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BCH 445
Biochemistry of nutrition
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Energy Needs & Requirements

Food is the only source of body which undergoes Metabolism and liberate / Generates Energy – required for vital activities of the body i.e. main function of nutrient is to provide Energy and Heat i.e. Chemical Stored Energy ATP.

Energy: the capacity to do work, such as moving or heating something.

The energy yielding nutrients are Carbohydrates, proteins and fats

Calorie: The unit used to measure energy & used to express energy value of food.

Measurement of energy: Energy is measured as calories.

Standard Calories is amount of heat required to raise temp. of 1 gm H_2O one degree in pressure 1 atmosphere.

Small calorie (c) or gram calorie (cal)

Large Calorie (C) or kilogram calorie (Cal)

i.e. 1000 Cal = 1 kilo Cal

1 kilo = 4.2 Kilo Joules (KJ)



Caloric value of

CHO = 4 Kcal / gm energy

Protein = 4 Kcal / gm energy

Fat = 9 Kcal / gm energy

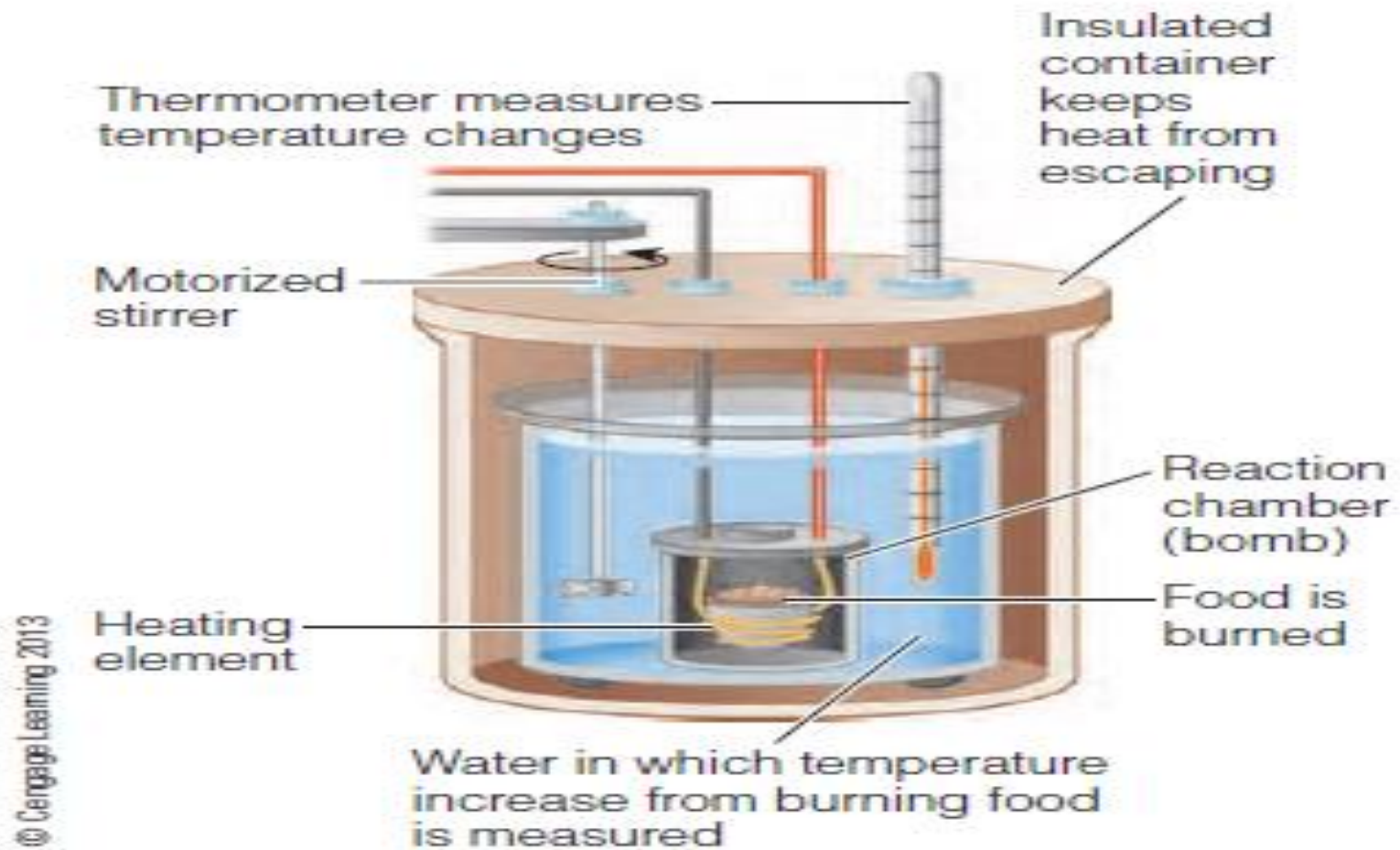


Food energy: The amount of energy in food that is available through digestion. This energy is not a nutrient but is released from food components. The amount of food energy in a particular food could be measured by completely burning the dried food in a bomb calorimeter (estimate of the potential energy of the foods) a method known as direct calorimetry

- The energy value of a food indicates its value to the body as a fuel.

Physiological fuel value: The number of kcalories that the body derives from a food, in contrast to the number of Kcalories determined by calorimetry.

- Food energy values can be determined also by Indirect calorimetry, which measures the amount of oxygen consumed during complete burning of food. 1L of O₂ consumed equals to 4.83kcal of energy expended.



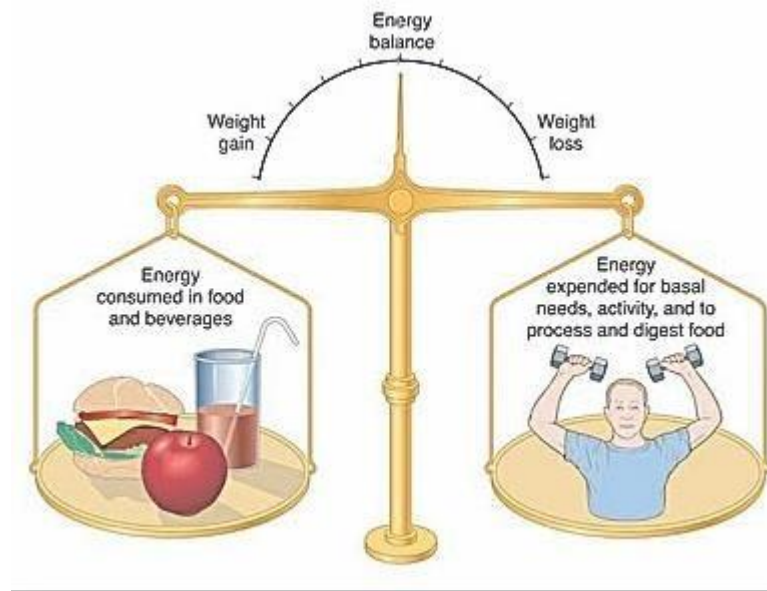
