Energy Requirements

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Learning objectives:

- **To understand energy balance**
- **To identify the factors affecting TER & BMR.**
- **To calculate TER for:**

1. **Normal person**
2. **Pregnant & lactating**
3. **Overweight person**

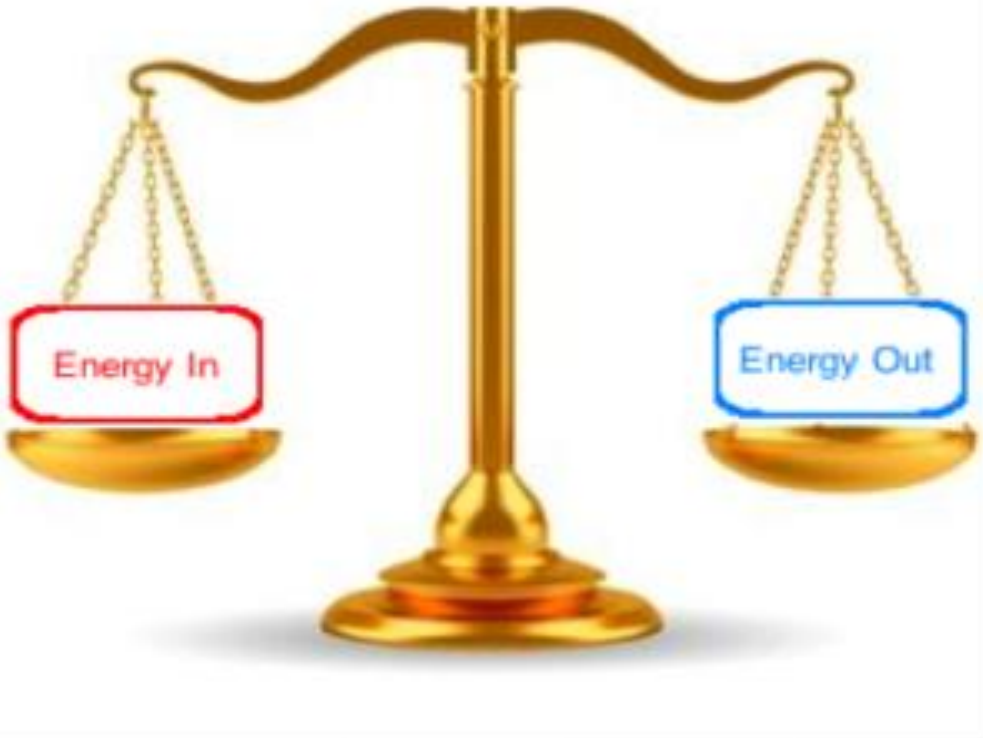
The need for energy

- The human body needs a continuous regular supply of nutrients.
- Energy required for all body processes, growth & physical activity; even at rest the body requires energy for muscle contraction, active transport of molecules, &ions, synthesis of macromolecules from simple precursors,

