JHARKHAND
Rai University

Established by an Act of Govt. of Jharkhand
as per Section 2f of UGC Act,1956

A practical manual on

Fundamentals of Genetics

Credits: 3(2+1)

Subject code: 13A.151

Semester: II

Compiled by:
Shweta Singh
Assistant Professor,
Department of Agriculture,
Faculty of Science and Engineering,
Jharkhand Rai University, Namkom.

Laboratory Manual

Fundamentals of Genetics

Practical No. 1 Study of microscope.

Aim: To study parts and working of a typical compound microscope.

Apparatus and materials required:

A compound microscope

Principle:

It has a series of two lenses; (i) the objective lens close to the object to be observed and (ii) the ocular lens or eyepiece, through which the image is viewed by eye. Light from a light source (mirror or electric lamp) passes through a thin transparent object. The objective lens produces a magnified 'real image' first image) of the object. This image is again magnified by the ocular lens (eyepiece) to obtain a magnified 'virtual image' (final image), which can be seen by eye through the eyepiece. As light passes directly from the source to the eye through the two lenses, the field of vision is brightly illuminated. That is why; it is a bright-field microscope.

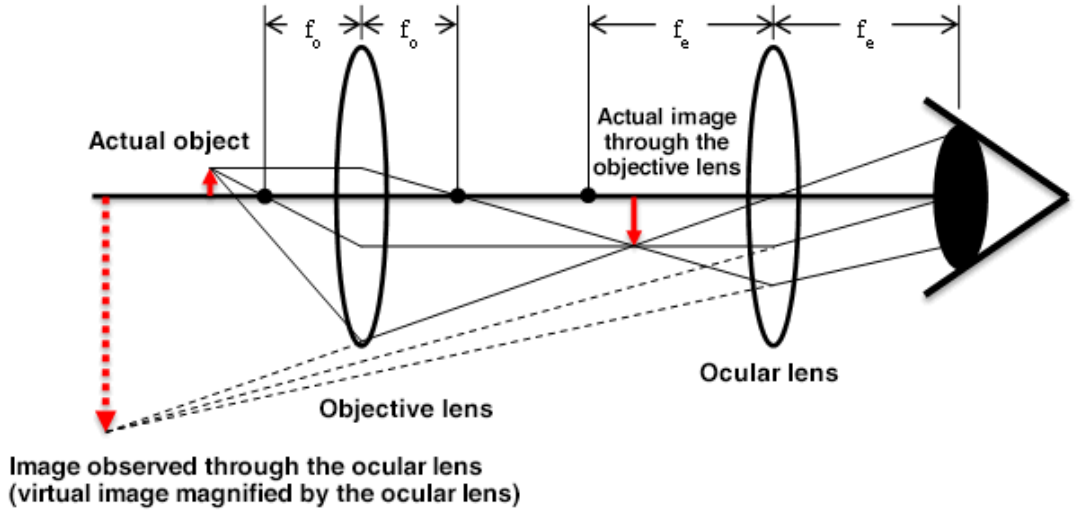


Figure: Ray diagram of a Compound Microscope

Parts of a Compound Microscope

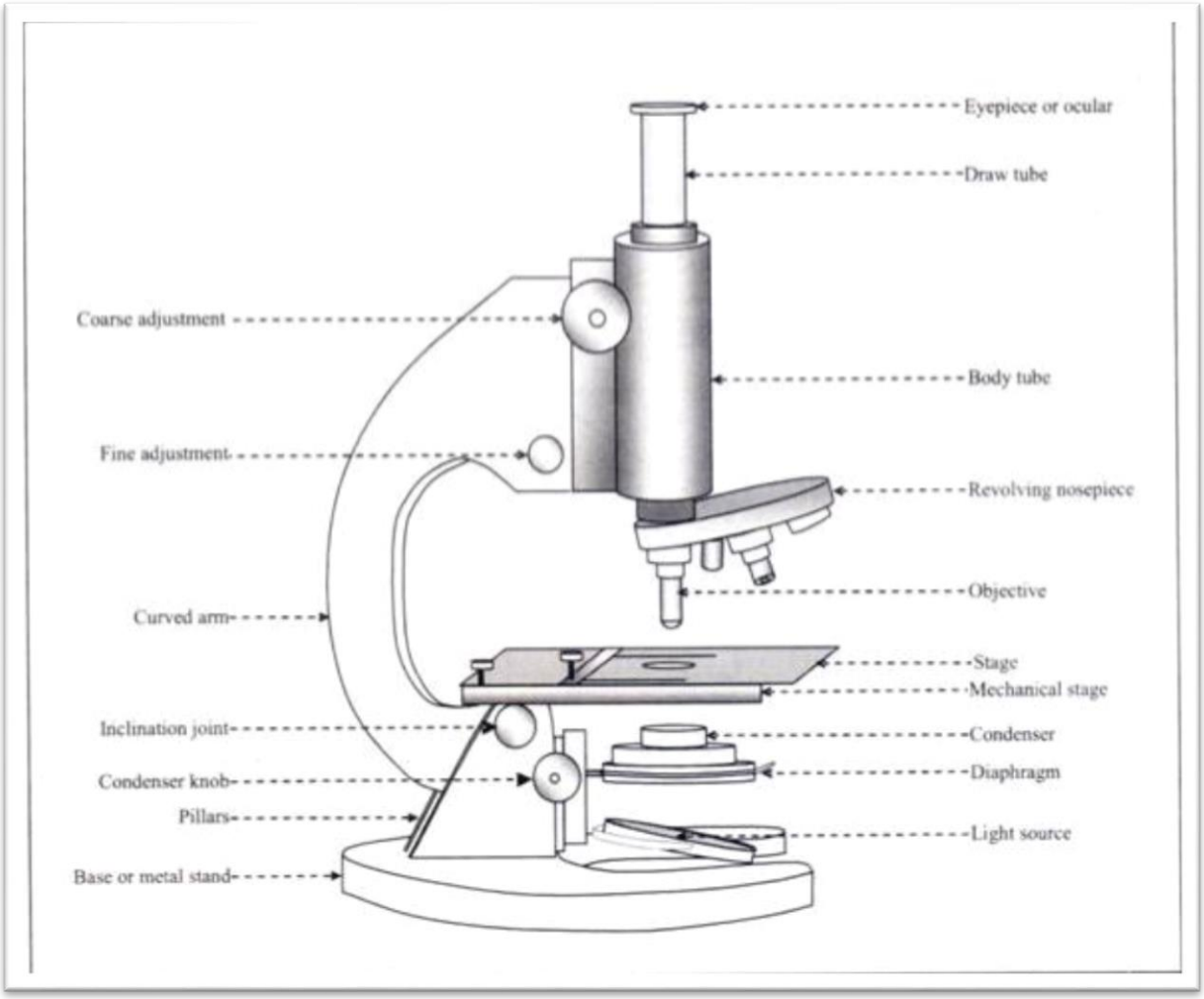


Figure: Parts of a compound microscope

Parts of compound microscope can be divided into two main categories:

A. Mechanical Parts

1. Base
2. Pillars
3. Inclination Joint
4. Curved arm
5. Body tube
6. Draw tube
7. Coarse adjustment
8. Fine adjustment
9. Stage
10. Mechanical stage

11. Revolving nosepiece

B. Optical Parts

1. Light Source
2. Diaphragm
3. Condenser or substage condenser
4. Objective
5. Eyepiece or ocular

A. Mechanical Parts

The components of mechanical parts are as follows:

1. Base or Metal Stand: The whole microscope rests on this base. Mirror, if present, is fitted to it.

2. Pillars: It is a pair of elevations on the base, by which the body of the microscope is held to the base

3. Inclination joint: It is a movable joint, through which the body of the microscope is held to the base by the pillars. The body can be bent at this joint into any inclined position, as desired by the observer, for easier observation. In new models, the body is permanently fixed to the base in an inclined position, thus needing no pillar or joint.

4. Curved Arm: It is a curved structure held by the pillars. It holds the stage, body tube, fine adjustment and coarse adjustment.

5. Body Tube: It is usually a vertical tube holding the eyepiece at the top and the revolving nosepiece with the objectives at the bottom. The length of the draw tube is called 'mechanical tube length' and is usually 140-180 mm (mostly 160 mm).

6. Draw Tube: It is the upper part of the body tube, slightly narrower, into which the eyepiece is slipped during observation.

7. Coarse Adjustment: It is a knob with rack and pinion mechanism to move the body tube up and down for focusing the object in the visible field. As rotation of the knob through a small angle moves the body tube through a long distance relative to the object, it can perform

coarse adjustment. In modern microscopes, it moves the stage up and down and the body tube is fixed to the arm.

8. Fine Adjustment: It is a relatively smaller knob. Its rotation through a large angle can move the body tube only through a small vertical distance. It is used for fine adjustment to get the final clear image. In modern microscopes, fine adjustment is done by moving the stage up and down by the fine adjustment.