Bomb Calorimeter: When food is burned, energy is released in the form of heat. Heat energy is measured in k calories.

- The body is less efficient than a calorimeter and cannot metabolize all of the energy-yielding nutrients in a food completely.
- The energy values of foods can also be computed from the amounts of carbohydrate, fat, and protein in the foods.

For example, a food containing 12 grams of carbohydrate, 5 grams of fat, and 8 grams of protein will provide 48 carbohydrate k calories, 45 fat k calories, and 32 protein K calories, for a total of 125 k calories.

Energy Balance

The energy balance means the amount of energy consumed **(energy in)** versus the amount of energy expended **(energy out)**. When a person is maintaining weight, energy in equals energy out.



If energy in is $>$ energy out = over fatness

If energy in is $<$ energy out = underweight



Energy In: The kCalories Foods Provide

Foods and beverages provide the “energy in” part of the energy-balance equation. How much energy a person receives depends on the composition of the foods and beverages and on the amount the person eats and drinks.

Energy Out: The kCalories the Body Expend

The generation of heat, known as thermogenesis, can be measured to determine the amount of energy expended.

The total energy a body expends reflects three main categories of thermogenesis:

- **Energy expended for basal metabolism**
- **Energy expended for physical activity**
- **Energy expended for food consumption**

Energy Requirements

The energy requirements

- Basal metabolic rate
- Energy expenditure in daily activities
- Energy expenditure in work

Energy Requirement Determinants

- Physical activity
- Climate
- Personal factors

Basal metabolic rate (BMR):

The rate of energy use for metabolism under specified conditions: after a 12-hour fast and restful sleep, without any physical activity or emotional excitement, and in a comfortable setting. It is usually expressed as kcalories per kilogram body weight per hour.