Body Weight

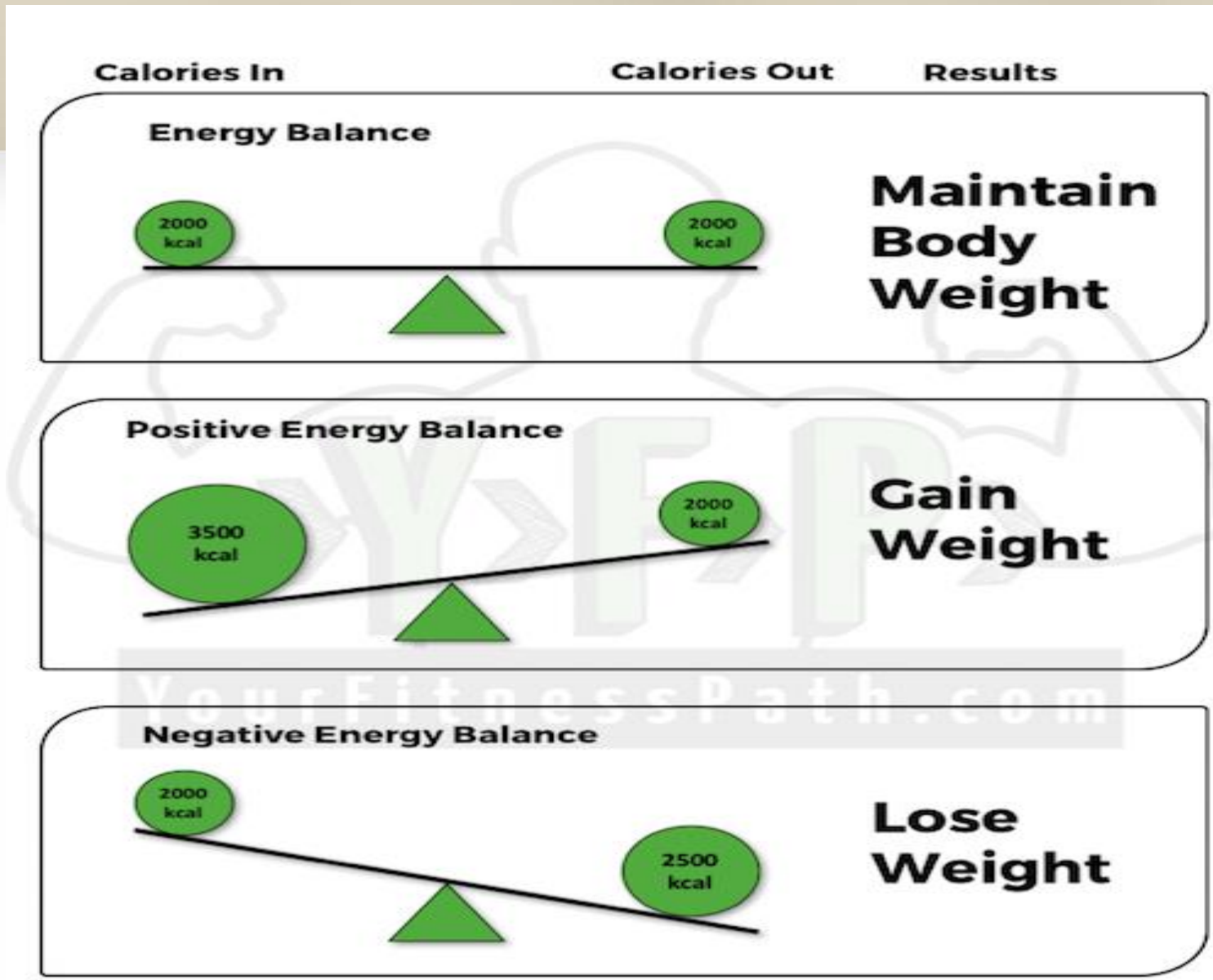
- Body composition : this term is used to describe the percentages of fat ,muscle, bone, water and other tissues that make up body weight.
- Achieving and maintaining a **healthy weight** is about managing energy balance and increasing the proportion of **lean** tissue **to fat**.
- Energy balance = energy in – energy out.

Neutral Energy Balance



Energy balance

- Energy in = calories consumed per day.
- Energy out = basal metabolic rate (BMR) + thermic effect of foods, + physical activity per day.
- Small increments in calories consumed per day or week can **contribute to weight gain over time.**


Calories In
Calories Out
Results
Energy Balance
2000 kcal
2000 kcal
Maintain Body Weight
Positive Energy Balance
3500 kcal
2000 kcal
Gain Weight
Negative Energy Balance
2000 kcal
2500 kcal
Lose Weight
www.yourfitnesspath.com

How is the energy content of food found out?

Burning food in a bomb calorimeter.

NUTRITION INFORMATION

Servings per package: 1	**Average quantity**	
Serving Size: 170g	Per serving	Per 100g
Energy	410kJ	240kJ
Protein	5.2g	3.1g
Fat - total	2.8g	1.7g
- saturated fat	0g	0g
Carbohydrate	11.5g	6.7g
- Sugars	3.5g	2.1g
Dietary fibre	2.2g	1.3g
Sodium	30mg	17mg
Potassium	335mg	210mg
Gluten	0mg	0mg
Iron	2.0mg	1.2mg

Sources of Stored Energy

When food is not available ,as during sleep, or longer periods of fasting or extreme stress of starvation , the body draws energy from Its(3)stores

1- Glycogen

A 12-to 48 hour reserve of glycogen exists in liver and muscles and quickly depleted if not replenished by daily food intake .

