

Date:

# KAVERI'S IAS | UPSC

1

Question No.

Remarks

Research based Questions. All the Questions are compulsory!

Word Limit in questions should be adhered to.

## Section A

1. Answer the following Questions in not more than 150 words. Each Question carries 10 Marks.

A. Explain the importance of numerical and structural variation in chromosomes.

Chromosome variation means change in number of chromosome due to abnormalities during cell division (mitosis or meiosis) or due to introduction of plant with certain chemicals.

Numerical variation in chromosome means change in number of chromosome eg:- Aneuploidy or Euploidy. Structural variation means change in structure of chromosome eg:- Deletion, duplication, inversion and translocation.

### Importance of Chromosome Variation

1. It is important for plant evolution.
2. It is primary ingredient in plant breeding.
3. It often contribute to genetic barrier that to the gene flow that exist between two species.
4. It can identify certain genetic disease in plants.
5. Chromosome variation help the plants to deal with climate change.
6. It is important tool for assessment.

6.0

Formulas are missing

Give graphical representation of types.

eg: missing

Date:

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2

Question No.

Remarks

Relevant  
Points

of pesticides exposure to the plants.

7. It is essential in maintaining biodiversity among species.

8. Reciprocal translocation along with alternate chromosome segregation maintain heterozygosity and prevent lethal gene expression

9. Inversion prevent pairing between homologous part and suppress crossing over.

Conclusion

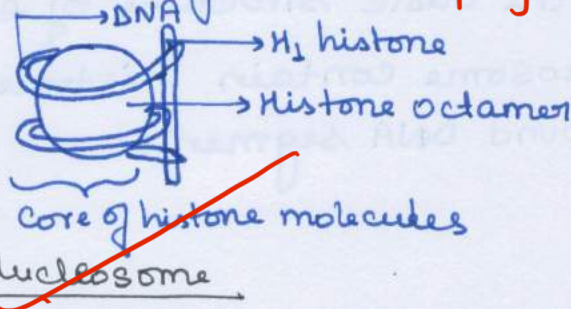
Thus it can be concluded that numerical and structural variation in chromosome is important in several aspects to the plants.



6.5

B. Describe the basic structure of nucleosome.

Nucleosome is structural unit of DNA packaging in ~~Eukaryotes~~. **Eukaryotes.**



A nucleosome is DNA segment surrounded by histone protein octamers resembling a thread coiled around a spool.

Function of nucleosome is to reduce the size and volume of DNA strand so that it can fit inside the nucleus.

Structure of nucleosome

1. Nucleosome core particle is made up of 146 base pairs of DNA
2. Two copies of  $H_2A$ ,  $H_2B$ ,  $H_3$  and  $H_4$  makes up the histone octamer
3. Each nucleosome is joined to other by linker DNA (10-80 base pairs length).
4. Nucleosome core particle and linker DNA together generate cylinder of 11nm diameter.
5. In Interphase stage of cell cycle unfolding chromatin as beaded

Show Octamer structure

Date:

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4

Question No.

Remarks

String is observed. String is DNA segment while beads are nucleosome core particle.

Thus the basic structure of ~~chromosomes~~ nucleosome contain histone octamer surround DNA segments.



5.5

C. What is the significance of chromatin organization and packaging in genome?

Chromatin is genetic material or a comprising DNA, RNA and associated proteins, constitute chromosome within the nucleus of Eukaryotic cell.

Organisation of chromatin in 3 level :-

- (i) DNA wrapping around "nucleosome - the beads on string structure"
- (ii) A 30 nm condensed chromatin fibre consist of nucleosome arrays in their most compact form.
- (iii) Higher level of packing into metaphase chromosome.

Significance of chromatin organization & packaging in genome :-

- (i) Chromatin organisation play crucial role in genome replication. It control DNA replication and gene expression.
- (ii) It is important for transcriptional silencing and DNA repair. It prevent damage of DNA.
- (iii) It play crucial role in Recombination of genetic material
- (iv) Support the DNA molecule to permit the process of cell cycle - meiosis and mitosis.

Fluorant  
& dig.

Relevant

Date:

# KAVERI'S IAS | UPSC

6

Question No.

Remarks

Thus Chromatin organisation & packaging of genome is significant in order to fit DNA molecule into the nucleus and prevent its damage.