- **Basal metabolism: The energy needed to maintain life when a body is at complete digestive, physical, and emotional rest.**

- **It represents about 60-70% of the energy needed by your body on a daily basis.**
- **An additional 5-10% of energy needed is for the digestion, absorption and utilization of nutrients.**
- **An additional 7% or so is used to keep the body warm in cold condition.**

Energy expenditure in daily activities:

It is the energy required for the non- occupational activities such as sitting, standing, dressing, walking, etc.

Energy expenditure in work:

Additional calories are required for the performance of daily work.

Estimating Energy Requirements (EER): BY equations based on research measuring total daily energy expenditure.

Factors influence BMR and consequently energy expenditure:

Gender, growth, age, physical activity and body composition and body size.

Gender. Women have a lower BMR than men, in large part because men typically have more lean body mass. Two sets of energy equations, one for men and one for women.

Growth. The BMR is high in people who are growing. For this reason, pregnant and lactating women, infants, children, and adolescents have their own sets of energy equations.

Age. The BMR declines during adulthood as lean body mass diminishes. This change in body composition occurs, in part,

because some hormones that influence appetite, body weight, and metabolism become more, or less, active with age. Physical activities tend to decline as well, bringing the average reduction in energy expenditure to about 5 percent per decade. The decline in BMR that occurs when a person becomes less active reflects the loss of lean body mass and may be minimized with ongoing physical activity. Because age influences energy expenditure, it is also factored into the energy equations.

Physical activity. Using individual values for various physical activities is time-consuming and impractical for estimating the energy needs of a population. Instead, various activities are clustered according to the typical intensity of a day's efforts. Energy equations include a physical activity factor for various levels of intensity for each gender.

Body composition and body size. The BMR is high in people who are tall and so have a large surface area. Similarly, the more a person weighs, the more energy is expended on basal metabolism. For these reasons, energy equations include a factor for both height and weight.

Energy needs vary between individuals depending on such factors as gender, growth, age, physical activity, and body size and composition. Even when two people are similarly matched, however, their energy needs still differ because of genetic differences. Perhaps one day genetic research will reveal how to estimate requirements for each individual.

TABLE 8-1**Factors That Affect the BMR**

Factor	Effect on BMR
Age	Lean body mass diminishes with age, slowing the BMR. ^a
Height	In tall, thin people, the BMR is higher. ^b
Growth	In children and pregnant women, the BMR is higher.
Body composition (gender)	The more lean tissue, the higher the BMR (which is why males usually have a higher BMR than females). The more fat tissue, the lower the BMR.
Fever	Fever raises the BMR. ^c
Stresses	Stresses (including many diseases and certain drugs) raise the BMR.
Environmental temperature	Both heat and cold raise the BMR.
Fasting/starvation	Fasting/starvation lowers the BMR. ^d
Malnutrition	Malnutrition lowers the BMR.
Hormones (gender)	The thyroid hormone thyroxine, for example, can speed up or slow down the BMR. ^e Premenstrual hormones slightly raise the BMR.
Smoking	Nicotine increases energy expenditure.
Caffeine	Caffeine increases energy expenditure.
Sleep	BMR is lowest when sleeping.

Estimate Energy Requirements determination

To determine your estimated energy requirement (EER), use the appropriate equation, inserting your age in years, weight (wt) in kilograms, height (ht) in meters, and physical activity (PA) factor.

To convert pounds to kilograms, divide by 2.2

To convert inches to meters, divide by 39.37.

For men 19 years and older:

$$\text{EER} = [662 - (9.53 \times \text{age})] + \text{PA} \times [(15.91 \times \text{wt}) + (539.6 \times \text{ht})]$$

For women 19 years and older:

$$\text{EER} = [354 - (6.91 \times \text{age})] + \text{PA} \times [(9.36 \times \text{wt}) + (726 \times \text{ht})]$$

For example, consider an active 30-year-old male who is 5 feet 11 inches tall and weighs 178 pounds.

