Q. Pacemaker Reaction of Glycolysis -

Fructose-6-phosphate
↓ Phosphofructokinase
Fructose-1,6-Bisphosphate

This Fructose-1,6-Bisphosphate is only ~~necessary~~ necessary for Glycolysis. phosphofructokinase decides the fate of Glucose and conducts Glycolysis.

ATP count → The total no. of ATP produced in glycosis is 4 from one glucose molecule. 2 molecules of ATP are utilised in the first half of glycolysis.

So, there is a net gain of 2 ATP molecules in Glycolysis.

Q. Cyclic vs Non-cyclic photophosphorylation.

Cyclic	Non-cyclic
(1) Photosystem-I is involved in the cyclic photophosphorylation process.	(1) Both photosystems I and II are involved in the non-cyclic photophosphorylation process.
(2) Electrons tend to pass in a cyclic manner.	(2) Electrons tend to pass in a non-cyclic manner.
(3) ATP molecules get generated in this process.	(3) Both ATP and NADPH molecules get formed.
(4) P700 is known to be the active reaction centre.	(4) P680 is known to be the active reaction centre.
(5) This process is ideal only in the case of bacteria.	(5) This process is ideal amongst all the green plants.

Q. Dihybrid cross Ratio.

Phenotypic ratio : 9:3:3:1
Genotypic ratio : 1:2:1:2:4:2:1:2:1

Q. How does the ratio 9:3:3:1 changes in case of Dominant & Recessive epistasis.

→ For Dominant epistasis the ratio 9:3:3:1 becomes 12:3:1
For Recessive " " " " " 9:3:4

[For Duplicate Dominant → 15:1
For Duplicate Recessive → 9:7]

Glycolysis can be thought of as comprising two stages :

Stage I : This is the trapping and preparation phase. No ATP is generated in this stage rather two units of ATP used up in this stage. The strategy of these initial steps in glycolysis is to trap the glucose in the cell and form a compound that can be readily cleaved into two phosphorylated three-carbon units glyceraldehyde 3-phosphate.

Stage II : This is a series of steps that harvest some of the energy contained in glyceraldehyde 3-phosphate as ATP. In this stage two molecules of glyceraldehyde 3-phosphate converted to two molecules of pyruvate with four molecules of ATP are formed.

molecules of ATP are made per molecule of NADH oxidized in the mitochondrial

Therefore, under aerobic cellular respiration, from glucose to carbon di oxide and water, ATP will be formed as follows :

	ATP	NADH	$FADH_2$	Total ATP
In glycolysis	2	2 (6 ATP in ETC)		8
In link reaction		2 (6 ATP in ETC)		6
In citric acid cycle	2	6 (18 ATP in ETC)	2 (4 ATP in ETC)	24
				38

5.11 Fermentation

(without fermentation, the electron carrier would be full of electrons, the entire process would back up and no ATP will be produced.)

Fermentation is an anaerobic biological process by which cells extract energy from glucose. The pool of NADH and NAD^+ is very small in the cytoplasm. Hence, NADH formed during glycolysis needs to be recycled so that NAD^+ is available for glycolysis. Fermentation takes place to regenerate NAD^+ by passing the electrons of NADH off to other molecules. If the condition is anaerobic, pyruvic acid must be converted to a reduced product so that NADH produced in glycolysis is reoxidized. This can take place by two methods:

8. Different high energy molecules formed during Glycolysis, Intermediate & Krebs cycle. Their count

Anaerobic

	Glycolysis	Intermediate	Krebs	Fermentation	ATP count
ATP	2	×	×	×	= 2
GTP	×	×	×	×	
NADH	2	×	×	−2	= (3×2)−(3×2)
$FADH_2$	×	×	×	×	

∴ Total ATP = 2 + 6 − 6 = 2

Aerobic

	Glycolysis	Intermediate	Krebs	Fermentation	ATP count
ATP	4−2=2	×	×	×	= 2
GTP	×	×	2	×	= 2
NADH	2	2	6	×	= 10×3=30
$NADH_2$	×	×	2	×	= 2×2=4

∴ Total ATP = 2+2+30+4 = 38.

Q.

Aerobic Respiration	Anaerobic Respiration
① Takes place in the presence of oxygen.	① Takes places in absence of oxygen.
② It occurs within the mitochondria of a cell.	② It occurs within the cytoplasm of a cell.
③ For each molecule of glucose, 38 molecules of ATP are generated.	③ For each molecule of glucose, only 2 molecules of ATP are generated

Q. Photosystems

→ i) Photosystem-I (uses light energy to convert $NADP^+$ to $NADPH_2$)

→ ii) Photosystem-II (These are protein complexes absorbing light energy)

Phases of Growth

Consider a population of organisms introduced into a fresh, nutrient-rich medium, a mixture of substances or in which microorganisms grow. Such organisms display four major phases of growth (Figure 1).