9. Stage: It is a horizontal platform projecting from the curved arm. It has a hole at the center, upon which the object to be viewed is placed on a slide. Light from the light source below the stage passes through the object into the objective.

10. Mechanical Stage (Slide Mover): Mechanical stage consists of two knobs with rack and pinion mechanism. The slide containing the object is clipped to it and moved on the stage in two dimensions by rotating the knobs, so as to focus the required portion of the object.

11. Revolving Nosepiece: It is a rotatable disc at the bottom of the body tube with three or four objectives screwed to it. The objectives have different magnifying powers. Based on the required magnification, the nosepiece is rotated, so that only the objective specified for the required magnification remains in line with the light path.

B. Optical Parts:

These parts are involved in passing the light through the object and magnifying its size.

The components of optical parts include the following:

1. Light Source:

Modern microscopes have in-built electric light source in the base. The source is connected to the mains through a regulator, which controls the brightness of the field. But in old models, a mirror is used as the light source. It is fixed to the base by a binnacle, through which it can be rotated, so as to converge light on the object. The mirror is plane on one side and concave on the other.

It should be used in the following manner:

(a) Condenser Present:

Only plane side of the mirror should be used, as the condenser converges the light rays.

(b) Condenser Absent:

(i) Daylight:

Plane or concave (plane is easier)

(ii) Small artificial light:

High power objective: Plane side

Low power objective: Concave side

2. Diaphragm:

If light coming from the light source is brilliant and all the light is allowed to pass to the object through the condenser, the object gets brilliantly illuminated and cannot be visualized properly. Therefore, an iris diaphragm is fixed below the condenser to control the amount of light entering into the condenser.

3. Condenser:

The condenser or sub-stage condenser is located between the light source and the stage. It has a series of lenses to converge on the object, light rays coming from the light source. After passing through the object, the light rays enter into the objective.

The ‘light condensing’, ‘light converging’ or ‘light gathering’ capacity of a condenser is called ‘numerical aperture of the condenser’. Similarly, the ‘light gathering’ capacity of an objective is called ‘numerical aperture of the objective’. If the condenser converges light in a wide angle, its numerical aperture is greater and vice versa.

If the condenser has such numerical aperture that it sends light through the object with an angle sufficiently large to fill the aperture back lens of the objective, the objective shows its highest numerical aperture (Figure 4.7). Most common condensers have numerical aperture 1.25.

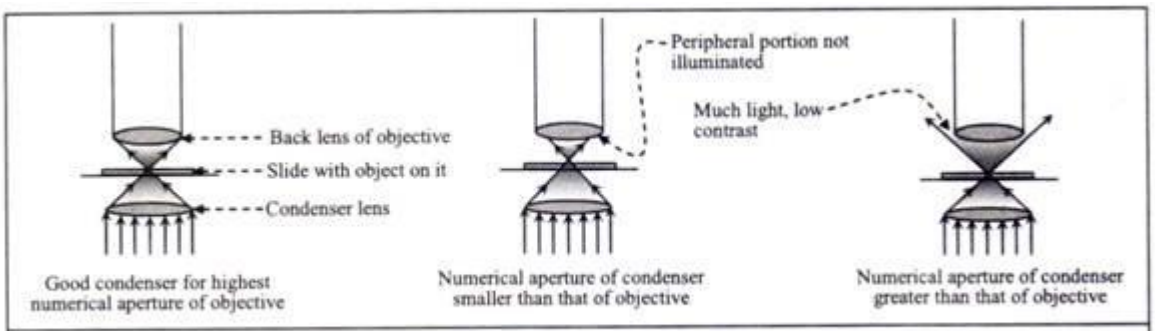


Figure 4.7: Numerical aperture of condensers

If the numerical aperture of the condenser is smaller than that of the objective, the peripheral portion of the back lens of the objective is not illuminated and the image has poor visibility. On the other hand, if the numerical aperture of condenser is greater than that of the objective, the back lens may receive too much light resulting in a decrease in contrast.

There are three types of condensers as follows:

(a) Abbe condenser (Numerical aperture=1.25): It is extensively used.

(b) Variable focus condenser (Numerical aperture =1.25)

(c) Achromatic condenser (Numerical aperture =1.40): It has been corrected for both spherical and chromatic aberration and is used in research microscopes and photomicrographs.

4. Objective:

It is the most important lens in a microscope. Usually three objectives with different magnifying powers are screwed to the revolving nosepiece.

The objectives are:

(a) Low power objective (X 10):

It produces ten times magnification of the object.

(b) High dry objective (X 40):

It gives a magnification of forty times.

(c) Oil-immersion objective (X100):

It gives a magnification of hundred times, when immersion oil fills the space between the object and the objective

The scanning objective (X4) is optional. The primary magnification (X4, X10, X40 or X100) provided by each objective is engraved on its barrel. The oil-immersion objective has a ring engraved on it towards the tip of the barrel.

Resolving Power of Objective:

It is the ability of the objective to resolve each point on the minute object into widely spaced points, so that the points in the image can be seen as distinct and separate from one another, so as to get a clear un-blurred image.

It may appear that very high magnification can be obtained by using more number of high power lenses. Though possible, the highly magnified image obtained in this way is a blurred, one. That means, each point in the object cannot be found as widely spaced distinct and separate point on the image.

Mere increase in size (greater magnification) without the ability to distinguish structural details (greater resolution) is of little value. Therefore, the basic limitation in light microscopes is one not of magnification, but of resolving power, the ability to distinguish two adjacent points as distinct and separate, i.e. to resolve small components in the object into finer details on the image.

Resolving power is a function of two factors as given below:

(a) Numerical aperture (n.a.)

(b) Wavelength of the light (λ)

(a) Numerical aperture:

Numerical aperture is a numerical value concerned with the diameter of the objective lens in relation to its focal length. Thus, it is related to the size of the lower aperture of the objective,

through which light enters into it. In a microscope, light is focused on the object as a narrow pencil of light, from where it enters into the objective as a diverging pencil (Figure 4.8).

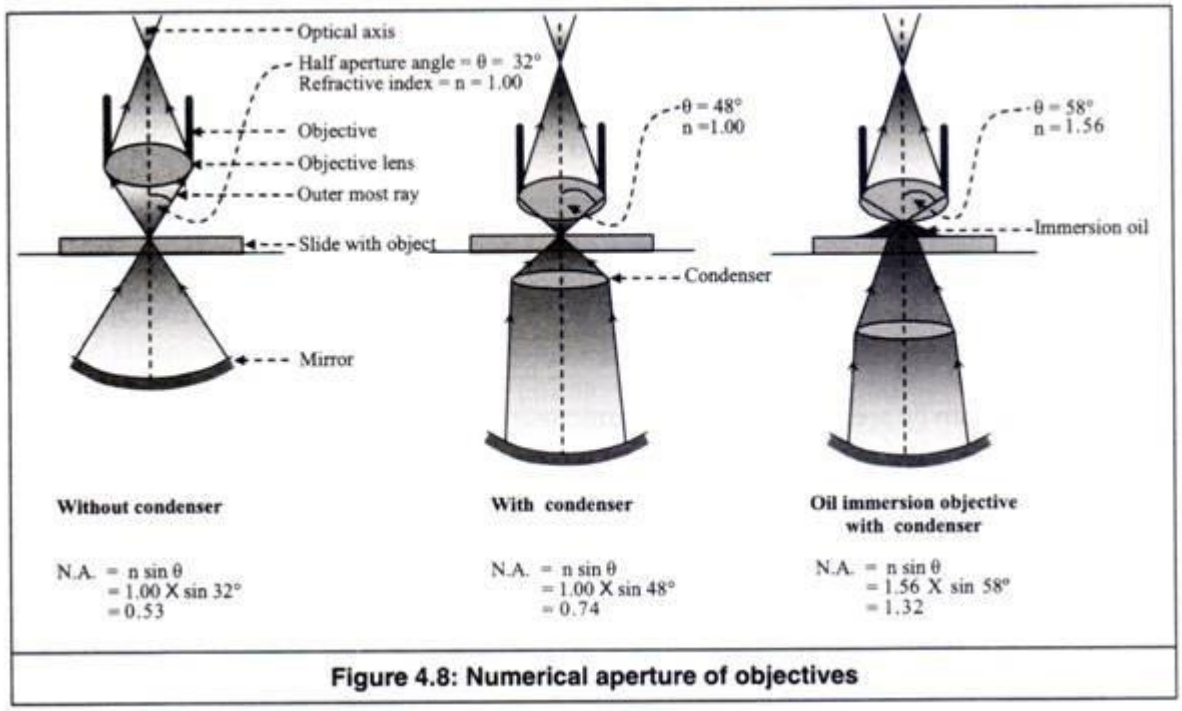


Figure 4.8: Numerical aperture of objectives

The angle 9 subtended by the optical axis (the line joining the centers of all the lenses) and the outermost ray still covered by the objective is a measure of the aperture called ‘half aperture angle’.