First, conversion weight from pounds to kilograms and height from inches to meters, $178 \text{ lb} \div 2.2 = 80.9 \text{ kg}$ and $71 \text{ in} \div 39.37 = 1.8 \text{ m}$

Next, consider level of daily physical activity and selects the appropriate PA factor from the following table:

Physical Activity (PA) Factors for EER Equations

	Men	Women	Physical Activity
Sedentary	1.0	1.0	Typical daily living activities
Low active	1.11	1.12	plus 30–60 min moderate activity
Active	1.25	1.27	plus ≥ 60 min moderate activity
Very active	1.48	1.45	plus ≥ 60 min moderate activity and 60 min vigorous or 120 min moderate activity

NOTE: Moderate activity is equivalent to walking at 3 to 4½ mph.

(In this example, 1.25 for an active male.) Then, inserts age, PA factor, weight, and height into the appropriate equation:

$$\text{EER} = [662 - (9.53 \times 30)] + 1.25 \times [(15.91 \times 80.9) + (539.6 \times 1.8)]$$

$$\text{EER} = [662 - 286] + 1.25 \times [1287 + 971]$$

$$\text{EER} = 376 + 1.25 \times 2258$$

$$\text{EER} = 376 + 2823$$

$$\text{EER} = 3199$$

The estimated energy requirement for an active 30-year-old male who is 5 feet 11 inches tall and weighs 178 pounds is about 3200 kcalories/day.

For **most people**, the actual energy requirement falls within these ranges:

- For men, EER \pm 200 kcal
- For women, EER \pm 160 kcal

For **almost all people**, the actual energy requirement falls within these ranges:

- For men, EER \pm 400 kcal
- For women, EER \pm 320 kcal

Body Mass Index (BMI): Defined as weight in kilograms, divided by the square of the height in meters (describes relative weight for height)

$$\text{BMI} = \frac{\text{weight (kg)}}{\text{height (m)}^2} \text{ or } \frac{\text{weight (lb)}}{\text{height (in)}^2} \times 703$$

What the Numbers Mean

BMI	Condition
Below 18.5	Underweight
18.5-24.9	Normal Weight
25-29.9	Overweight
Above 30	Obese

For example, a person who is 5'5" (1.65 m) tall and weighs 174 lb (79 kg):