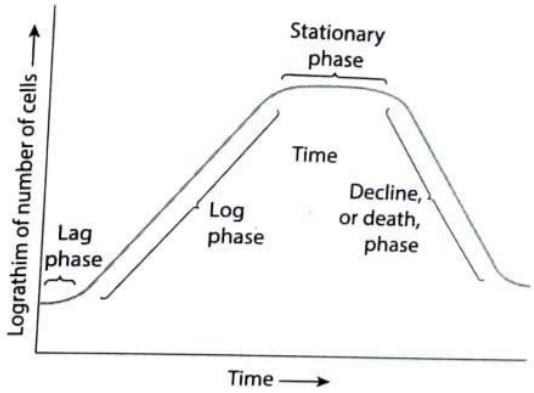


Figure 1 A standard bacterial growth curve.

1. **Lag phase:** In the lag phase, the organisms do not increase significantly in number, but they are metabolically active—growing in size, synthesizing enzymes, and incorporating various molecules from the medium.
2. **Log phase:** Once organisms have adapted to a medium, population growth occurs at an exponential, or logarithmic (log), rate. When the scale of the vertical axis is logarithmic, growth in this log phase appears on a graph as a straight diagonal line, which represents the size of the bacterial population. During the log phase, the organisms divide at their most rapid rate—a regular, genetically determined interval called the generation time. The population of organisms doubles in each generation time.
3. **Stationary phase:** When cell division decreases to the point that new cells are produced at the same rate as old cells die, the number of live cells stay constant. The culture is then in the stationary phase, represented by a horizontal straight line.
4. **Decline (Death) phase:** As conditions in the medium become less and less supportive of cell division, many cells lose their ability to divide, and thus the cells die. In this decline phase, or death phase, the number of live cells decreases at a logarithmic rate, as indicated by the straight, downward-sloping diagonal line.

division into two daughter cells takes place. All these processes, that is cell division, DNA replication and cell growth, are tightly regulated and under genetic control.

Phases of Cell Cycle

The cell cycle can be divided into two major phases based on cellular activities that are readily visible with a light microscope:

Interphase

The interphase or the resting phase is the part of the cell cycle during which a cell grows, replicates cell organelles and DNA, assembles the "machinery" of mitosis and condenses its DNA. It is the period between two cell divisions.

The interphase is divided into the following three phases (Figure 5):

1. **Gap 1 (G_1) phase:** G_1 represents the time gap between the last cell division and the start of DNA replication. It is also known as first growth phase, post-mitotic phase and pre-synthetic phase. It may last from few minutes to several days depending on the frequency of division of the cell. It is also characterized by formation of biochemical and cellular organelles like mitochondria, Golgi complex, ribosomes, etc.
2. **Synthesis (S) phase:** During the S stage of interphase, the DNA of the cell is replicated in the nucleus in preparation for cell division and its amount doubles. The chromosome number, however, remains the same. The centriole present in the cytoplasm also duplicates. It is also known as invisible stage of M-phase, as replication of chromosome occurs in this phase.
3. **Gap 2 (G_2) phase:** G_2 represents the time gap between the end of DNA replication and the beginning of cell division. It is also known as second growth phase, pre-mitotic phase and post-synthetic phase. During the G_2 stage of interphase, the supercoils of DNA condense into tightly compacted bodies that become visible as chromosomes during mitosis. Protein synthesis also takes place in the G_2 phase which is required for preparation of mitosis. It is also accompanied by cell growth.