For example, glycogen stores maintain normal blood-glucose levels for body functions during sleep hours

2-Adipose tissue

Although fat storage is larger than glycogen , the supply varies from person to person , and the balanced amount needs to maintained as an added resource.

3-Muscle mass

Energy stored as protein exist in limited amounts in muscle mass, but this lean mass must be maintained for health.

Only during longer periods of fasting or starvation the body turns these tissues for energy.

Total energy requirement (TER):

- This depends on summation of 3 components:

1-Basal metabolic rate.

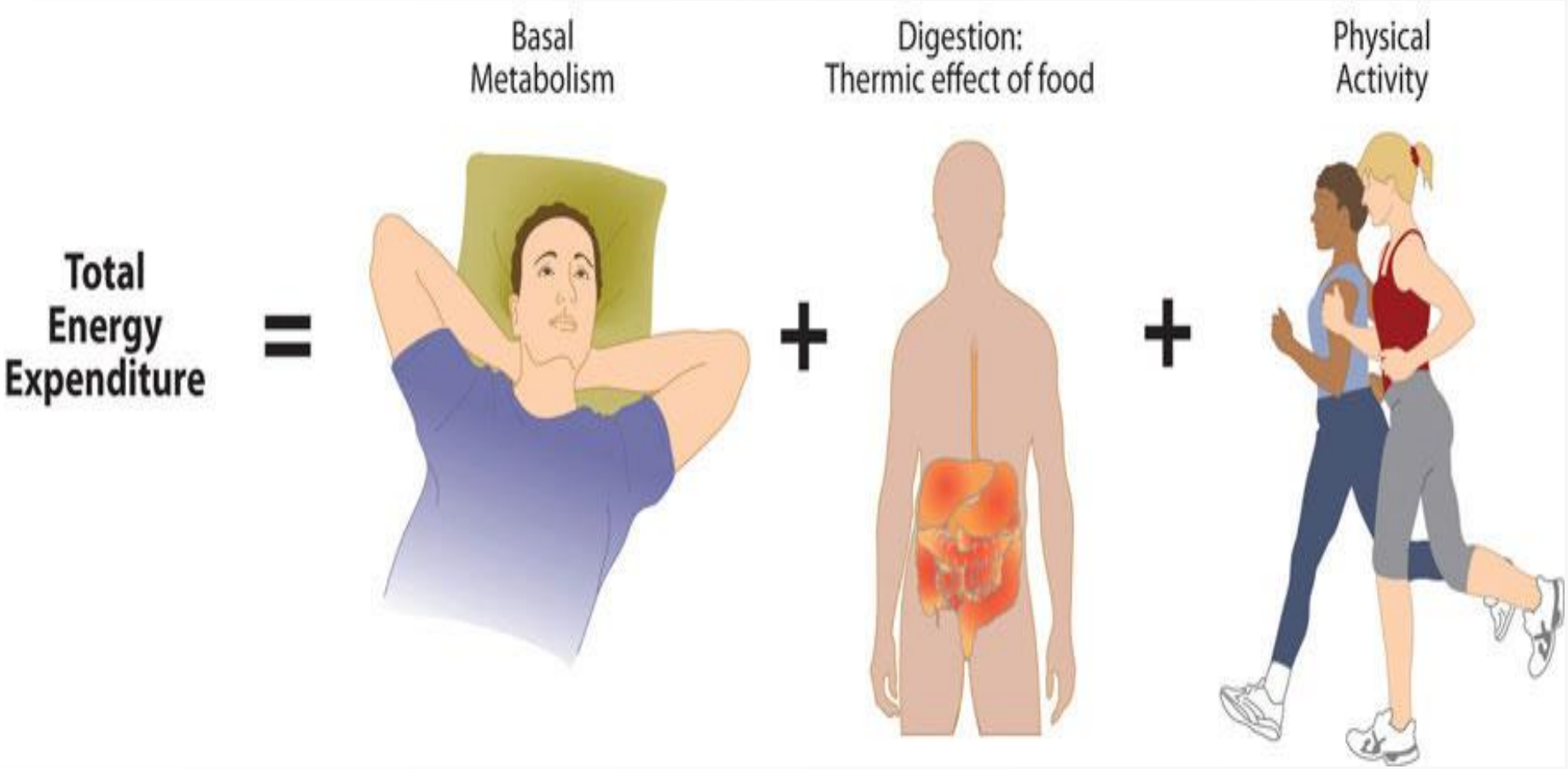
2-Physical activity.

