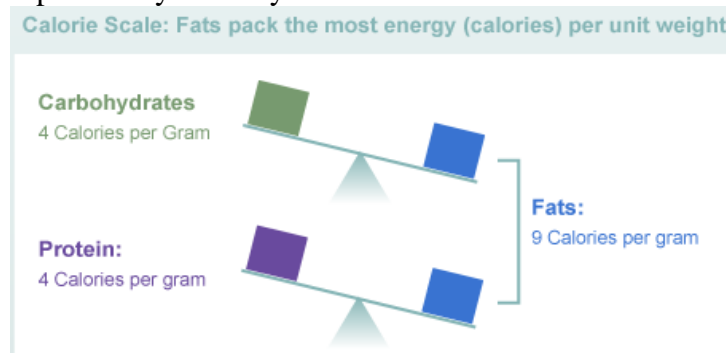


### - Energy homeostasis is maintained through a balance between:

- **Intake (what you eat):** fats, carbohydrates and proteins.
- **Output (energy expenditure):** exercise and basal metabolic rate (e.g. the energy which is used at rest, in a comfortable temperature, 12-14 hours after the last meal for normal metabolic functions of the body). Energy output can be divided into:
  - ✓ External work: which is represented by heat loss (e.g. thermal energy).
  - ✓ Internal work: which is represented by:
    - ❖ *Basal metabolism: 60-65%.*
      - Notice that the basal metabolic rate of a man of average size is nearly 2000 kcal/day.
      - Factors which affect the metabolic rate include the following:
        - Height, weight and surface area of the body.
        - Sex: due to androgens (in males).
        - Age.
        - Muscular exertion.
        - Recent ingestion of food.
        - Environmental temperature.
        - Reproduction and lactation.
        - Emotional status.
        - Circulating levels of thyroid hormone (hyperthyroidism increases metabolism).
        - Circulating levels of epinephrine and norepinephrine (when they are increased, sympathetic nervous system will be enhanced and this will increase metabolic rate of the body).
    - ❖ *Physical activities: 25%*
    - ❖ *Thermic effect of food: 10%*

### - The energy input per gram in the food which you eat:

- **Carbohydrates:** each gram provides your body with 4 kcal.
- **Proteins:** each gram provides your body with 4 kcal.
- **Fats:** each gram provides your body with 9 kcal.



### - Obesity:

- **Definition:** it is represented by excessive fat accumulation in the body.
- **How fat accumulates?**
  - ✓ When energy intake is more than energy output of the body, the excess energy will be stored as fat in adipose tissues.
- **What are the causes of obesity?**
  - ✓ Childhood overnutrition: this leads to increase in the number of fat cells in the child.
  - ✓ Neurogenic abnormalities.
  - ✓ Genetic factors: represented by abnormalities in the following:
    - ❖ One or more of the pathways regulating feeding center.
    - ❖ Energy expenditure and fat storage.

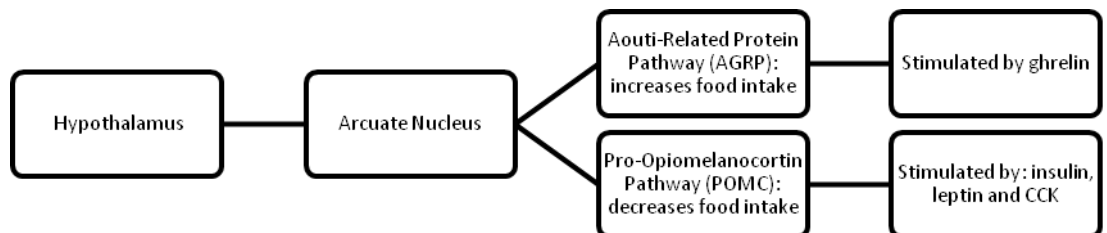


- ❖ Mutation MCRY monogenic form.
- ❖ Congenital leptin deficiency mutation of leptin receptors.
- ✓ Excessive energy intake with decreased physical activity.