$$\text{BMI} = \frac{174 \text{ lb}}{65 \text{ in}^2} \times 703 = 29$$

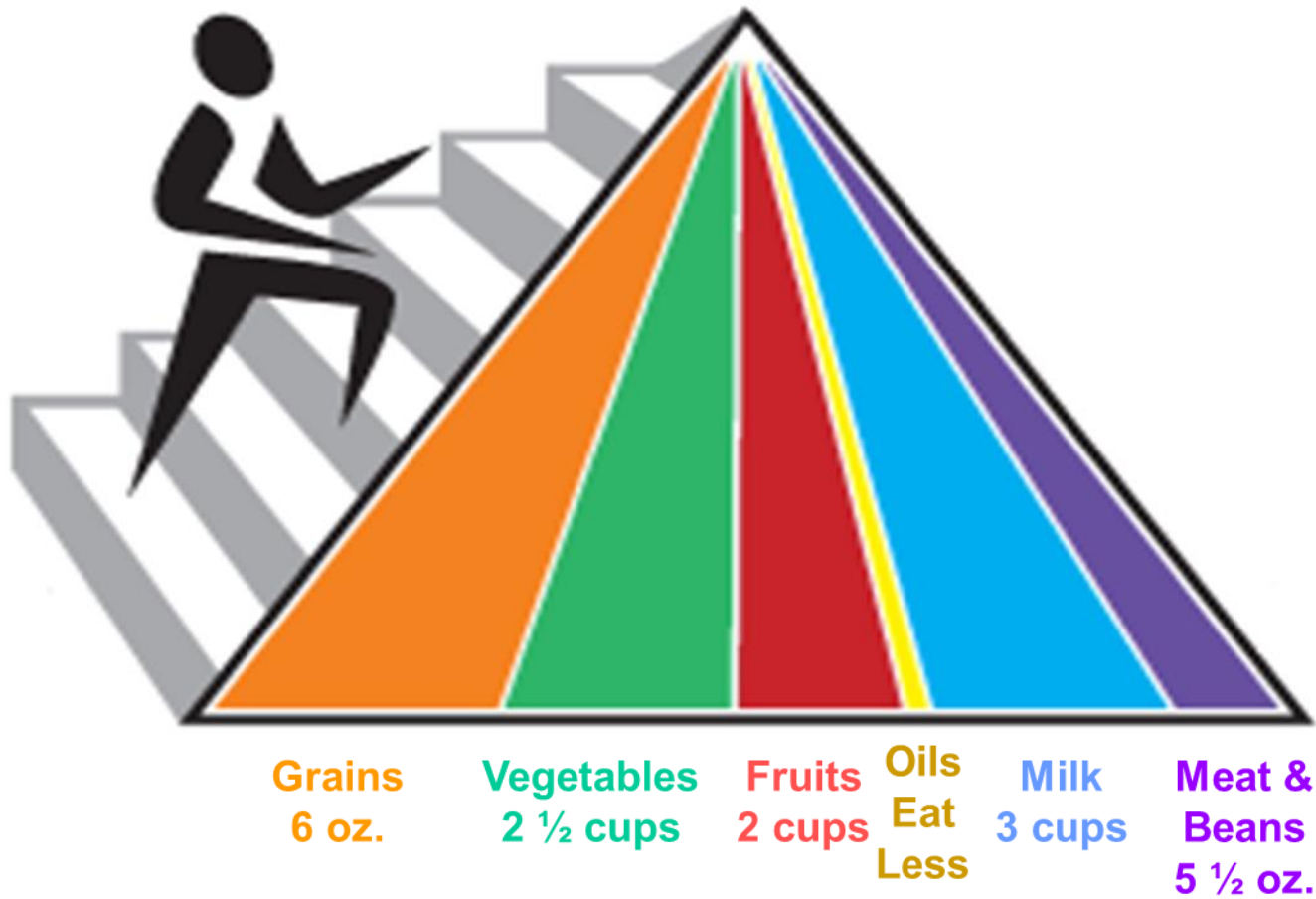
or

$$\text{BMI} = \frac{79 \text{ kg}}{1.65 \text{ m}^2} = 29$$

This person has a BMI of 29 and is considered overweight.

The adequate diet & Food Pyramids

- **Good nutrition is important to good health. This will give your body energy and help you grow.**
- **Make “smart” choices from every food group.**
- **Eating foods from the Food Guide Pyramid and being physically active will help you grow healthy and strong!**
- **Eat a variety of foods. A balanced diet is one that includes all the food groups.**



The Food Guide Pyramid

It is an outline of what to eat each day based on the dietary guidelines. It's a general guide that lets you choose a healthful diet.

Dietary Guidelines.

- 1. Aim for fitness (aim for healthy weight).**
- 2. Be physically active each day.**
- 3. Let the pyramid guide your choices.**
- 4. Choose a variety of grains daily, especially whole grains.**

- 5. Choose a variety of fruits and vegetables daily.**
- 6. Keep food safe to eat.**
- 7. Choose a diet that is low in saturated fat and cholesterol and moderate in total fat.**
- 8. Choose beverages and foods to moderate your intake of sugars.**
- 9. Choose and prepare food with less salt.**

Eat good fats and avoid bad fats.

- **Good fats are the oils found in nuts, seeds, grains and fish.**
- **They are high in the unsaturated fats necessary for good health.**
- **Good fats should contribute 30 to 45% of the total fat.**
- **Avoid saturated fats (animal fats and tropical oils e.g. coconut) to minimize the risk of heart disease.**
- **Trans-saturated fats are mainly found in margarines and commercial baked foods.**

Eat whole-grain carbohydrates.

- **whole-grain are more nutritious than refined carbohydrates. Being more slowly digested**
- **Place less stress on pancreatic insulin production.**
- **Sources of whole grain carbohydrates include whole meal bread, whole wheat, brown rice.**
- **Avoid white bread, baked goods and pasta made with white flour.**

Avoid red meat as a protein source and emphasize plant proteins.