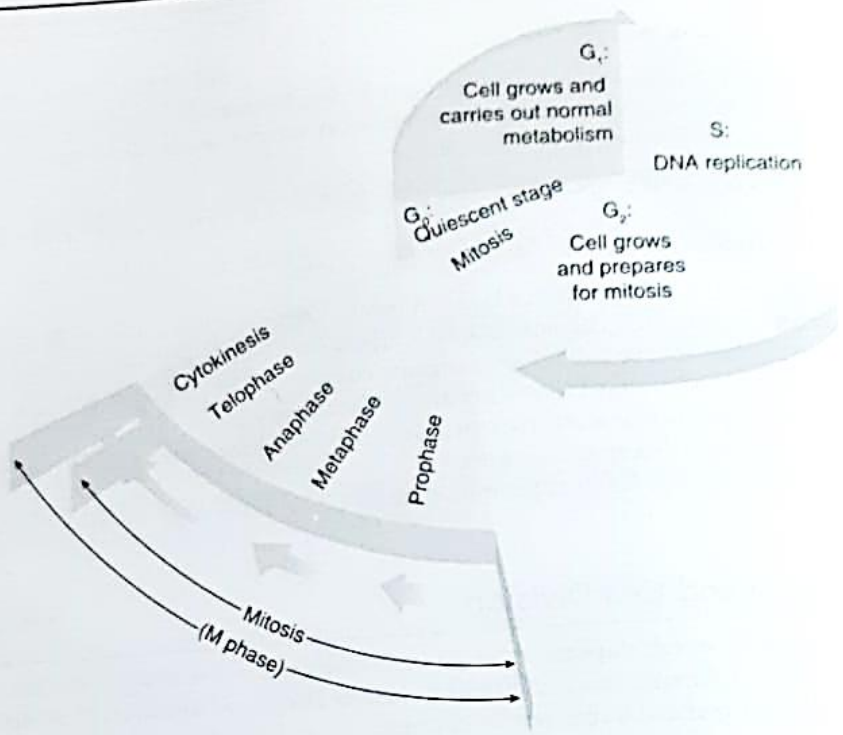


Figure 5 Cell cycle.