A wide pencil of light passing through the object ‘resolves’ the points in the object into widely spaced points on the lens, so that the lens can produce these points as distinct and separate on the image. Here, the lens gathers more light.

On the other hand, a narrow pencil of light cannot ‘resolve’ the points in the object into widely spaced points on the lens, so that the lens produces a blurred image. Here, the lens gathers less light. Thus, the greater is the width of the pencil of light entering into the objective (29), the higher is its ‘resolving power’.

The numerical aperture of an objective is its light gathering capacity, which depends on the site of the angle 8 and the refractive index of the medium existing between the object and the objective.

Numerical aperture (n.a.) = n sin θ

Where,

n = Refractive index of the medium between the object and the objective and

θ = Half aperture angle

For air, the value of 'n' is 1.00. When the space between the lower tip of the objective and the slide carrying the object is air, the rays emerging through the glass slide into this air are bent or refracted, so that some portion of it do not pass into the objective. Thus, loss of some light rays reduces numerical aperture and decreases the resolving power.

However, when this space is filled with an immersion oil, which has greater refractive index (n=1.56) than that of air (n=1.00), light rays are refracted or bent more towards the objective. Thus, more light rays enter into the objective and greater resolution is obtained. In oil immersion objective, which provides the highest magnification, the size of the aperture is very small.

Therefore, it needs bending of more rays into the aperture, so that the object can be distinctly resolved. That is why, immersion oils, such as cedar wood oil and liquid paraffin are used to fill the gap between the object and the objective, while using oil-immersion objective.

(b) Wavelength of light (λ):

The smaller is the wavelength of light (λ), the greater is its ability to resolve the points on the object into distinctly visible finer details in the image. Thus, the smaller is the wavelength of light, the greater is its resolving power.

Limit of resolution of objective (d):

The limit of resolution of an objective (d) is the distance between any two closest points on the microscopic object, which can be resolved into two separate and distinct points on the enlarged image.

Points with their in-between distance less than ‘d’ or objects smaller than ‘d’ cannot be resolved into separate points on the image. If the resolving power is high, points very close to each other can be seen as clear and distinct.

Thus, the limit of resolution (the distance between the two resolvable points) is smaller. Therefore, smaller objects or finer details can be seen, when’d’ is smaller. Smaller ‘d’ is obtained by increasing the resolving power, which in turn is obtained by using shorter wavelength of light (λ) and greater numerical aperture.

Limit of resolution = d = λ/2 n.a.

Where,

λ = Wave length of light and

n.a. = Numerical aperture of the objective.

If λ_{green} = 0.55 p and n.a. = 1.30, then d = λ/2 n.a. = 0.55/2 X 1.30 = 0.21 μ. Therefore, the smallest details that can be seen by a typical light microscope is having the dimension of approximately 0.2 μ. Smaller objects or finer details than this cannot be resolved in a compound microscope.

5. Eyepiece:

The eyepiece is a drum, which fits loosely into the draw tube. It magnifies the magnified real image formed by the objective to a still greatly magnified virtual image to be seen by the eye (Figure 4.9).

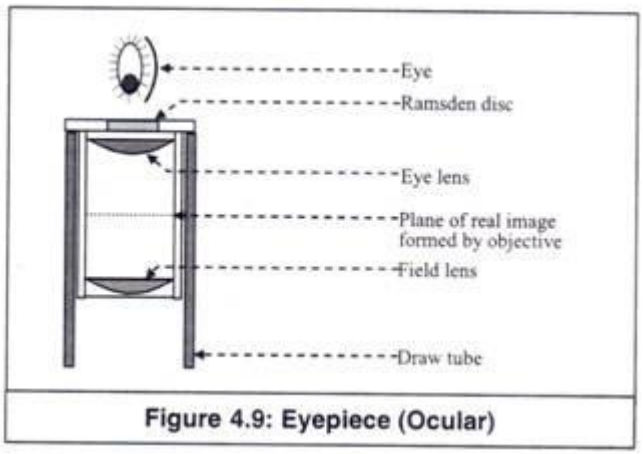


Figure 4.9: Eyepiece (Ocular)

Usually, each microscope is provided with two types of eyepieces with different magnifying powers (X10 and X25). Depending upon the required magnification, one of the two eyepieces is inserted into the draw tube before viewing. Three varieties of eyepieces are usually available.

They are the Huygenian, the hyper plane and the compensating. Among them, the Huygenian is very widely used and efficient for low magnification. In this eyepiece, two simple Plano-convex lenses are fixed, one above and the other below the image plane of the real image formed by the objective.

The convex surfaces of both the lenses face downward. The lens towards the objective is called ‘field lens’ and that towards eye, ‘eye lens’. The rays after passing through the eye lens come out through a small circular area known as Rams-den disc or eye point, where the image is viewed by the eye.

Total magnification:

The total magnification obtained in a compound microscope is the product of objective magnification and ocular magnification.

$M_t = M_{ob} \times M_{oc}$

Where,

M_t = Total magnification,

M_{ob} = Objective magnification and

M_{oc} = Ocular magnification

If the magnification obtained by the objective (M_{ob}) is 100 and that by the ocular (M_{oc}) is 10, then total magnification (M_t) = M_{ob} X M_{oc} =100 X 10 =1000. Thus, an object of lq will appear as 1000 µ.

Practical No. 2 Study of cell structure

Aim: To prepare a stained temporary mount of an onion peel and to record observations and draw labelled diagrams.

Apparatus and materials required:

An onion, glass slide, watch glass, coverslip, forceps, needles, brush, blade, filter paper, safranin, glycerine, dropper, water, and a compound microscope.

Principle: All living organisms are made up of cells. The shape, size and the number of these units vary in organisms. The three major components of a cell are the cell membrane, cytoplasm and nucleus. In a plant cell, a cell wall surrounds the cell membrane.

Procedure:

1. Take an onion and remove its outermost peel.

2. Now cut a small part from an inner scale leaf with the help of a blade.

3. Separate a thin, transparent peel from the convex surface of the scale leaf with the help of forceps.

4. Keep this peel in a watch glass/ glass slide containing water.

5. Add two drops of safranin stain in another watch glass/ glass slide to stain the peel (around 30 seconds).

6. Take a clean slide and put a drop of glycerine in the centre of the slide.

7. With the help of a brush and needle transfer the peel on the slide. Glycerine prevents the peel from drying up.

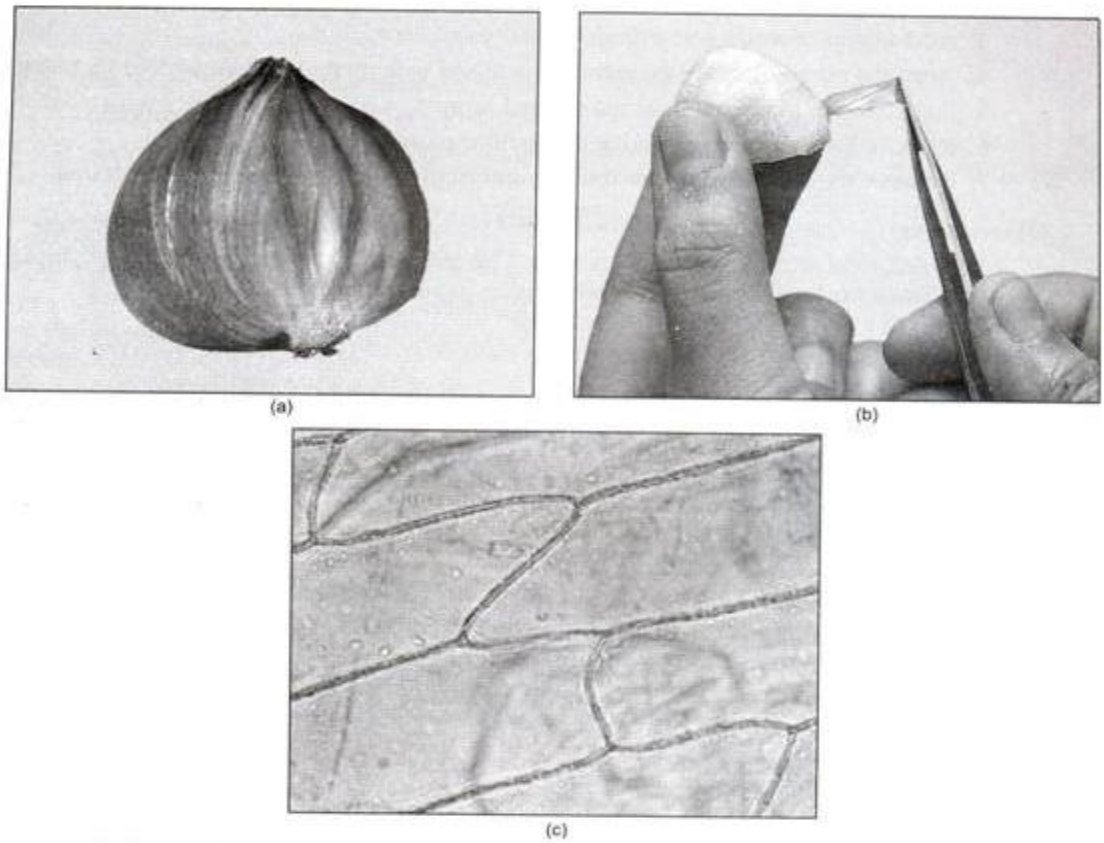
8. Carefully cover it with a coverslip and avoid any air bubble from entering interring the coverslip.

