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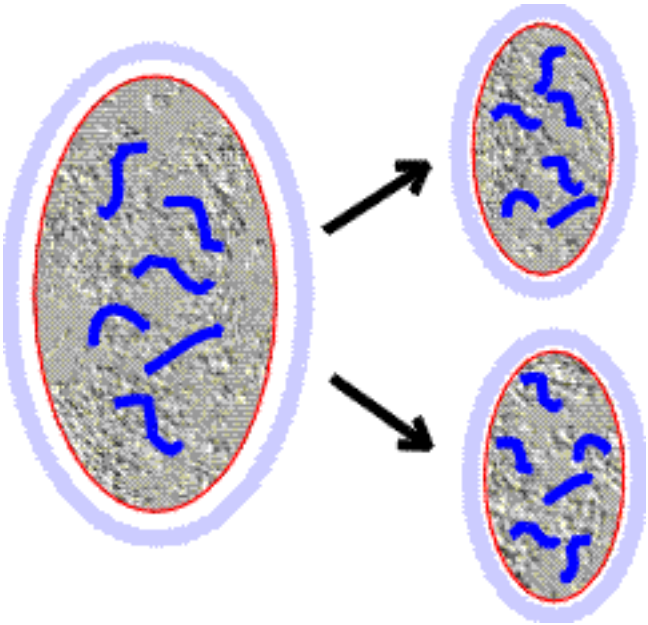
CELL CYCLE



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INTERPHASE

This is the hidden phase of cell division and it has three stages, which are called **G1**, **S** and **G2.**

G1 STAGE

In this stage, cell makes enzymes and RNA

S STAGE

In this stage, DNA is made

G2 STAGE

In this stage, DNA is duplicated

AMITOSIS

Amitosis is a kind of cell division in which the divides directly without formation of spindle fibers. Amitosis is also called uncontrolled cell division. There are three types of amitosis,

NORMAL AMITOSIS

During this kind of division, following events occur

- First the nuclear membrane shrinks towards inside. This gradual shrinkage of nuclear membrane is called **Nuclear Constriction**.
- As the nuclear membrane shrinks, the cell membrane also starts shrinkage. The shrinkage of cell membrane is called **Cytoplasmic Constriction.**
- Finally one nucleus is divided to make two nuclei
- Around each newly formed nucleus, the cell membrane will divide to form two cells.

This kind of cell division is simple and rapid and is very common in prokaryotes such as bacteria and single cellular eukaryotic organisms such as amoeba, paramecium and euglena.

NUCLEAR BUDDING

Nuclear budding is a kind of amitosis, in which the cell divides in same manner. The only difference is that the nucleus is divided not from the middle, therefore the newly formed cells will have nucleus of un-equal size.

NUCLEAR FRAGMENTATION

In this kind of amitosis, the speed of nuclear division is extra fast, so the nucleus divided repeatedly, but the cytoplasm cannot follow the speed of nuclear division. As result, the cell contains a cluster of nuclei.

This kind of cell division is generally found in the old body tissues, and in the tissues where some kind of disease present. Nuclear fragmentation is generally considered as a root cause of cancer and tumor.

APOPTOSIS

Apoptosis may be defined as programmed death of cells. In human beings, many cells die every day and new cells are formed also. The cells of body which die in natural way are actually programmed like that.

MEIOTIC ERROR
The meiotic error may be defined as a genetic problem, in which the chromosomes do not separate properly during anaphase stage of meiosis cell division.

EXPLANATION:
During anaphase of meiosis, the chromosomes are separated in normal way. Therefore each gamete will receive equal number of chromosomes. But in certain conditions, the chromosomes do not separate properly, with the result gametes may get one extra chromosomes or one less chromosomes than required number.

Trisomic condition: It is a condition, in which the child will get on extra chromosomes (2n+1=47)

Monosomic condition: It is a condition, in which child will have one less chromosomes (2n-1=45)

Nullisomic condition: It is a condition in which 2 chromosomes are missing (2n-2=44)

Generally this is called Non-disjunction.