Comment

- Learn space management



3

### D. Distinguish between Mitosis & meiosis

Mitosis occur in somatic cell of producing identical sister chromatid.

Meiosis occur in reproductive cell of producing four daughter cell.

Mention germ cell + ploidy level.

Be more specific with definition

Mitosis

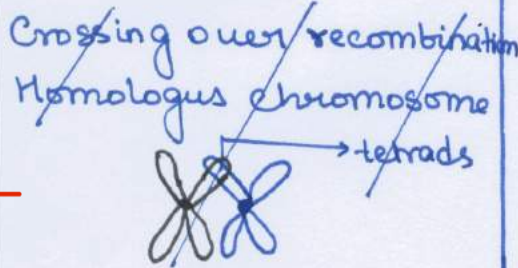
Meiosis

Interphase

Each chromosome replicate and produce two identical sister chromatid

Chromosome not yet divisible but DNA has been replicated or duplicated

Prophase



Avoid this

• It occur in somatic cell

It occur in germ / reproductive cell

• Nucleus divide only once

Nucleus divide twice (Karyogenesis)

• Two identical daughter cell produce

Four daughter cell are formed

• Daughter cells are diploid in nature (2n)

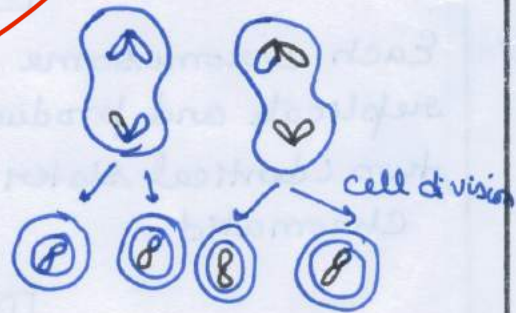
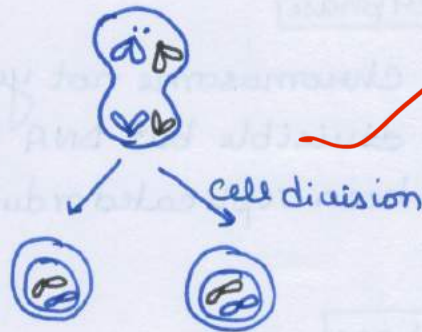
Daughter cells are haploid in nature (n)

• Number of chromosome not change in daughter

• Number of chromosome reduced to half.

Relevant

- Chromosome number double at beginning of cell division
- No crossing over in chromosome
- Equational division
- Chromosome number double at end of first meiotic division.
- Crossing over occurs in Prophase I of 1st meiotic division.
- Reduction division



### Comments :-

- Avoid colloquial language, be scientific in your approach.
- All steps of M-phase are missing.



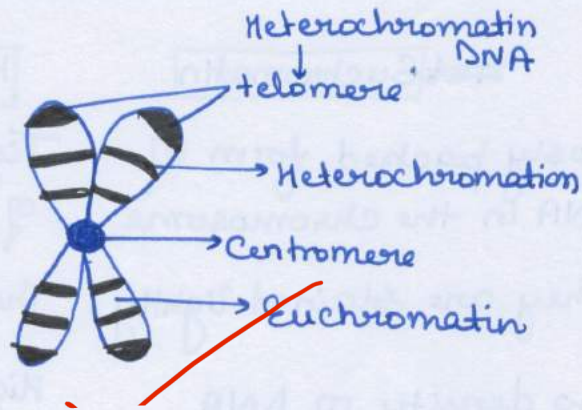
7

## E. Difference between Heterochromatin and Euchromatin

Introduction  
is missing

Euchromatin	Heterochromatin
① loosely packed form of DNA in the chromosome	Tightly packed form of DNA in chromosome
② They are stained lightly	They are stained dark
③ low density of DNA	High density of DNA
④ Generally inactive	Generally inactive
⑤ Around 90% of human genome is Euchromatin	less abundant occurrence in genome
⑥ Only present in Eukaryotic cell and prokaryotic cell	Present in both <sup>only</sup> Eukaryotes and prokaryotes
⑦ Present in inner body of the nucleus	Found in periphery of nucleus
⑧ DNA is affected by genetic process	Phenotype of an organism remain unchanged
⑨ Allow the genes to transcribe and genetic variation occur	Maintain Allow regulation of gene expression.
⑩ Early replicate	late Replicate
⑪ Euchromatin regions are not sticky	Heterochromatin regions are sticky

Relevant  
points.



comment:-

- space mangement missing
- differences can be divided

Structure

Functions

Location



Date:

# KAVERI'S IAS | UPSC

11

Question No.