3-Specific dynamic action of food (S.D.A.)= thermic effect of food (TEF)

4-Other factors like growth, pregnancy, lactation &temperature regulation

Energy requirement =BMR+ physical activity +TEF

Total energy requirement (TER):



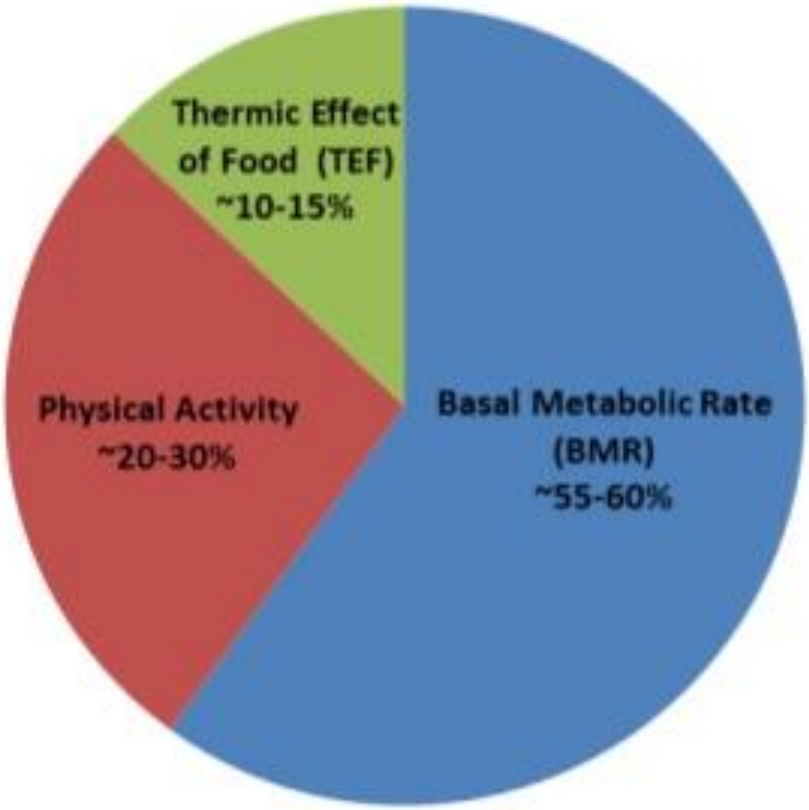
COMPONENTS OF ENERGY EXPENDITURE

Basal Metabolic Rate
BMR

Physical Activity PA

Specific Dynamic Action of Food
SDA

Growth



Basal metabolic rate(BMR)

- Which is the **minimum amount of energy needed by the body at rest in fasting state (post absorptive state) to sustain life processes.**
- Basal energy expenditure is measured as BMR by **direct & indirect calorimeter**.

Conditions to measure BMR:

The person should be;

- At complete physical & mental rest.
- Relaxed but not sleep.
- At least 12 h. after last meal.
- Several hours after strenuous exercise or activity.
- In a comfortable temp. & environment.

Factors Affecting BMR:

- **A-Primary Factors:**

1-Surface area: BMR more in taller person (more surface area).

2-Gender: BMR lower in female 5-10% than male of the same wt. &Ht. (smaller body size and more body fat).

3-Age: BMR higher in children < 2y than elderly people (more energy required for rapid growth) , also higher at puberty than adolescence **(BMR decrease 2% for each decade of life due to fat accumulation).**

4-Endorine secretion:

a- Thyroid gland hormones;

- In **hypothyroidism** BMR decr. by 30-50%.
- In **hyperthyroidism** BMR incr. by 50-75%.

b- Growth Hormon leads to incr. BMR

c- Sympathetic stimulation (stress, strain &emotion) incr. BMR.

d- Sex Hormon: fluctuation of BMR during the menstrual cycle;

-At a mid cycle → decr. BMR & incr. 7.7% in post ovulation.

5-Body composition: more in muscular tissues.