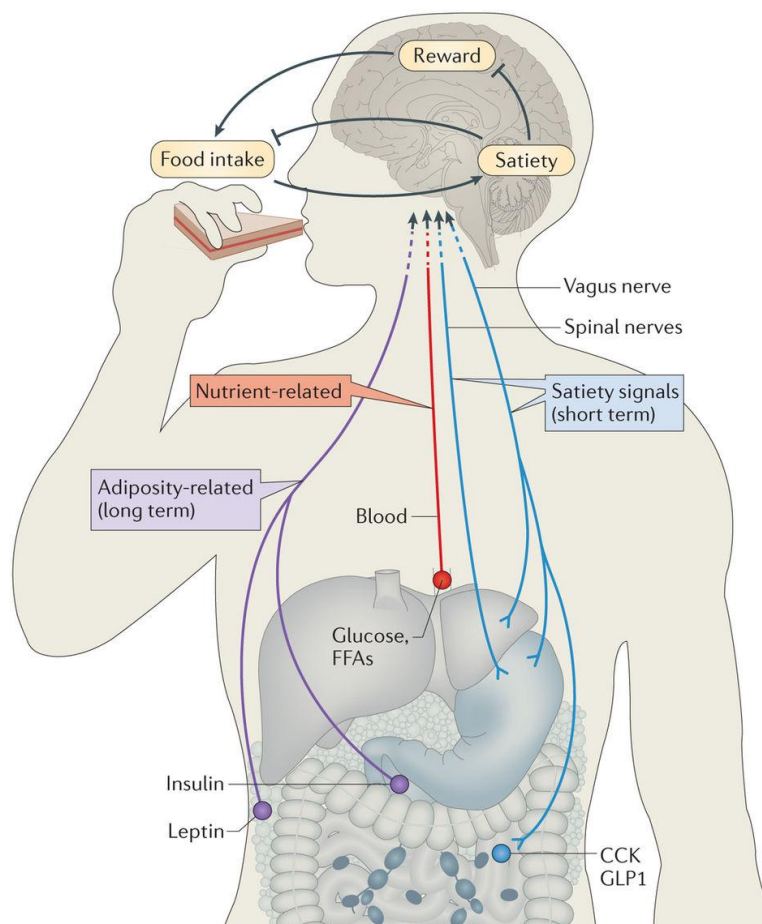
• **Regulation of food intake:**

- ✓ Hypothalamus has two centers which control hunger and satiety:
  - ❖ *Lateral nuclei:* is the feeding center (any lesion in this center will cause anorexia or weight loss).
  - ❖ *Ventromedial nuclei:* is the satiety center (any lesion in this center will cause overeating or weight gain).
- ✓ Regulation of food intake is also done by: neurohumoral signals from GI tract (e.g. CCK, ghrelin and PYY) and adipose tissue (e.g. leptin).
- ✓ Short-term regulation of feeding:
  - ❖ When you eat, stomach will be stretched by food and this is going to send signals through the vagus nerve which will inhibit eating.
  - ❖ The presence of fats and carbohydrates in gastrointestinal tract will result in CCK and insulin release, respectively → this inhibits further eating.
  - ❖ Intestinal release of peptide YY (PYY) and Glucagon-Like Peptide (GLP) inhibits feeding.
  - ❖ Ghrelin stimulates feeding and it is released from oxyntic cells of the stomach.
- ✓ Intermediate and long-term regulation of feeding:
  - ❖ High glucose (after having a meal) increases firing rate in satiety center while decreasing firing rate in hunger center.
  - ❖ When there is a lot of energy which is stored in the body in the form of fat in adipose tissue → this will result in the release of leptin which reduces appetite.



✓ What are orexigenics and anorexigenics?

- ❖ *Orexigenics:* are substances which stimulate feeding. Examples: neuropeptide-Y, AGRP, orexins A and B, endorphins, amino acids, cortisol and ghrelin.
- ❖ *Anorexigenics:* are substances which inhibit feeding. Examples: leptin, serotonin, norepinephrine, insulin, CCK and PYY.



✓ Health risks associated with body weight and fat:



Anorexia nervosa



Cachexia

- ❖ *Underweight:*
  - Seen in wasting disease such as cancer.
  - Menstruation stops in females when body fat is less than 12%.
- ❖ *Overweight:*
  - Coronary heart disease (e.g. myocardial infarction especially seen with central obesity).
  - Type-II diabetes (non-insulin dependent).
  - Cancer.
  - Hypertension.
- ❖ *Inanition:* extreme weight loss caused by inadequate availability of food or by pathophysiologic factors.
- ❖ *Anorexia:* reduction in food intake caused primarily by diminished appetite.
- ❖ *Anorexia nervosa:* abnormal psychic state in which a person loses all desire for food and even becomes nauseated by food.
- ❖ *Cachexia:* metabolic disorder of increased energy expenditure leading to weight loss which is caused by reduced food intake alone.

- Endocrine functions of adipocytes:

- **Energy balance:** by the regulating hormone leptin.
- Providing factors for the complement system concerned with immunity (e.g. factor D).
- Prothrombotic agents such as plasminogen-activator inhibitor I.
- Component of blood pressure-regulating system.
- **Adiponectin, an abundant adipose-derived protein whose levels are reduced in obesity, enhances insulin sensitivity and lipid oxidation and it has vascular protective effects. In contrast, resistin which is increased in obesity induces insulin resistance.**