9. Remove any excessive glycerine with a filter paper.

10. Observe the prepared mount of the peel under the low and high magnification of a compound microscope.

Observations:

A large number of rectangular cells are visible. These cells lie close to each other with intercellular spaces between them. These cells are surrounded by distinct cell walls. These cells have a dark stained nucleus and a large vacuole in the centre.



(a)–(b) Methods of separating an onion peel (c) Structure of onion cells as seen under a microscope (450 ×)

Precautions:

1. Overstaining and under staining should be avoided.

Practical No. 3

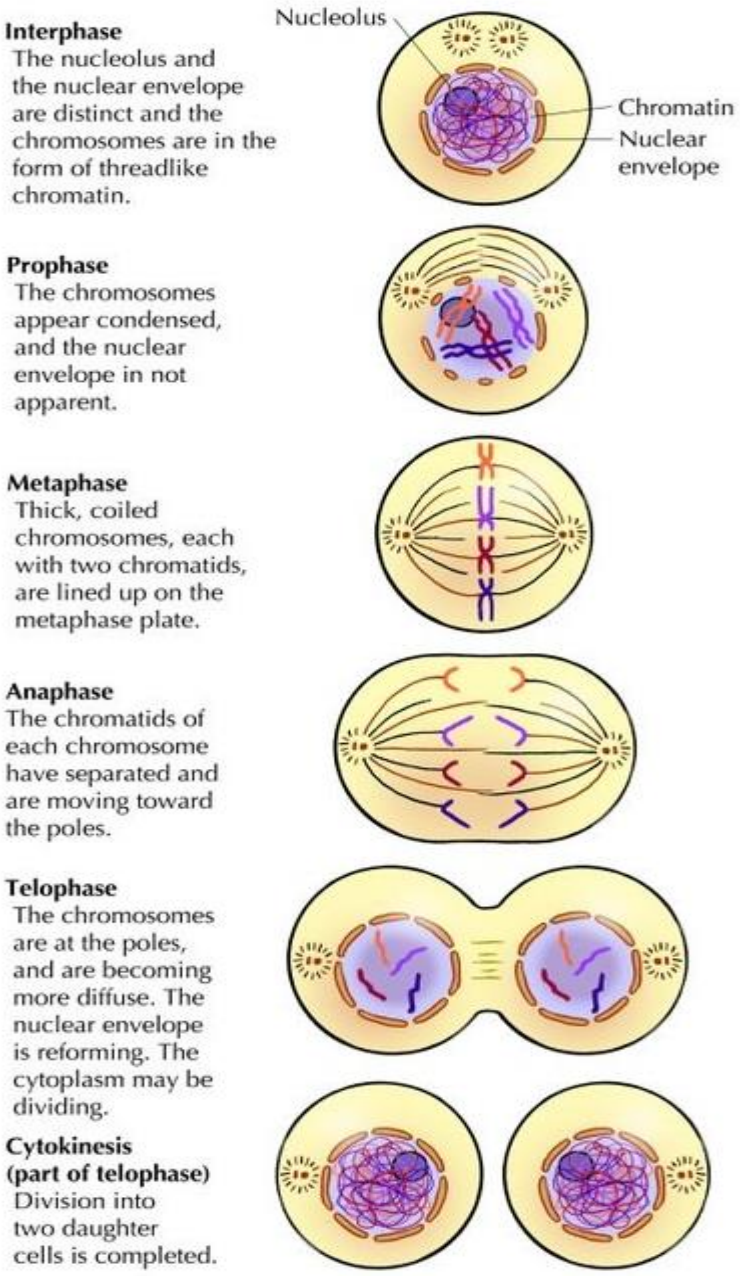
Aim: To study different types of Cell divisions (Mitosis and Meiosis).

Apparatus and materials required:

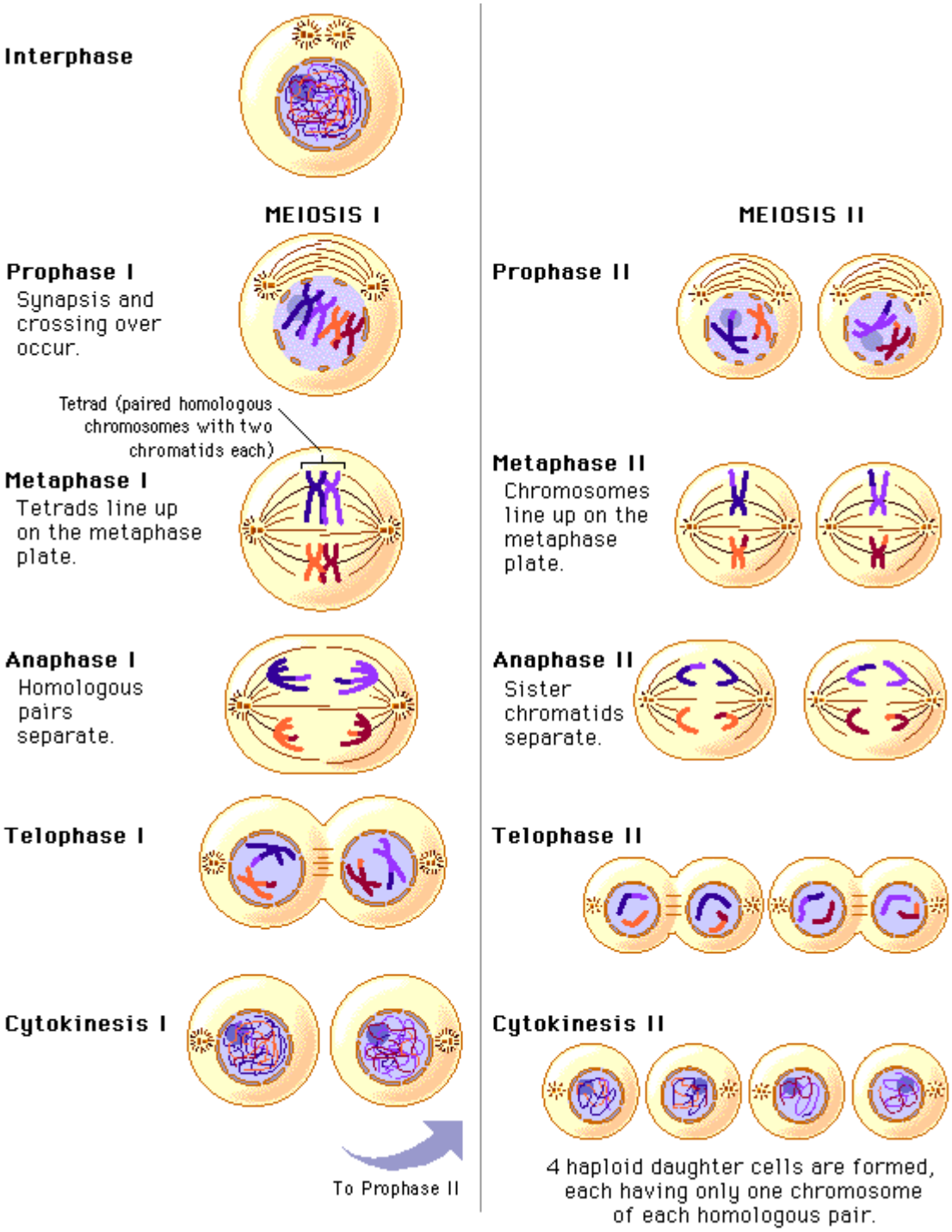
Permanent slides of Mitosis & meiosis and a compound microscope.