6-Pregnency: **20% incr**. BMR in the 3rd trimester

B- Secondary factors:

1- Nutritional Status:

In severe malnutrition & prolong starvation lead to 50% decrease in BMR (as adaptive mechanism).

2- Sleep ⟶ 10% decrease in BMR.

3-Fever ⟶ increase in BMR by 13% for each 1C above 37C

4-Muscle tone: in athletes (incr. muscle tone) ⟶ increase BMR (due to more O2 consumption during muscle contraction).

B- Secondary factors:

5-Climate:

* A low climate temp.increases heat loss and lead to increase in BMR 5% /10 C decrease. (more in Eskimo).

* An increase in climate temp lead to decrease in BMR (as in Africa), but the *basal energy expenditure* will increase due to stimulation of sweating.

6-Caffeine:

increase BMR.

To calculate the energy requirement:

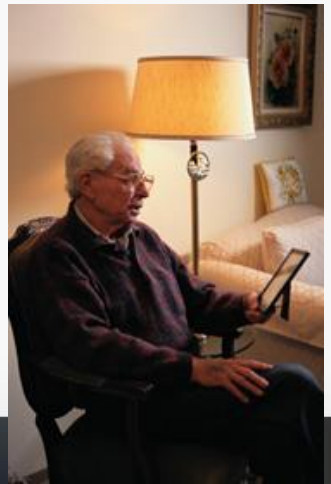
1-BMR

- **BMR for male= I.B.W. (kg)×1Kcal/kg /hr × 24hr**

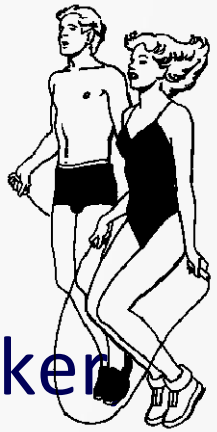
- **BMR for female= I.B.W. (kg)× 0.95 Kcal / kg/ hr × 24hr**
  I.B.W.= ideal body wt.

2-Physical Activity: to calculate physical activity either;

- **A-Physical activity=BMR × activity factor**
- **B-Rough classification of occupation =(activity);**
  (sedentary)- Light activity = 20-30% of BMR
  office worker, lawyer, doctor, teacher,
  shop worker.



- **Moderate activity= 40% of BMR** : industrial worker, farmer, student (studying:1- 2 kcal/min), solder (not in active service), housewife, carrying a load& cycling.



- **Heavy activity = 50% of BMR:** agriculture worker, unskilled laborer, mine worker, solder in active service, &walking with a load uphill.