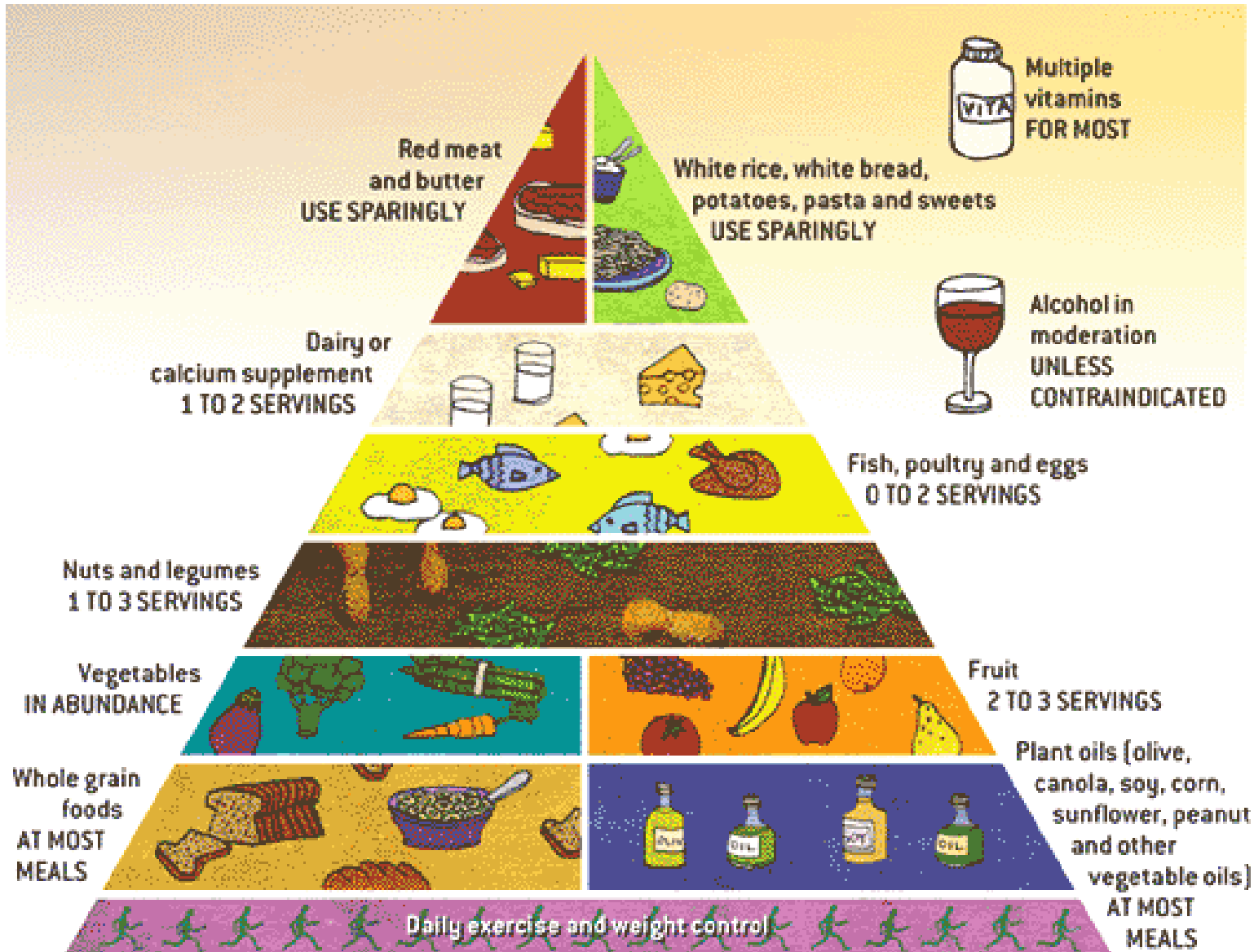
- **Red meat consumption is linked to a variety of chronic diseases & increases the risk of hip fracture.**
- **Animal proteins are usually packaged with saturated fat.**

Eat plenty of vegetables and fruits.

- **Potatoes are not included as a vegetable.**
- **Dark green leafy vegetables, and fruit are clearly beneficial.**
- **A diet high in fruits and vegetables lowers blood pressure and cholesterol and reduces the risk of cancer.**

Take a multivitamin daily.