Cell Divisions

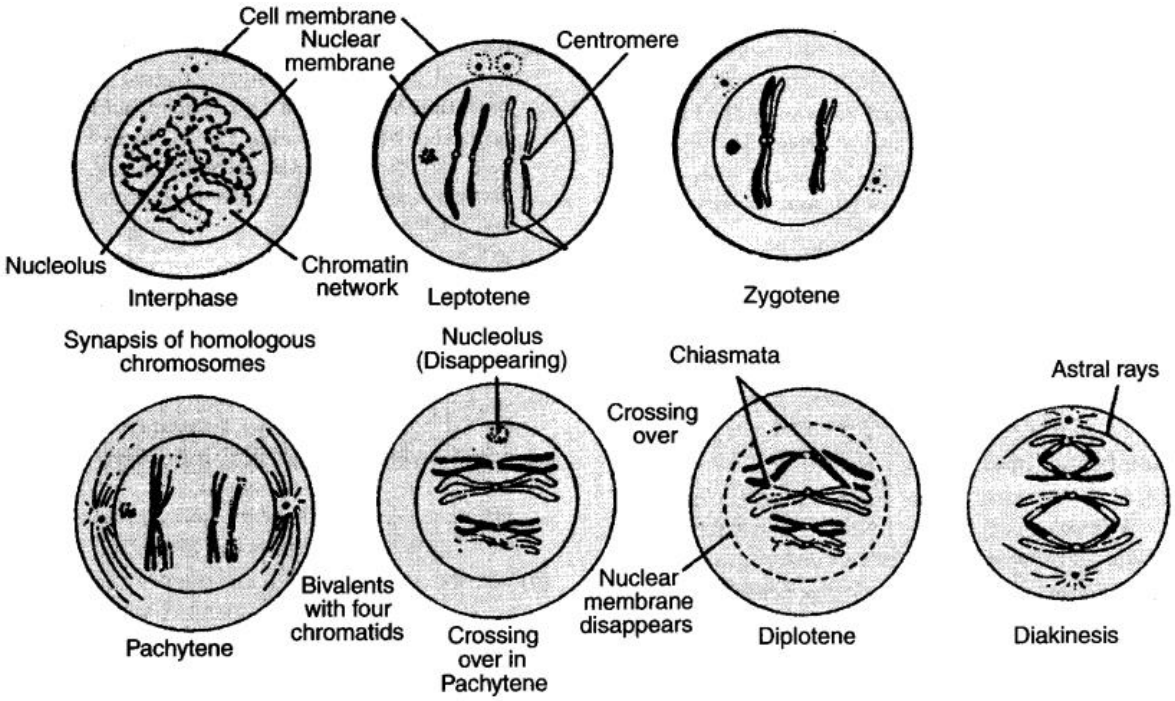
A. Mitosis



B. Meiosis


Interphase
MEIOSIS I
MEIOSIS II
Prophase I
Synapsis and crossing over occur.
Tetrad (paired homologous chromosomes with two chromatids each)
Metaphase I
Tetrads line up on the metaphase plate.
Anaphase I
Homologous pairs separate.
Telophase I
Cytokinesis I
To Prophase II
Prophase II
Metaphase II
Chromosomes line up on the metaphase plate.
Anaphase II
Sister chromatids separate.
Telophase II
Cytokinesis II
4 haploid daughter cells are formed, each having only one chromosome of each homologous pair.

Substages of Prophase I



Practical No. 4

Aim: Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross.

Q1. What will be the appearance of (a) F_1 and (b) F_2progenies when a pure (homozygous) tall pea plant is crossed with a pure (homozygous) dwarf pea plant?
Tallness (T) gene is dominant over dwarfness (t) gene.

Q2. When a plant homozygous for tall is crossed with a plant homozygous for dwarf, what will be the appearance of the offsprings of a cross of F_1 with its tall parent? What is the term given for such a cross?

Q3. When a plant homozygous for tall is crossed with a plant homozygous for dwarf, what will be the appearance of the off-springs of a cross of F_1 with its dwarf parent? What is the term given for such a cross?

Q4. Work out for the genotypes of the parents of the cross between a tall and a dwarf pea plant which result into about one half of the tall and one half of dwarf off-springs.

Q5. What will be the result of selfing the F_1 generation in a cross when round and yellow seeded pea plants (YYRR) are crossed with green and wrinkled (yyrr) seeded pea plant?

Q6. When round and yellow seeded pea plants (YYRR) are crossed with green wrinkled (y y r r) seeded pea plants the F_1 are yellow and round seeded plants (Yy Rr).
What will be the results when this F_1 is crossed with round and yellow seeded parents? What is the term given for such a cross?

Practical No. 5

Aim: Experiments on epistatic interactions including test cross and back cross.

1. In sweet pea, two allelic pairs CcPp are known to effect pigment formation in the plants flowers. The dominant C P are both necessary for coloured flower. Absence of either results in white flowering plant. A dihybrid plant is crossed to a white one (flowering plant) which is heterozygote at the 'C' loci.

a. What is the genotype of dihybrid plant?

b. What is the genotype of the white plant?

c. What kind of flower, coloured or white (include the ratio) are to be accepted from the cross above.

d. What type of epistatic is being demonstrated?

2. Assumed that another allelic pair in sweet pea effect pigment formation in addition to the gene mentioned in question 1. The presence of dominant gene R is required for red flower while its recessive allele 'r' produces yellow flower. What would be the phenotype of the flowering plant in relation to flower colour.

3. In a certain breed of dog, the dominant 'B' is required for black fur, its recessive 'b' produces brown colour. However, the dominant 'I' is epistatic to the colour locus and inhibits pigment formation. What would be the phenotype of the following of the parents, show the ratio in F2 generation?

a. bbii × BbIi

b. bbii × Bbii

c. bbIi × BBIi

Practical No. 6

Practice on mitotic and meiotic cell division.

Apparatus and materials required: Compound microscope, Onion root tip, glacial acetic acid, ethanol, acetocarmine, glass slide, cover slip, blade, needle.

Principle

All organisms are made of cells. For an organism to grow, mature and maintain tissue, new cells must be made. All cells are produced by division of pre-existing cells. Continuity of life depends on cell division. There are two main methods of cell division: mitosis and meiosis. In this tutorial we will learn about mitosis.

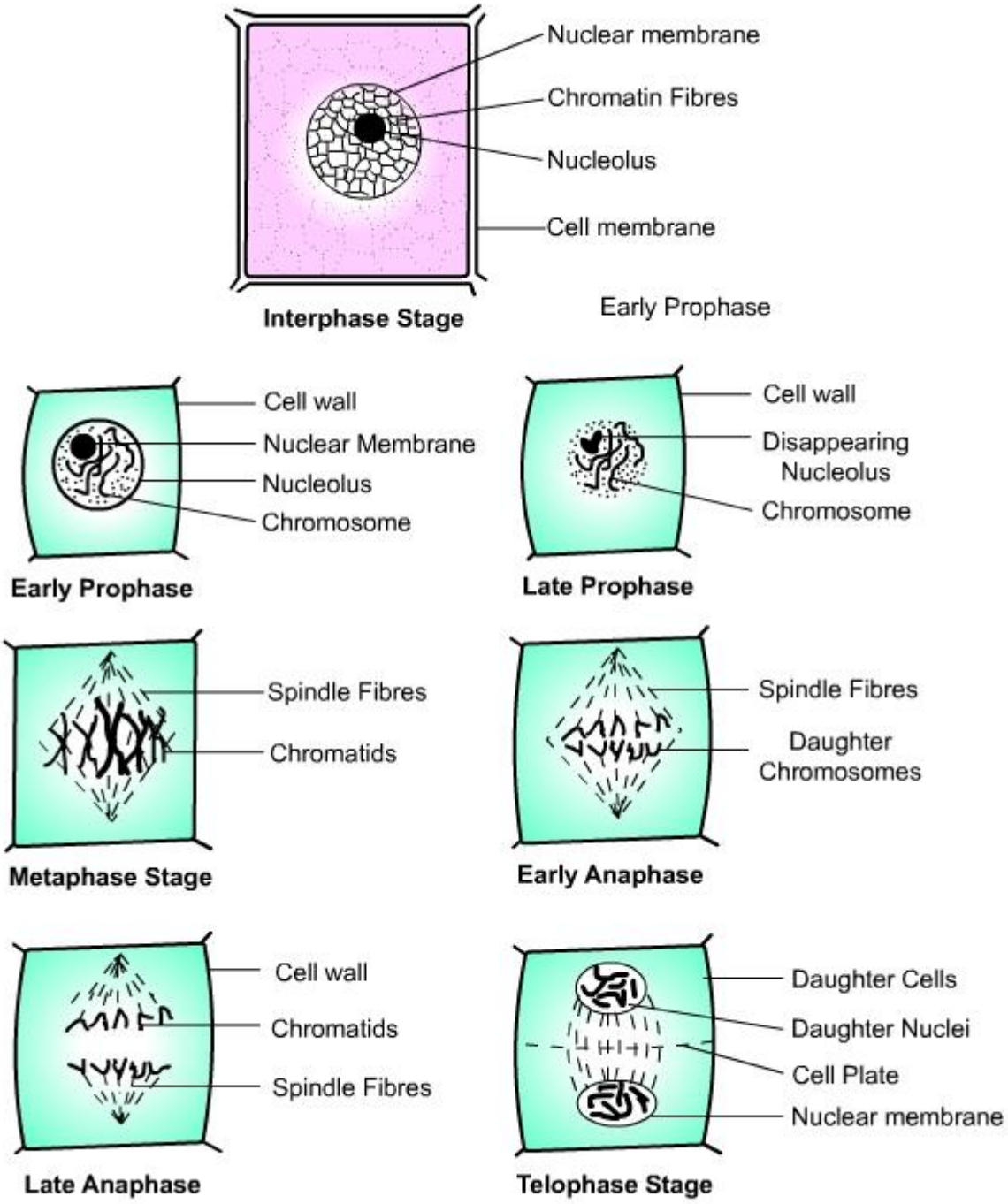
What is Mitosis?