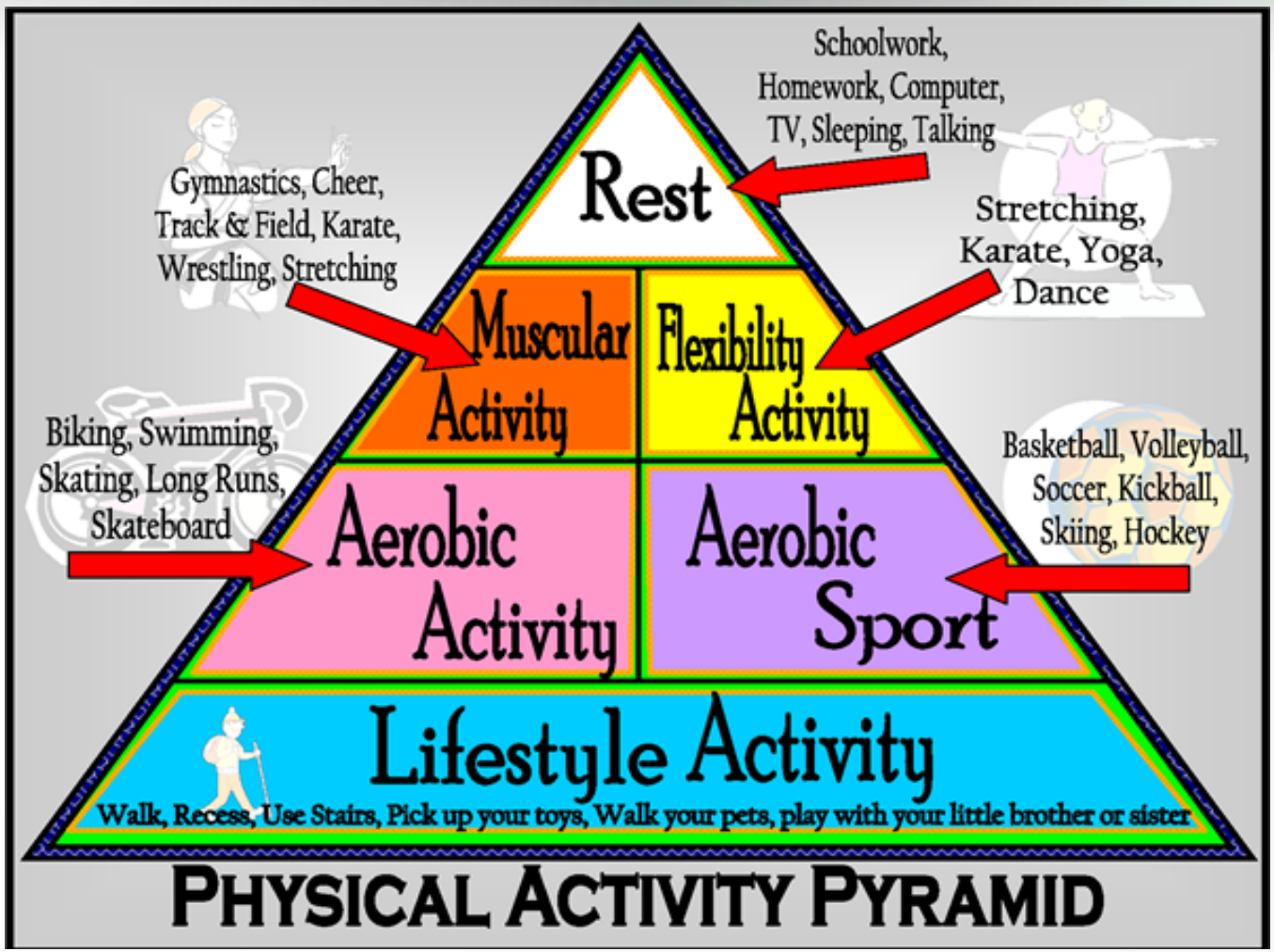
- Body composition influences BMR Weight training can help shift bodycomposition toward more lean tissue, thereby speeding up your metabolism.

- ***NOTE***: mental activity does not appreciably affect the energy requirement.

Level of activity	gender	Activity Factor
Light	Male	1.6
	Female	1.5
Moderate	Male	1.7
	Female	1.6
Very active	Male	≥2.1
	Female	≥1.9

The effect of exercise on metabolism:

- Exercise increases the metabolism
  - Immediate increase in metabolism during exercise and post-exercise.
  - Over time, there is also a permanent increase in BMR as **lean muscle** tissue increases.
- Most important factor affecting the metabolic rate is the **intensity** or **speed** of the exercise.
- With continuous physical activity – body begins to adapt the stress of exercise, and causes health benefits.


Schoolwork, Homework, Computer, TV, Sleeping, Talking
Rest
Gymnastics, Cheer, Track & Field, Karate, Wrestling, Stretching
Stretching, Karate, Yoga, Dance
Muscular Activity
Flexibility Activity
Biking, Swimming, Skating, Long Runs, Skateboard
Basketball, Volleyball, Soccer, Kickball, Skiing, Hockey
Aerobic Activity
Aerobic Sport
Lifestyle Activity
Walk, Recess, Use Stairs, Pick up your toys, Walk your pets, play with your little brother or sister
PHYSICAL ACTIVITY PYRAMID

3-Thermic Effect of Food (TEF): Specific Dynamic Action of food (SDA)= =diet induced thermo-genesis:

Which is the amount of energy it spends by the body to digest , absorb, & metabolize the food ,

Reaches its maximum level **3-5 hours after ingestion of food**.

This effect is not equal for all type of food;

- TEF of protein= **25-30%** of BMR
- TEF of CHO = **6%** of BMR
- TEF of fat = **4%** of BMR
- TEF for **mixed diet= 6-10 % of BMR**

Diet-Induced Thermogenesis:

- There is a significant elevation of the metabolism that occurs after ingestion of a meal, energy needed to absorb, transport, store and metabolize the food consumed.

— Highest elevation noticed 1-hr after a meal and lasts for about 4 hours.