NON-DISJUNCTION:
Abnormal separation of chromosomes is called non-disjunction. Non-disjunction is relatively common. It is estimated that 1 in 5 normal human pregnancies spontaneously aborts in the first two months due to a fertilized egg having too many or too few chromosomes.

DOWNS SYNDROME (Trisomic condition)
It is a kind of genetic dis-order in which child is born with one extra chromosome. The name Down comes from Dr John Langdon Down, who first described the condition in 1866. In 1959 Professor Lejeune proved that Down's syndrome is a genetic condition caused by the presence of an extra chromosome.

The person with Down's syndrome has an extra chromosome **21** – making 47 in all. This results in a disruption to the growth of the developing baby. This extra chromosome can come from either the mother or the father.

Symptoms:
Child suffering from this syndrome will have following symptoms

1. Long tongue
2. Short mouth
3. Low IQ
4. Mental disorder
5. Flat face
6. folded eyes
7. short body stature
8. Female can fertilize
9. Male are unable to reproduce
10. Life expectancy is maximum 40 years

KLINEFELTORS SYNDROME (TRISOMIC CONDITION)

It may be defined as a genetic dis-order found in males. In this dis-order, a child gets one extra X chromosome. It means that he will have 44 autosomes XY as sex chromosomes and on extra X chromosome. This means that the child will have XXY as sex chromosomes. Klinefeltors syndrome is a tiresome condition. Klinefeltors syndrome is found in approximately 1 of 700 men.

SYMPTOMS:
Person suffering from this syndrome will have following symptoms

1. At birth the testicles of boys are of normal size.
2. At the age of 11-12 years, the testicles stay very small (only 2 cms).
3. Usually only few sperms developed in the testicles
4. Men with Klinefelter's syndrome are infertile.
5. They have delayed, speech, and maturation

TURNERS SYNDROME: (Monosomic condition)
It may be defined as a female genetic disorder in which the female child is born with total 45 chromosomes. Out of 45 chromosomes, 44 are autosomes and instead of 2 sex chromosomes, there is only one X chromosomes. This means there is one sex chromosome missing.

SYMPTOMS:
Women suffering from this disorder will show following symptoms.

1. Short neck,
2. Facial hairs
3. Deep voice
4. Raised chest
5. unable to reproduce

MITOSIS
Mitosis occurs in four steps.
Prophase:

During prophase, chromosomes slowly condense within the nucleus. Centrosomes move to apposite poles and form aster.

- The net work of chromosomes appear
- Two structures called centrioles, both located on one side of the nucleus, separate and move toward opposite poles of the cell.
- Centrioles begin to form three types of fibers called spindle fibers. These fibers are **Continuous, Discontinuous and Asters**
- The chromosomes break the newt work and line up.
- The chromosomes now change their size. From long, they become short and from thin they become thick
- The nuclear membrane begins to disappear in prophase but will completely disappear in the beginning of metaphase.
- The chromosomes move upward, therefore more spindles are formed.

METAPHASE

During metaphase, the chromosomes become attached to opposite poles and aligned to across the spindle

- In metaphase, the spindle fibers attach to the chromatids near the centromeres.
- Two individual chromosomes stand in back to back manner at the equator. One chromatid faces one pole of the cell, and its linked partner faces the opposite pole.
- Due to shrinkage of spindle fibers, the chromatids will split.

ANAPHASE

During anaphase, the chromosomes split and chromatids move rapidly to apposite poles

- The discontinuous spindle fibers will shrink towards the poles
- The identical chromatids are separated into single chromosomes, which are taken to opposite poles of the cell.

TELOPHASE

During telophase, new nuclei are formed from the separated groups of chromosomes

- As these two identical groups of single chromosomes gather at opposite poles of the cell, telophase begins.
- A new nuclear membrane is formed around each new group of chromosomes.