Mitosis is very important to life because it provides new cells for growth and replaces dead cells. Mitosis is the process in which a eukaryotic cell nucleus splits in two, followed by division of the parent cell into two daughter cells. Each cell division consists of two events: cytokinesis and karyokinesis. Karyokinesis is the process of division of the nucleus and cytokinesis is the process of division of cytoplasm.

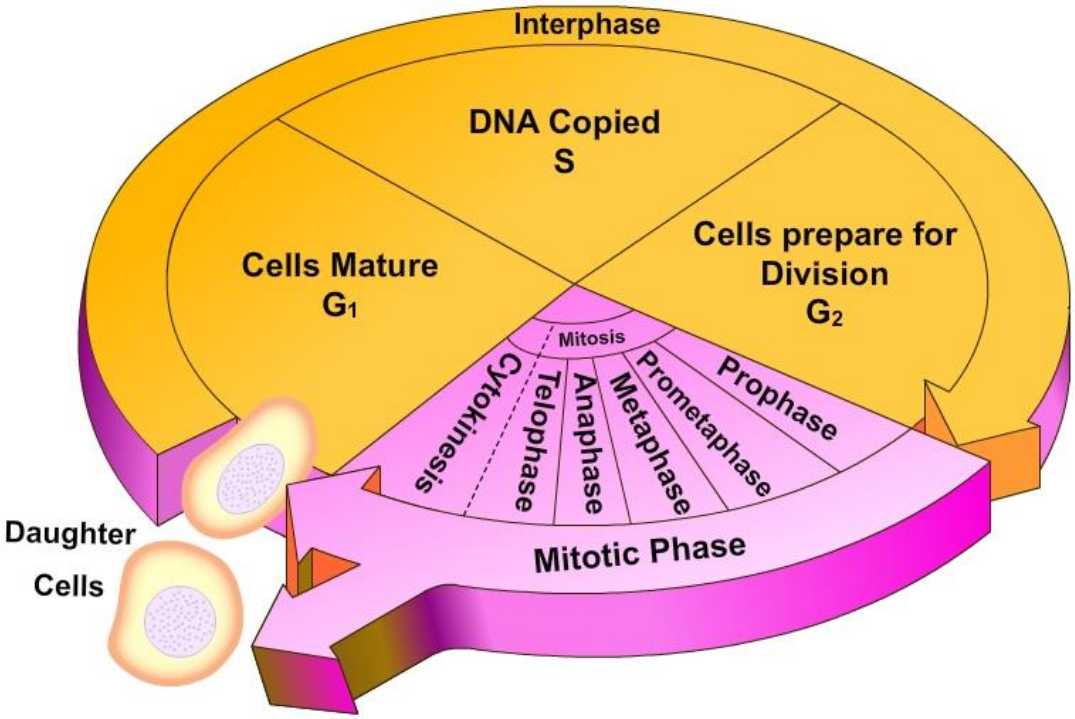
Events during Mitosis

1. Prophase:
    1. Mitosis begins at prophase with the thickening and coiling of the chromosomes.
    2. The nuclear membrane and nucleolus shrinks and disappears.
    3. The end of prophase is marked by the beginning of the organization of a group of fibres to form a spindle.
2. Metaphase
    1. The chromosome become thick and two chromatids of each chromosome become clear.
    2. Each chromosome attaches to spindle fibres at its centromere.
    3. The chromosomes are arranged at the midline of the cell.
3. Anaphase
    1. In anaphase each chromatid pair separates from the centromere and move towards the opposite ends of the cell by the spindle fibres.
    2. The cell membrane begins to pinch at the centre.
4. Telophase
    1. Chromatids arrive at opposite poles of cell.
    2. The spindle disappears and the daughter chromosome uncoils to form chromatin fibres.
    3. The nuclear membranes and nucleolus re-form and two daughter nuclei appear at opposite poles.

4. Cytokinesis or the partitioning of the cell may also begin during this stage.

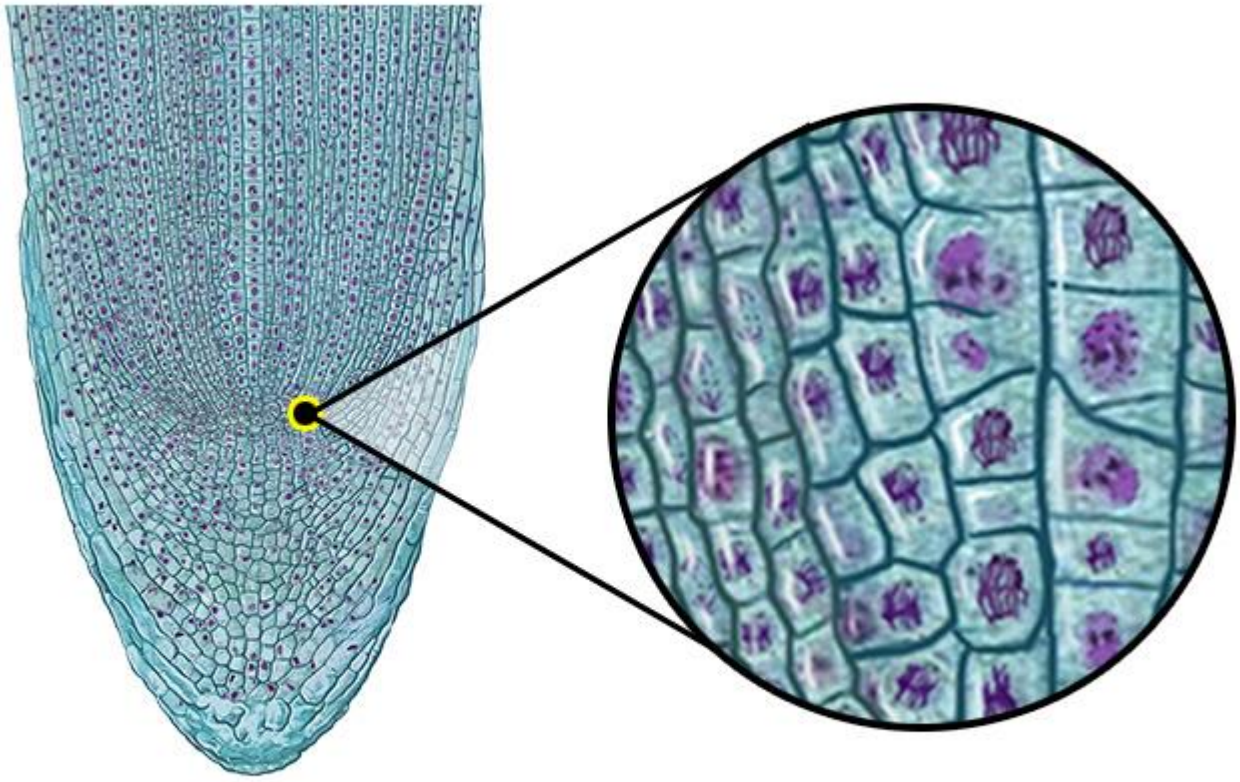


The stage, or phase, after the completion of mitosis is called interphase. It is the non dividing phase of the cell cycle between two successive cell divisions. Mitosis is only one part of the cell cycle. Most of the life of a cell is spent in interphase. Interphase consist of three stages call G1, S and G2.



Mitosis in Onion Root Tip

The meristamatic cells located in the root tips provide the most suitable material for the study of mitosis. The chromosome of monocotyledonous plants is large and more visible, therefore, onion root tips are used to study mitosis. Based on the kind of cells and species of organism, the time taken for mitosis may vary. Mitosis is influenced by factors like temperature and time.