Remarks

1/2

2. Answer the following Questions in not more than 250 words. Each Question carries

A. Discuss briefly the general principles of cellular adhesion. Give a note on identification and characterization of Adhesion receptors. 15 marks.

Cell adhesion is the process of interaction of cell to cell or cell to matrix with help of protein molecules or through direct contact.

Date:

# KAVERI'S IAS | UPSC

17

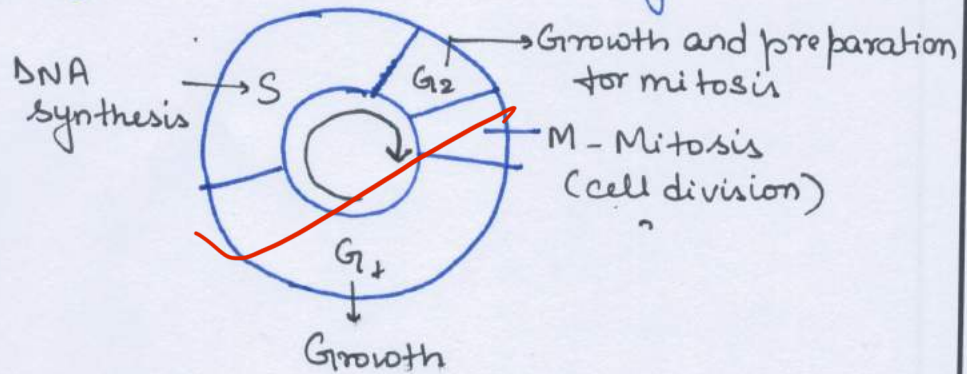
Question No.

Remarks

1 1/2

C. What is cell cycle? What chemicals regulate the cell cycle and how does it work & control in cell biology. 20 marks.

A cell cycle is series of events take place during cell division and its growth.



G<sub>1</sub>, S and G<sub>2</sub> together known as Interphase while M is cell division phase.



3. Answer the following Questions in not more than 250 words. Each Question carries

A. Answer the following:

6

- a) Explain the mechanism of cell signaling and the role of cell receptors in regulating this process. 10 marks.
- b) Discuss the role of Histone in regulating chromatin structure with special emphasis on Histone N-terminal tails as well as nucleosome assembly. 10 marks.

(a) Cell signaling is process by which cells communicate with each other and with external environment.

Stages of Cell signaling

- (i) Binding of signal molecule to the receptor
- (ii) Signal transduction where chemical signal activate the enzymes.