- The spindle fibers break down and the newly formed chromosomes begin to unwind.

KARYOKINESIS

- The constriction of nuclear membrane will occur, and two nucleus are formed within on cell.

CYTOKINESIS

- The final phase of the cell cycle is known as cytokinesis.
- In cytokinesis, the cell's cytoplasm separates in half, with each half containing one nucleus.
- Animals and plants do cytokinesis in slightly different ways.
- In animals, the cell membrane pinches in, creating a cleavage furrow, until the mother cell is pinched in half.
- In plants, cellulose and other materials that make up the cell wall are transported to the midline of the cell and a new cell wall is constructed.
- The new cells enter interphase, and the cell cycle begins again.

MEIOSIS

There are ma ng sexual reproduction, le makes ova, which a of these two male a mber of chromosome somes as the parents h le reduce their diploid

Meiosis is a kind of cell division, which results into formation of male and female gametes. This division helps the sexually reproducing organisms to reduce their diploid chromosomes to the level of haploid.
In meiosis, there is one round of DNA replication in a diploid cell (2*n* to 4*n*) followed by two separate divisions resulting in four haploid cells (*n*)

Meiosis differs from normal cell division, or mitosis, because in meiosis two consecutive cell divisions take places instead of one.

The process of meiosis is completed in following stages

INTER PHASE

Prior to meiosis, the corn cell undergoes interphase, in which it synthesizes materials needed for cell growth and prepares for cell division. During this stage the cell's genetic information, in the form of deoxyribonucleic acid (DNA), is replicated. Each of the two consecutive cell divisions consists of four stages: prophase, metaphase, anaphase, and telophase.

PROPHASE-I

During prophase-I crossing over between chromatids of homologous chromosomes may occur, allowing the formation of new combinations of genetic information

The prophase of Meiosis –I is prolong. This is further divided into following stages

LEPTOTENE

This stage starts the prophase process. Following events occur

- The chromosomes which are thin long thread like structures appear as individual and are called **Monads**

ZYGOTENE

- In this stage, two homologous chromosomes are attracted towards each other and form pairs which are called **Bivalents**
- These bivalents join each other at the location of centromeres. Their attachment is called **synapsis**
- The chromosomes now become short and thick and begin to coil around each other

PATCHYTENE

- During this stage, when the chromosomes are coiled around each other they are broken longitudinally into sister chromatids and are called **tetrads.**
- After breaking up, the chromosomes begin to uncoil, but can not do that due to presence of synapsis between them

DIPLOTENE

- During this stage, the synaptic force looses therefore homologous chromosomes uncoil and begin to separate
- The formation of chiasmata takes place which is a point where homologous chromosomes are still attached with each other
- At this stage, crossing over takes place during which a block of genes may cross from one to another chromosomes.

DIAKINESIS

- In this stage, Nuclear membrane disappears
- Nucleolus also disappears
- Spindle fiber formation takes place
- The chromosomes finally separate from each other. This process is called **Terminalization**
- Bivalents become thick and are quite visible.
-

METAPHASE-I

At the end of metaphase-! Homologous chromosomes are aligned on the central plane of the spindle.

- During metaphase I, the spindle fibers attach to the chromatids near the centrioles.
- The spindle fibers move the tetrads so that they line up in a plane halfway between two centrioles.

ANAPHASE-I

During Anaphase-I homologous chromosomes move to opposite poles

- Anaphase I begin when the spindle fibers pull the tetrads apart, pulling the maternal and paternal chromosomes toward opposite sides of the cell.

TELOPHASE-I

- The first meiotic division concludes with telophase I, when the two new groups of chromosomes reach opposite sides of the cell.
- A nuclear membrane may form around the two new groups of chromosomes and a division of cell cytoplasm forms two new daughter cells.

MEIOSIS-II

Meiosis II is similar to mitosis except that there is no S phase of DNA synthesis.