Mitosis in Onion Root Tip

Procedure

- Take an onion and place it on the tile.
- Carefully remove the dry roots present using a sharp blade.
- Grow root tips by placing the bulbs in a beaker filled with water.
- New roots may take 3–6 days to grow.
- Cut off 2–3 cm of freshly grown roots and let them drop into a watch glass.
- Using a forceps, transfer them to the vial containing freshly prepared fixative of aceto-alcohol (1:3: glacial acetic acid: ethanol).
- Keep the root tips in the fixative for 24 hours.
- Using a forceps, take one root and place it on a clean glass slide.
- Using a dropper, place one drop of N/10 HCl on the root tip followed by 2–3 drops of acetocarmine stain.
- Warm it slightly on burner. Care should be taken that the stain is not dried up.
- Carefully blot the excess stain using filter paper.
- Using a blade, cut the comparatively more stained tip portion of the root, retain it on the slide and discard the remaining portion.

- After that, put one drop of water on the root tip.
- Mount a cover slip on it using a needle.
- Now, slowly tap the cover slip using the blunt end of a needle so that the meristematic tissue of the root tip below the cover slip is properly squashed and spread as a thin layer of cells.
- This preparation of onion root tip cells is now ready for the study of mitosis.
- Place the slide under the compound microscope and observe the different stages of mitosis.
- Various stages of mitosis are prophase, metaphase, anaphase and telophase.

Practical No. 7

Aim: Experiments on probability and Chi-square test.

Q1. A die is rolled, find the probability that an even number is obtained.

Q2. Two coins are tossed, find the probability that two heads are obtained.

Q3 Two dice are rolled, find the probability that the sum is

a) Equal to 1
b) Equal to 4
c) Less than 13

Q4. In an experiment designed to study the inheritance of flower color in four-o'clocks, two plants with pink flowers were crossed. In the progeny from this cross, there were 42 plants with red flowers, 86 with pink flowers, and 39 with white flowers. Using a chi-square test, determine whether those numbers are consistent with the single-gene, incomplete dominance inheritance pattern.

Q5. Trying to understand the inheritance of the dominant yellow gene in mice, researchers mated two yellow heterozygous mice. A typical result was 56 yellow progeny to 31 wild-type.

(a) Use a chi-square test to determine if the outcome of this cross is consistent with the usual 3:1 ratio predicted by Mendelian inheritance for a dominant gene.

(b) You will find that the chi-square test done in part (a) indicates the data are not consistent. Now try the hypothesis that the dominant allele is lethal in the homozygous condition. Repeat the chi-square test.

Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of x^2								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21
11	3.053	4.575	5.578	7.584	10.341	13.70	17.28	19.68	24.72
12	3.571	5.226	6.304	8.438	11.340	14.85	18.55	21.03	26.22
13	4.107	5.892	7.042	9.299	12.340	15.98	19.81	22.36	27.69
14	4.660	6.571	7.790	10.165	13.339	17.12	21.06	23.68	29.14
15	5.229	7.261	8.547	11.037	14.339	18.25	22.31	25.00	30.58
16	5.812	7.962	9.312	11.912	15.338	19.37	23.54	26.30	32.00
17	6.408	8.672	10.085	12.792	16.338	20.49	24.77	27.59	33.41
18	7.015	9.390	10.865	13.675	17.338	21.60	25.99	28.87	34.80
19	7.633	10.117	11.651	14.562	18.338	22.72	27.20	30.14	36.19
20	8.260	10.851	12.443	15.452	19.337	23.83	28.41	31.41	37.57
22	9.542	12.338	14.041	17.240	21.337	26.04	30.81	33.92	40.29
24	10.856	13.848	15.659	19.037	23.337	28.24	33.20	36.42	42.98
26	12.198	15.379	17.292	20.843	25.336	30.43	35.56	38.89	45.64
28	13.565	16.928	18.939	22.657	27.336	32.62	37.92	41.34	48.28
30	14.953	18.493	20.599	24.478	29.336	34.80	40.26	43.77	50.89
40	22.164	26.509	29.051	33.660	39.335	45.62	51.80	55.76	63.69
50	27.707	34.764	37.689	42.942	49.335	56.33	63.17	67.50	76.15
60	37.485	43.188	46.459	52.294	59.335	66.98	74.40	79.08	88.38

Practical No. 8

Aim: Determination of linkage and cross-over analysis

Q1. An individual with cd genes was crossed with wild type + +. On test crossing F1, the progeny was + c 105, + d 115, cd 880, and + + 900. Distance between cd genes is:

a. 11 map units
b. 5.5 map units
c. 44 map units
d. 88 map units

Q2. A series of fruit fly mating shows that the recombination frequency between the gene for wing size and the gene for antenna length is 5% (i.e. the genetic distance between them is 5 centimorgans). List all possible recombination frequencies between the gene for colour and the gene for antenna length.

Q3. You are doing a genetics experiment with the fruit fly. In the "P" generation, you cross two true-breeding flies. The female parent is brown and wingless and the male parent is black with normal wings. All of the flies in the F1 generation (1600) are brown and have normal wings.

a. In case of complete linkage between the two genes, what would you the count of

i. brown, winged flies (of the genotype BbNn
ii. black, winged flies (of the genotype Bbnn)
iii. brown, wingless flies (of the genotype bbNn)
iv. black, wingless flies (of the genotype bbnn)

b. When you count the F2 generation, you really get: 85 brown winged flies 728 black winged flies 712 brown wingless flies 75 black wingless flies What is the genetic distance between the colour and wing genes?

Practical No. 9

Aim: Study on sex linked inheritance in Drosophila.

1. In a cross between a white eyed female fruit fly and red- eyed male, what percentage of the female offspring will have white eyed? (White eyes are X- linked recessive).

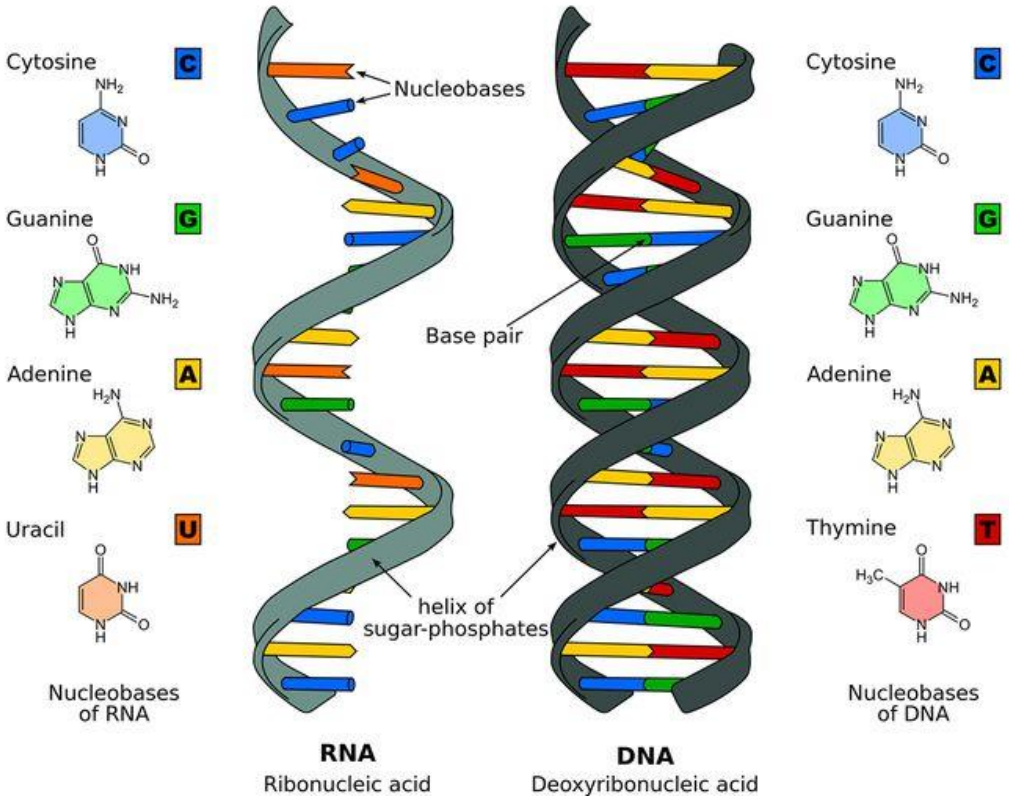
2. A female drosophila of unknown genotype was crossed with a white eyed male fly of genotype X^wY (X^wY is white eyed recessive and X^{w+} is red eyed dominant). Half of the male and half of the female offsprings were red- eyed. What is the genotype of female fly?