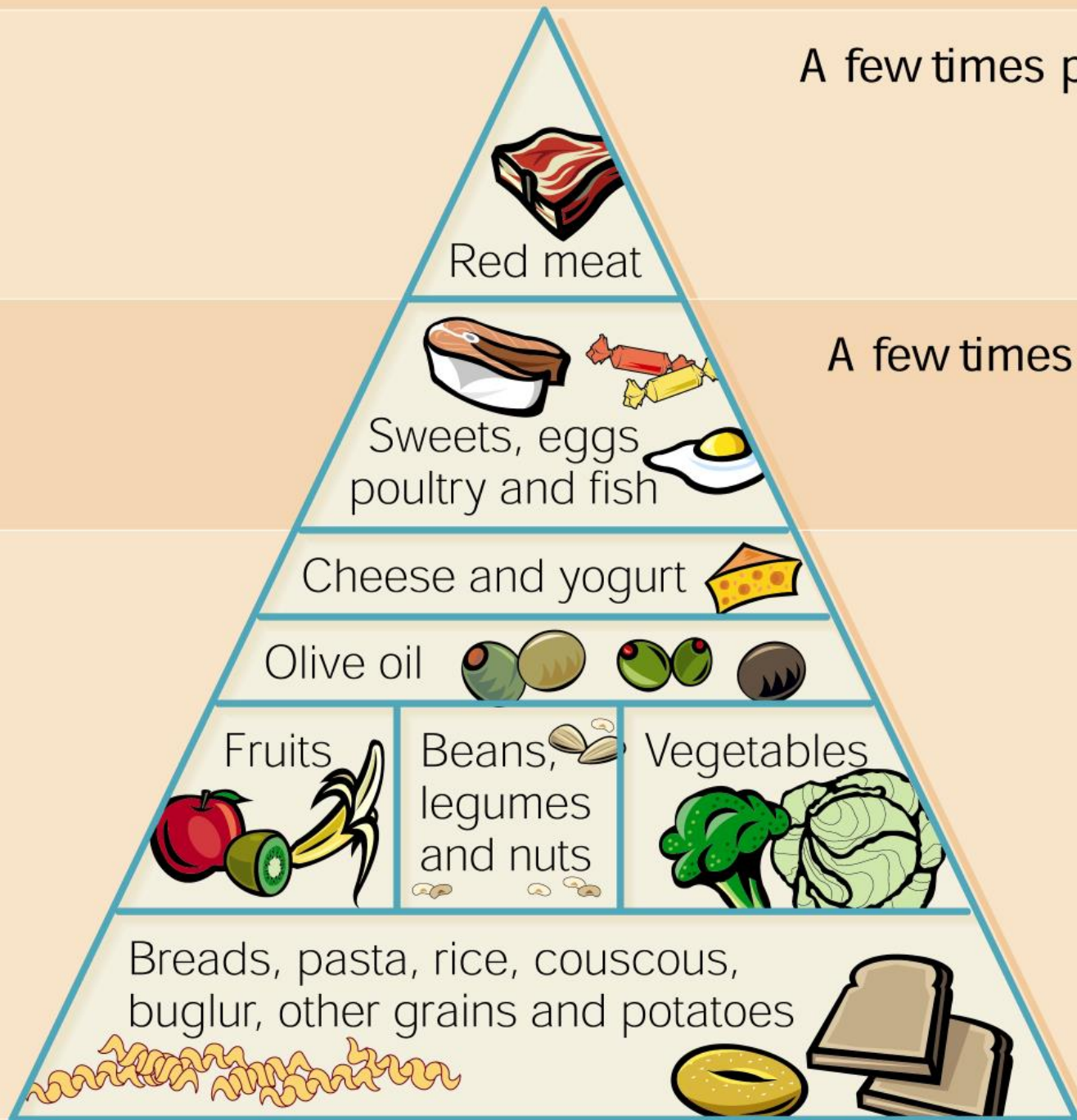
- **This recommendation is insurance against any inadvertent deficiencies.**



NEW FOOD PYRAMID

outlined by the authors distinguishes between healthy and unhealthy types of fat and carbohydrates. Fruits and vegetables are still recommended, but the consumption of dairy products should be limited.

Mediterranean Pyramid



Daily Food guide with Nutrient Pattern and Recommended Quantity.

Group	Key Nutrients	Quantity	Comments
Milk and Cheese	Calcium, Protein Phosphorus, riboflavin	3 cups for children 4 cups for teenagers 2 cups for adults	Low-fat milk products have generally all the same nutrient content, however they are lower in calories and vitamin A.
Meats, poultry, fish, beans	Protein, Iron Niacin, Thiamin Red meat -> Zinc Egg yolk and liver -> Vitamin A Dry beans and Nuts -> Magnesium	2 servings Serving size: 2-3 ounces 1 ounce of meat = 1 egg or ½ cup cooked beans 1 ounce = 30 gm	Legumes and nuts has a lower biological value than meat. They can be combined with animal or grain products to increase protein quality. Cholesterol and vitamin B12 are found only in animal sources.