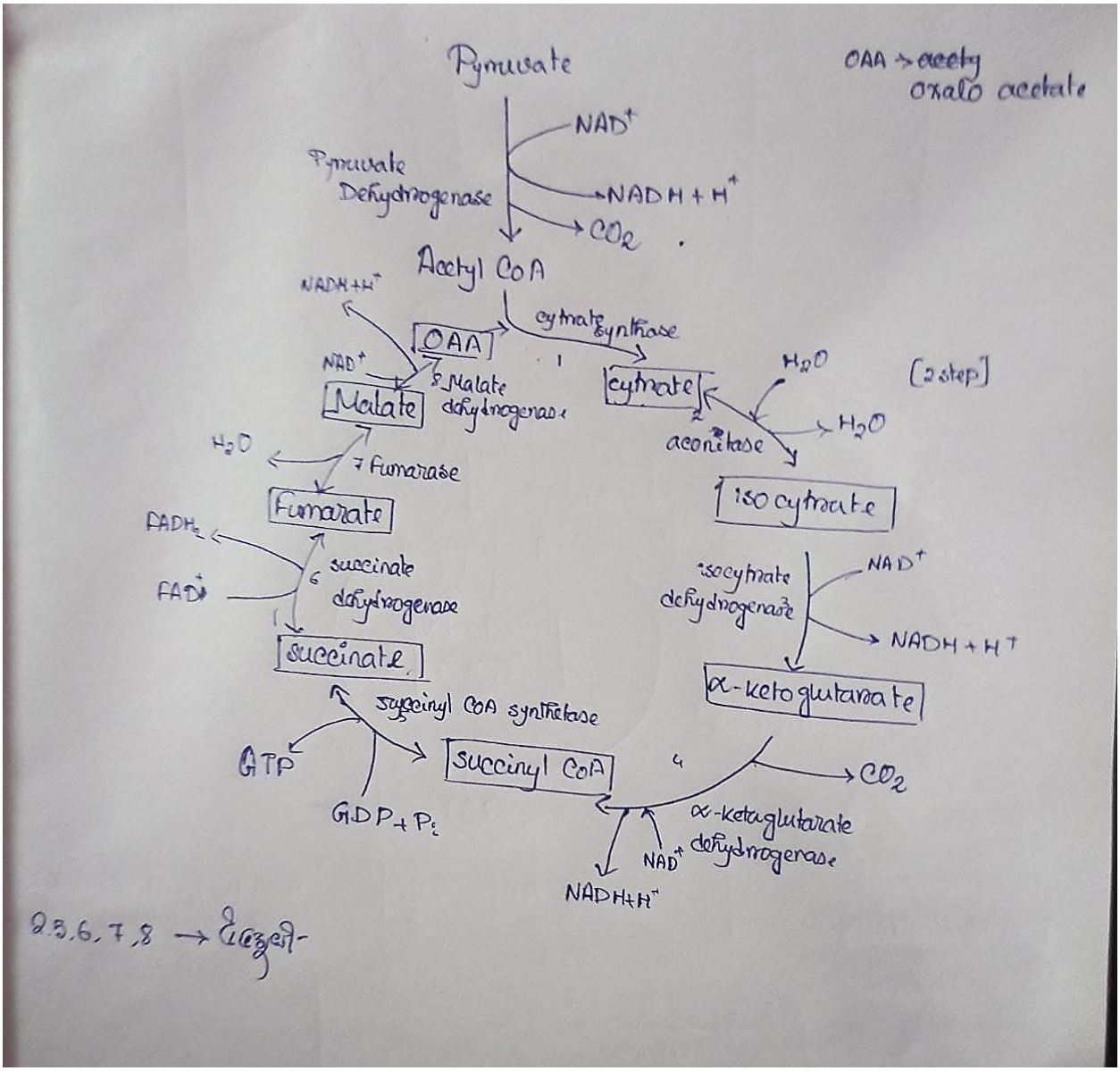
Mitosis (M) Phase

In M phase, the duplicated chromosomes are separated into two nuclei (*karyokinesis*, term coined by Schneider in 1887) and this is followed by cytokinesis (term coined by Whiteman in 1887) during which the entire cell divides into two daughter cells. These are diploid and contain identical sets of chromosomes and exactly the same information as parent cell. The cells at completion of mitosis can enter the G_1 phase of next cycle or are arrested at this stage (G_0).

G_0 Phase

The cells that have stopped dividing, whether temporarily or permanently, are said to be in the G_0 or quiescent stage to distinguish them from the typical G_1 phase cells that may soon enter S phase. The cells in G_0 stage are metabolically active, but they must receive a growth-promoting signal to proceed from G_0 into G_1 phase and thus re-enter the cell cycle.

Some cells, such as nerve cells, muscle cells, or red blood cells that are highly specialized lack the ability to divide. Cells that normally do not divide (such as liver cells) can be induced to begin DNA synthesis and divide when given appropriate stimulus. Some cells, such as stem cells in adult tissues have high level of mitotic activity.



Mendel's law of dominance states that:

"When parents with pure, contrasting traits are crossed together, only one form of trait appears in the next generation. The hybrid offsprings will exhibit only the dominant trait in the phenotype."

Law of Segregation

"During the formation of gamete, each gene separates from each other so that each gamete carries only one allele for each gene."

Law of Independent Assortment

"The law of independent assortment states that the alleles of different genes are inherited independently within the organisms that reproduce sexually."

9.1.3 Mendel Experiments :

Mendel chose the garden pea, Pisum sativum, for his experiments since it had the following advantages

- Well-defined discrete characters
- Bisexual flowers
- Predominant self fertilization
- Easy hybridization
- Easy to cultivate and relatively short life cycle

The characteristics of an organism are described as characters (or traits). Mendel studied several of these characters of *Pisum sativum* (all have two variants) these are

		Dominant	Recessive
1	Stem Length	Tall	Dwarf
2	Flower Position	Axial	Terminal
3	Flower Color	Violet	White
	Seed Coat Color	Grey	White
4	Pod Shaped	Inflated	Constricted
5	Pod Color	Green	Yellow
6	Cotyledon Colour	Yellow	Green
7	Seed Form	Round	Wrinkled

Test Cross :

A test cross is a cross to a homozygous recessive genotype.
It may be used to establish the genotype of an individual with the dominant phenotype.
e.g., Genotype could be AA or Aa so crossing with aa will give us different results.

AA × aa = All Aa (All one phenotype)

Aa × aa = 1 Aa : 1 aa (half one phenotype, half other)

The appearance of the recessive phenotype in the offspring of a test cross indicates that the unknown genotype was heterozygous. A test cross can also occur with 2 or more genes involved.

Back Cross :

A cross of a first filial generation (F1) to one of its parents or a cross of an F1 to an individual with an identical genotype to the parent

9.3 Gene interaction

Gene interaction is the influence of alleles and non-alleles on the normal phenotypic expression of genes.

It is two types

A. Intragenic Interaction

These interactions occur between the two alleles of same gene to produce a phenotype different from the normal dominant - recessive phenotype.

The common intragenic interactions are incomplete dominance, codominance, multiple alleles.

(i) Incomplete dominance : Sometimes two genes of allelomorphic pair do not show dominant—recessive relationship, but when present simultaneously (or come together), they show intermediate condition or blend together, which is called blending inheritance or incomplete dominance.

Incomplete inheritance is found in both plants and animals. Good examples are seen in *Mirabilis jalapa*, the plant. *Antirrhinum majus*, the snapdragon and Andalusian fowl.