(iii) Response is observed. gets generated

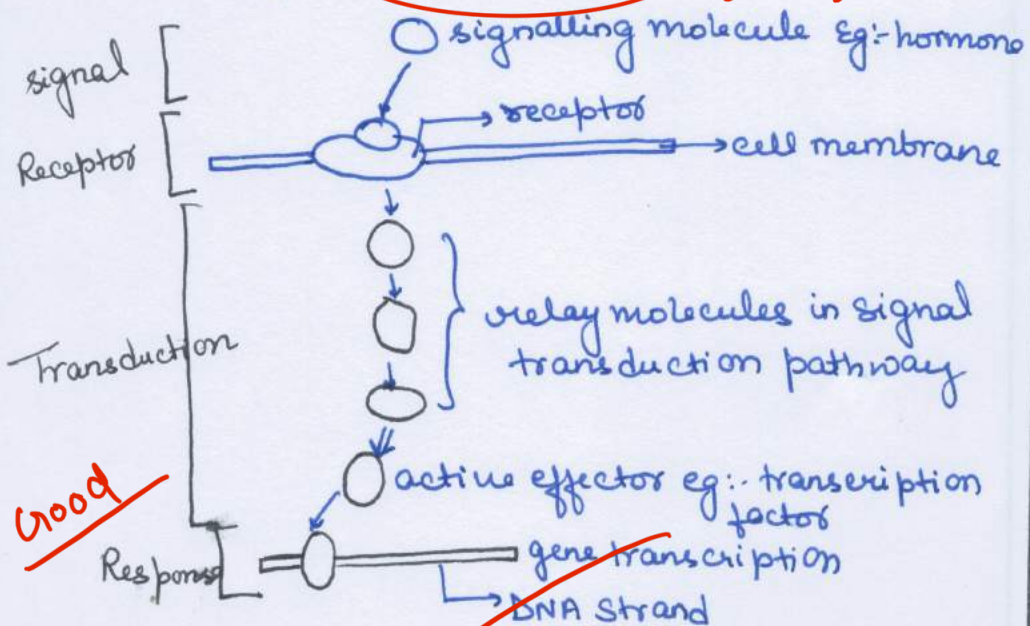


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Date:

# KAVERI'S IAS | UPSC

21

Question No.

Remarks

Role of cell receptor in regulating cell signalling

- Cellular receptors are protein either inside a cell or on its surface which receive signals.
- It bind to signalling molecules outside the cell and subsequently transmit signal through a sequence of molecular switches



Q.5

B. What is the function of Mitochondria in a cell? Write a note on structure of Mitochondrion. 15 Marks.

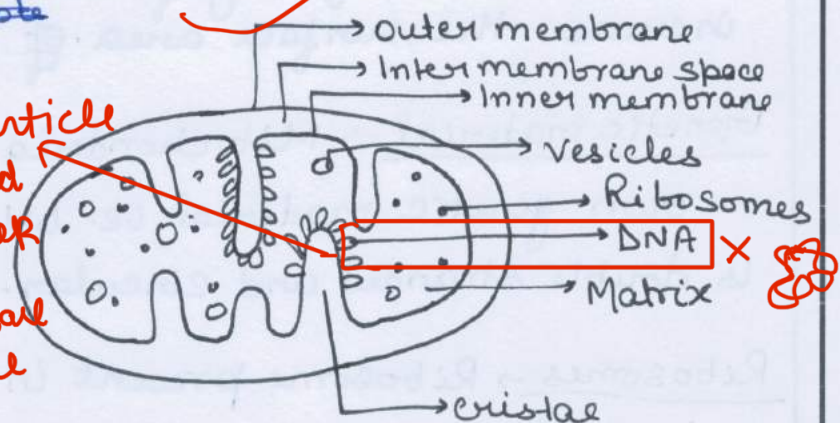
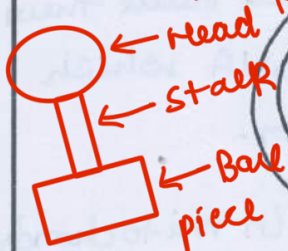
Mitochondria is present in Eukaryotic cell. It is a double membrane cell organelles. It is known as 'powerhouse of the cell'

### Function of Mitochondria

- ① Produce ATP (Adenosine tri phosphate) which is energy currency, by the process of oxidative phosphorylation
- ② Mitochondria play significant role in process of apoptosis or programmed cell death.
- ③ They provide site for aerobic respiration
- ④ Mitochondria can store and release calcium & regulate its concentration.
- ⑤ Specific Regulation of membrane potential and cellular metabolism.

Rate

• mention F<sub>1</sub> Particle





Mitochondria is double membrane structure

Outer Membrane - contain protein name porin which stimulate the permeability of outer membrane of mitochondria

Intermembranal space → Space between outer and inner membrane of mitochondria. It is fluid.

Inner membrane → Does not contain porin <sup>name of lipid membrane is cardiolipin</sup> thus like outer membrane. Thus permeability is lesser. It regulate the inflow of ions, molecules inside the mitochondria

Matrix → <sup>Central</sup> inner space of mitochondria known as Matrix. All the process like cellular respiration, oxidative phosphorylation take place here.

Cristae → Inward folding of inner membrane increase the surface area.

Genetic material → Mitochondria have their own genetic material i.e. DNA which is double stranded and circular.

Ribosomes → Ribosome present in mitochondria is 70s type with 50s and 30s subunits



Date:

# KAVERI'S IAS | UPSC

25

Question No.