- The greater the caloric content of the meal, the greater the effect on the metabolism.
- Protein and carbohydrates significantly increase thermogenesis; fat does not.

- **E.g. Calculate the total energy requirement (TER) of a 4th year medical male student whose ideal body wt. is 60 kg? and calculate his daily need of CHO, protein & fat in gram.** **10% of BMR for sleep**

(moderately active male 40% OF BMR)

- **BMR** =60kg ×1Kcal/kg/ hr ×24hr =1440 Kcal/day
- 10% of BMR for sleep= 0.1 × 1440=144 Kcal
- 1440 – 144 = 1296 Kcal/day
- **Physical activity** = 1440 Kcal/day ×40 % = 576Kcal/day
- **TEF** = 6% × 1440 Kcal/day = 86 Kcal/day
- **TER= 1296+ 576+86=1958 Kcal/day**

- **50-60 % CHO**
- **50% CHO = 50/100×1958= 979 Kcal**

- **1gram CHO= 4 Kcal**
- **, he needs 979/4**
- **= 245 gram CHO**

- **Protein 15 - 20%**
- **If he is older or with any health problem, protein need ,calculated in moderation**
- 15/100 **×1958 =294 Kcal**
- **1 gm of protein = 4 , 294 /4**
- **=74 gm of protein .**

- 25-30%fat
- 25%fat= 25/100×1958= 489 Kcal
- 1g fat=9 Kcal
- , he needs 489/9
- = 54 gm fat/day

- We can divide the need of fat according to its types ,only **10% saturated fat.**
- Fat should supply not more than **25- 30%** of the total calories of a healthy person on well balanced diet.
  - The majority of these calories, should consist of (unsaturated fat) rather saturated fat or Trans- fat.

4-Other factors; Like growth, pregnancy & lactation:

- **Growth:** additional energy is required to cover the cost of increasing B.wt.& Ht., a growing infant may store **12-15%** of energy expenditure for growth & formation of new tissues.
- When the child gets **older** , his rate of growth is **diminish** &the caloric requirement for growth is reduced but the TER is increased because of increased ***body* size**.

Age		Energy (Kcal/kg)	
0-0.5m		108	
0.6-1y		98	
1-3y		102	
4-6y		90	
7-10y		70	
11-14y	(male)	55	(female) 47
15-18y	(male)	45	(female) 40

Pregnancy &Lactation:

During pregnancy women need extra kcal

- To build up their own tissues,
- To build fat stores for making breast milk
- To build the baby tissues and the placenta..

Pregnancy &Lactation:

- Additional calories are required to meet the energy cost of pregnancy &lactation will added to the TER of normal women.

- In pregnancy **300 Kcal/day** (esp. in 2nd & 3rd trimester) In lactation **500 Kcal/day** will be added.

E.g. Calculate the TER of 60 kg housewife woman?

(moderately active female 40% OF BMR)

- BMR=60kg×0.95Kcal/kg/hr×24hr=1368Kcal /day
- 10% × 1368 = 136Kcal /day (1368-136)
- =1232 Kcal /day
- Phys. Act.=1368 Kcal/day×40%=547 Kcal/day
- TEF = 6% × 1368 Kcal/day = 82 Kcal/day
- TER = 1232+547+82 = 1861 Kcal /day
- If she is **pregnant** add **300** Kcal/day
- If she is **lactating** add **500** Kcal/day

energy requirement in overweight

- The one commonly used technique is to use an {adjusted weight}, which is the ideal weight plus [25%] of the difference between the observed and ideal weight.

ideal weight+0.25× [observe wt-ideal wt]

- **Example:** 46 years old lady, with IHD, her weight now is 85kg, her ideal weight should be 68 kg, with light physical activity, calculate herTER?

Adjusted weight=ideal weight+0.25× [observe wt-ideal wt]

Adjusted weight=68+0.25× [85-68] =72kg

- **BMR =0.95×72×24=1641 Kcal**
- **For sleep 10% of BMR = 10/100×1641=164.16 Kcal**

TEF=6% OF BMR= 6/100×1641=98 Kcal

Physical activity is light 30% of BMR

=0.3×1641=492

TER= [BMR-10%for sleep] +TEF+ physical activity

TER= [1641-164] +98+492=2067 Kcal