(ii) Codominance: The alleles which do not show dominance—recessive relationship and are able to express themselves independently when present together are called codominant alleles. Independent expression of two alleles in an individual is termed codominance. Multiple alleles are example of codominance.

3. **Epistasis (Inhibiting genes):** Epistasis is the interaction between non-allelic genes (present on separate loci) in which one-gene masks, inhibits or suppresses the expression of other gene. The gene that suppresses the other gene is known as inhibiting or epistatic factor and the one, which is prevented from exhibiting itself, is known as hypostatic. Although, it is similar to dominance and recessiveness, but the two factors occupy two different loci. Epistasis can be of the following types:
   (a) Dominant epistasis (12:3:1 or 13:3 ratio): In dominant epistasis out of two pairs of genes the dominant allele, (i.e., gene A) of one gene masks the activity of other allelic pair (Bb). Dominant epistasis in dogs.
   (b) Recessive epistasis (9:3:4 ratio): Epistasis due to recessive gene is known as recessive epistasis, that is, out of the two pairs of genes, the recessive epistatic gene masks the activity of the dominant gene of the other gene locus, for example, in mice agouti colour.
4. **Duplicate genes (15:1 ratio):** Sometimes two pairs of genes located on different chromosomes determine the same phenotype. These genes are said to be duplicate of each other. For example, in shepherd's purse (*Bursa bursapastoris*), the seed capsules have two shapes—triangular and oval. If the genotype is *aabb*, that is, only recessive alleles in both genes are present, then oval seed capsules were formed. However, if the dominant allele of either gene is present, triangular seed capsules are formed.

5. **Pleiotropic effect of genes:** Certain genes are known to control the viability of the organism. These genes are known as lethals or semilethals depending upon their influence. Complete lethal genes in homozygous condition kill nearly all homozygous individuals, while in the case of semilethal genes some homozygous individuals are able to survive.

9.7 Genetic disorders

Genetic disorders are of two types:

1. Mendelian Disorder :

They are mainly due to mutation of single gene and these disorders are inherited to the offspring following the principle of inheritance.

Examples of Mendelian Disorder

Hemophilia	X linked recessive genes.	In hemophilia blood lacks the capacity to coagulate.
Red green color blindness	X linked genes	Lack to differentiate between red and green color
Sickle cell anemia	Autosomal recessive genes	The disease is caused by a single gene, which is lethal in homozygous condition but has a slight detectable effect in the heterozygous condition.
â-Thalassemia	Autosomal recessive genes	A blood disorder involving lower-than-normal amounts of hemoglobin.
Phenylketonuria	Autosomal recessive genes	Phenylketonuria (PKU) is an genetic error of metabolism that results in decreased metabolism of the amino acid phenylalanine.
Alkaptonuria	Autosomal recessive genes	Alkaptonuria is an autosomal recessive genetic disorder condition that causes urine to turn black when exposed to air.

2. Chromosomal disorder

It is two types:

I. Autosomal chromosomal disorders

Down syndrome	It is due to an abnormal cell division results in an extra full or partial copy of chromosome 21.	Down's syndrome causes a distinct facial appearance, intellectual disability and developmental delays. It may be associated with thyroid or heart disease.
Edward's syndrome	It is due to a third copy of all or part of chromosome 18.	Symptoms include low birth weight, small abnormally shaped head and birth defects in organs that are often life threatening.
Philadelphia 22	It is due to shortened chromosome 22	leukemia

9.1.2 Terms related to Mendel Work

Gene	A gene is defined as a unit of heredity that may influence the outcome of an organism's traits.
Mendelian Characters (or Traits)	Clear and discrete characteristics of an organisms are described as mendelian characters (or Traits)
Allelomorphs or Alleles	Allelomorphs or Alleles are a pair of genes that control the two alternatives of the same character and located at the same locus in the homologous chromosomes.
Gene locus	It is the region on chromosome representing a single gene. The alleles of a gene are present on the same gene locus on the chromosome.
Heterozygous	The organism in which both the genes of a character are unlike is said to be heterozygous or hybrid.
Homozygous	The organism in which both the genes of a character is said to be homozygous or genetically pure for that character.

Dominant and Recessive	A heterozygote possesses two contrasting genes or alleles but only one of the two is able to express itself, while the other remains hidden. The gene which gains expression in Fl hybrid is known as dominant gene while its allele is unable to express itself in presence of the dominant gene is recessive gene.
Phenotypes	Phenotype of an individual refers to the expressed or observable structural and fuctional traits produced by interaction of genes and environment.
Genotypes	It is the genetic constitution of an organism which determines the characters.