PROPHASE-II

- In this division, the interphase does not occur
- In the second meiotic division the cell moves directly into prophase II.
- The nuclear membrane disappears
- And **diads** move to equator

METAPHASE-II

- During metaphase II, the chromosomes line up along the plane in the center of the cell.
- The half spindle fibers attach with the centromeres of diads
- Chromatids are finally separated from each other

ANAPHASE-II

- In this stage, the pairs of chromatids are pulled away from each other to wards the opposite ends of the cell poles

TELOPHASE II

- It is end of the meiosis.
- In this phase the spindle fibers disappear
- New nuclear membrane is formed around each new group of chromosomes to form four haploid cells.

PRACTICE SHEET 01

1. Shortest possible time for cell division may be----minutes
(a) 20 (b) 30 (c) 40 (d) None

2. A kind of amitosis in which nucleus is divided into different sizes are called
(a) Nuclear budding (b) Nuclear fragmentation (c) Amitosis (d) All

1. In cancer and tumor cells, the cell divided in a way that nucleus divides repeatedly and cytoplasm does not divide. That is called
(a) Nuclear budding (b) Nuclear fragmentation (c) Amitosis (d) All

2. Programmed death of cell is termed as
(a) Epitasis (b) Apoptosis (c) Both a&b (d) None

3. Apoptosis may occur at any stage of life but it is more common during
(a) Embryonic stage (b) Maturation stage (c) Aging (d) All of above

4. Any change in the normal number of chromosomes is called
(a) Heteroploidy (b) Aneuploidy (c) Polyploidy (d) All

5. If an animal has more that two homologous chromosome for given trait, the condition is called
(a) Heteroploidy (b) Polyploidy (c) Both a&b

6. Addition or subtraction of chromosomes is termed as
(a) Heteroploidy (b) Poly ploidy (c) Aneuploidy (d) All

7. One in every 900 births show ------syndrome
(a) Down's Syndrome (b) Turners Syndrome (c) Klinefelter syndrome (d) All
8. A person with XXY is ----------
(a) Klinefelters syndrome (b) Downs Syndrome (c) Both a&b (d) None

9. About 1 in every 5000 babies are X0. This genetic defect is termed as ----
(a) Down's Syndrome (b) Turners Syndrome (c) Klinefelters syndrome (d) All

MITOSIS

1. New cells can come only from preexisting cells.
(a) true (b) false

2. Cell division in unicellular organisms produces two new individuals that are like the parents.
(a) true (b) false

3. Binary fission does not utilize a spindle.

(a) true (b) false

4. The nucleoid of a prokaryote is enclosed by a membrane.
(a) true (b) false

6. Simple cell division distributes the chromosomes in such a way that each and every cell gets a full number.
(a) true (b) false

7. Each species has a characteristic chromosomal number which is called the diploid number.
(a) true (b) false

8. During telophase, new nuclear envelopes form around the daughter chromosomes.
(a) true (b) false

9. The period of DNA synthesis when replication occurs is termed the G_1 stage.
(a)true (b) false

10. During mitosis, the spindle forms.
(a) true (b) false

12. During _____, the chromosomes attach to the spindle and align at the metaphase plate of the spindle.
a. prophase b. prometaphase c. metaphase d. Anaphase

13. During _____, the chromosomes attached to kinetochore fibers are aligned at the metaphase plate.
a. anaphase b. metaphase c. prophase d. prometaphase

16. Meristem tissue is found in the _____ of a plant.
a. roots middle b. shoot tips c. stems middle d. all of the above

17. Cell division in multicellular organisms
a. is part of the growth process that produces the multicellular organism.
b. is important for renewal. c. is important for repair. d. all of the above.

18. It is apparent during prophase that nuclear division is about to occur because
a. the chromatin has condensed. b. the chromosomes are visible structures. c. both a and b.