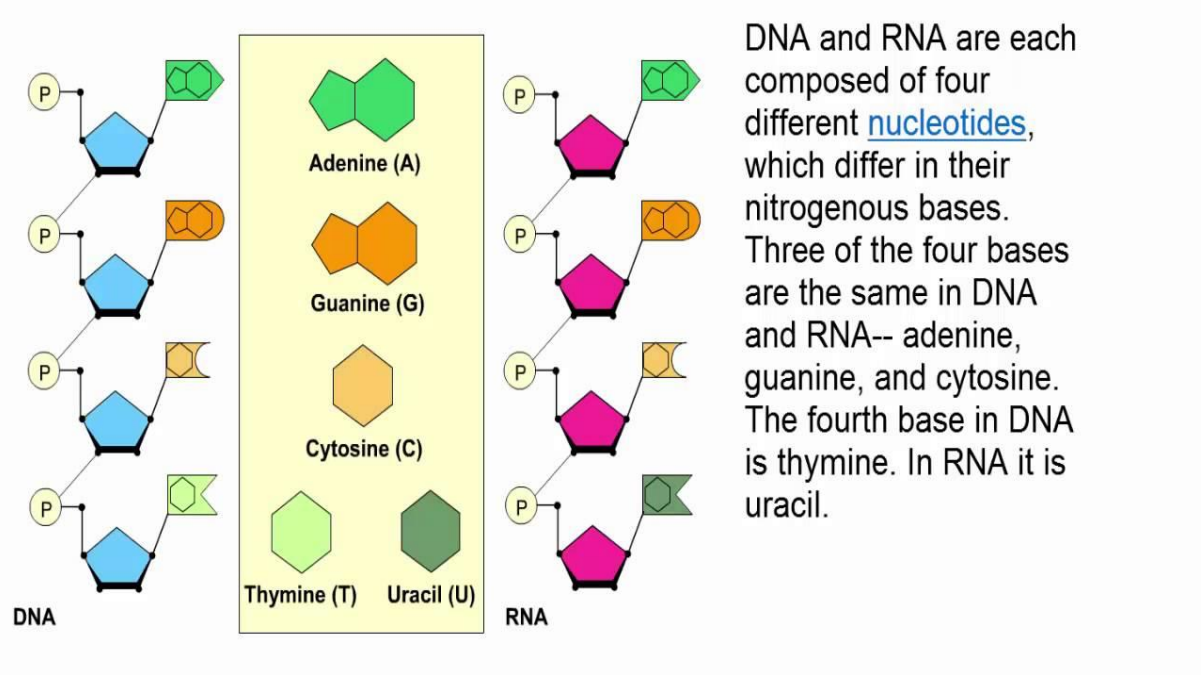
3. In a cross between a pure- bred red-eyed female fruit fly and white eyed male, what percent of the male offspring will have white eyes?

4. What is the genotype of red- eyed yellow – bodied female fruit fly, who is homozygous for the eye colour allele? Red eyes (W^+) and tan- bodies (Y^+) are dominant allele.

Practical No. 10

Aim: Study of models on DNA and RNA structures.





Basic chemical structure of DNA and RNA (heteropolymers of nucleotides)

• Monomer composition (nucleotide) – heterocyclic pentose sugar – phosphate – nitrogenous base

• RNA: polar ribose phosphate backbone

• DNA: polar deoxyribose phosphate backbone (no 2′-hydroxyl)

• Nucleotides joined by 3′,5′- phosphodiester linkages

• Nitrogenous bases – side chains

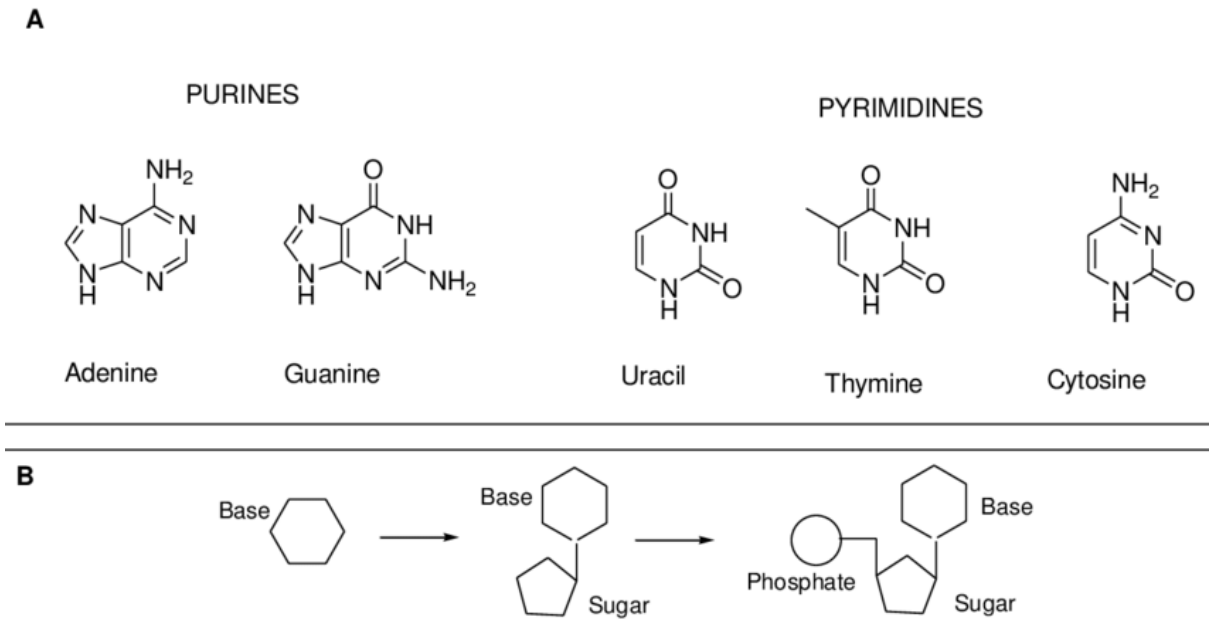
Major nitrogenous bases found in DNA and/or RNA (purines & pyrimidines)

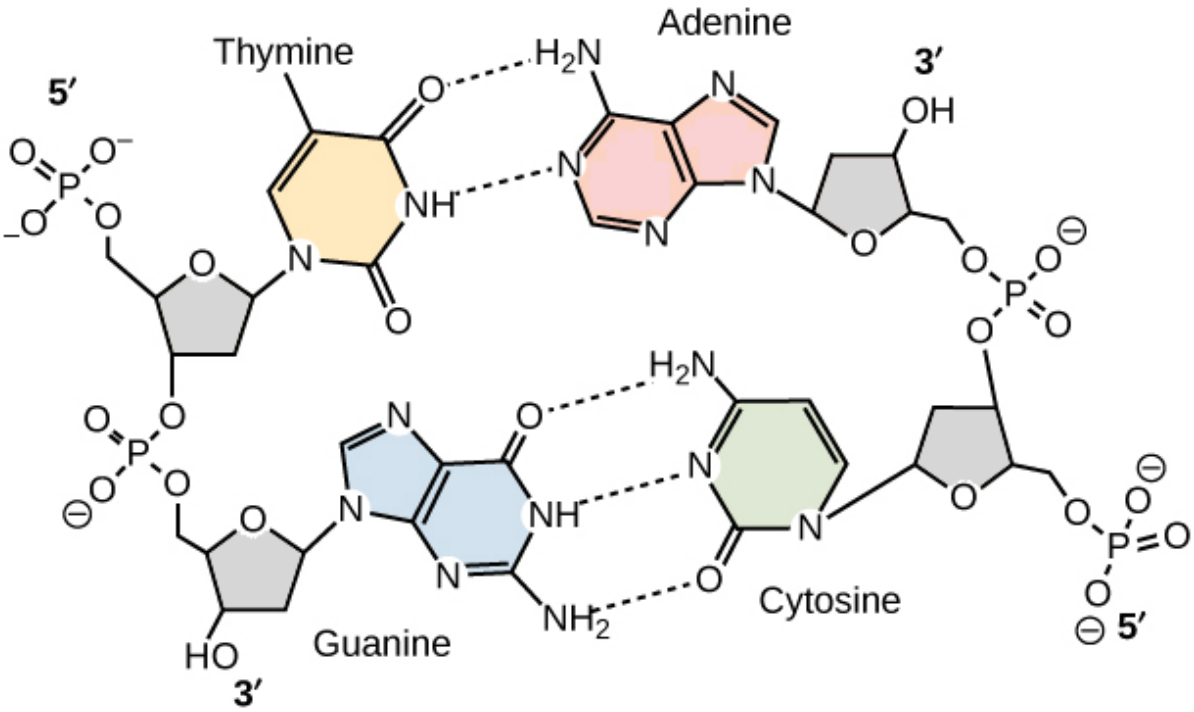
• DNA: A, G, C, T

• RNA: A, G, C, U

• N - β-glycosyl bond: 1′ carbon of ribose and N9 of Pur base (A, G) or N1 of Pyr base (C, T, U)

• Pur or Pyr base + ribose = nucleoside




Thymine
Adenine
5′
3′
OH
NH
H_2N
Guanine
Cytosine
HO
3′
5′