19. The spindle of animal cells consists of _____.

a. poles b. asters c. fibers d. all of the above

20. During anaphase
a. the spindle lengthens. b. the poles become more distant from one another. c. both a and b.

21. Microtubules are found in
a. the cytoplasm. b. flagella. c. centrioles. d. all of the above.

22. The mechanics of the cell cycle and the cause of cancer are _____ related.
a. distantly b. closely c. not 23. Interphase consists of the _____ stages of cellular growth and division.
a. G_1, M, and G_2 b. G_1, S, and G_2 c. M, S, and G_2 d. M, S, and G_1

24. During the G_1 stage
a. the cell grows in size. b. the cellular organelles increase in number. c. both a and b.

25. Mitosis is the type of nuclear division involved in
a. growth of the body. b. repair of the body. c. both a and b.

26. Cell division in eukaryotes involves
a. nuclear division. b. division of the cytoplasm. c. both a and b.

28. Cell division in multicellular organisms is important for
a. growth. b. repair. c. both a and b.

29. Each cell of an organism
a. contains only the DNA it needs. b. contains a full complement of DNA. c. depends on the cell.

30. Daughter cells as a result of mitosis have a complete copy of
a. chromosomes. b. genes. c. both a and b.

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MEIOSIS

1. Meiosis is more common than mitosis.
(a) true (b) false

2. Meiosis always increases the number of chromosomes.
(a) true (b) false

3. Exchange of genetic material is called crossing-over.
(a) true (b) false

4. Replication of DNA is necessary between meiosis I and meiosis II.
(a) true (b) False

6. It is apparent during prophase I that nuclear division is about to occur.
(a) true (b) false

7. After crossing-over during prophase I, the sister chromatids of a duplicated chromosome remain identical.

(a) true (b) false

8. There is no set way for the homologous chromosomes to align themselves at the metaphase plate of the spindle.
(a) true (b) false

9. A zygote always has the diploid number of chromosomes.
(a) true (b) false

10. Meiosis occurs at the same points during the life cycles of various organisms.
(a) true (b) false

11. In animals, the adult is always haploid.
(a) true (b) false

12. Mammals, including humans, have a life cycle that requires _____.
a. meiosis b. mitosis c. both a and b

13. In human females, meiosis is a part of _____.
a. ovulation b. Oogenesis c. neither a or b

14. Mitosis occurs in humans during
a. development of the zygote. b. growth of a child. c. repair of tissue at any time. d. all of the above.

15. In humans, meiosis
a. occurs only in the sex organs. b. produces the gametes. c. both a and b.

16. During _____, the chromosomes of each homologous pair separate and move to opposite poles.
a. prophase I b. metaphase I c. anaphase I d. telophase I

17. If telophase I takes place, which of the following always happens?
a. the nuclear envelope reforms b. cytokinesis occurs c. nucleoli appear d. both a and c

19. Metaphase I is characterized by
a. a fully formed spindle. b. alignment of the bivalents at the metaphase plate. c. both a and b.

20. During _____, the sister chromatids separate and therefore four daughter cells each have chromosomes with one chromatid.
a. meiosis I b. meiosis II c. mitosis d. both a and b

21. Crossing-over is an exchange of genetic material between _____ chromatids.
a. sister b. nonsister c. neither a or b

22. When a cell is 2n, the chromosomes
a. occur singly. b. occur in pairs. c. either a or b.

24. Sexual reproduction includes
a. gamete formation. b. fusion of gametes to form a zygote. c. both a and b.

25. In animals, meiosis
a. occurs during the production of gametes.
b. produces spores that divide mitotically to become a haploid generation. c. both a and b.

28. At the end of telophase II and cytokinesis, there are _____ haploid cells.
a. two b. four c. six

29. After synopsis during meiosis I, the homologous chromosomes _____.
a. separate b. join c. diffuse d. Split

30. Meiosis occurs in
a. animals. b. plants. c. fungi. d. all of the above

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