Remarks

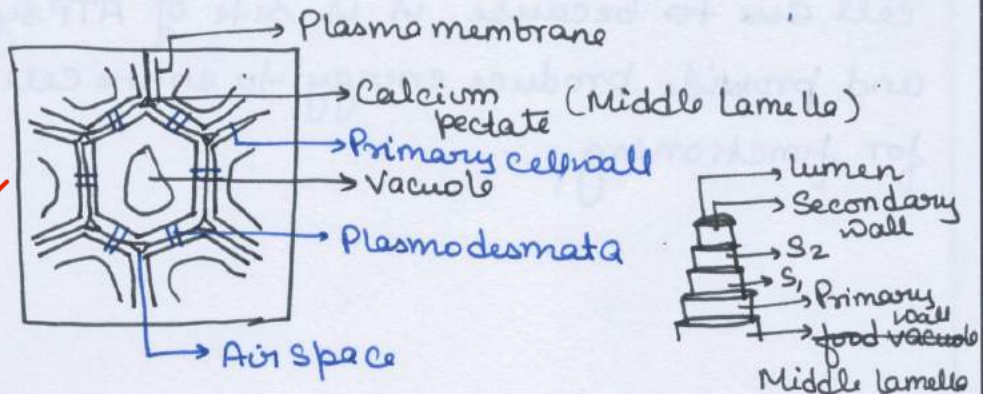
Vesicles → It is also known as food vacuoles which store food.

Mitochondria is known as powerhouse of cell due to because it is site of ATP synthesis and provide produce energy to entire cell for functioning.

2.5

C. Explain, with required diagrams, the chemical structure and function of primary cell wall and plasma membrane. 15 marks.

### Cell Wall



Cell wall is outer most layer of the cell. It is present in plant and fungus - Eukaryotes cell only. It is made up of calcium pectate in plant cell and chitin in fungus.

### Chemical Structure

1. Microfibril - microfibril is present in cell layers of cell wall. It help in cell to cell signalling

2. Primary cell wall

3. Secondary cell wall

4. Vacuole lumen

5. Plasmodesmata

6. Middle lamella

- cellulose
- Pectins
- gums
- mucilages
- hemicellulose
- callose
- gums
- lignin
- waxes etc.



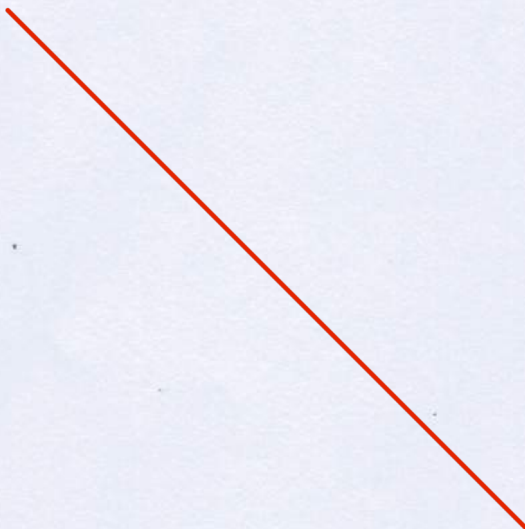
Date:

27

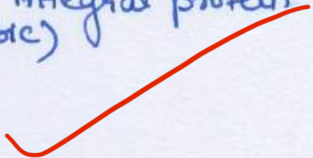
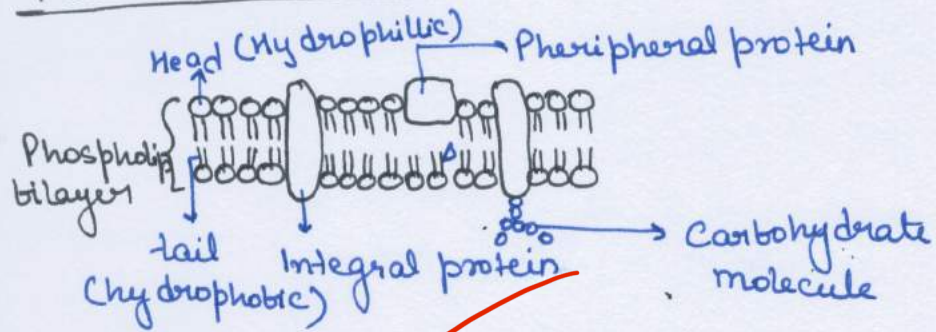
Question No.

Remarks

## Functions



## Plasma Membrane



Date:

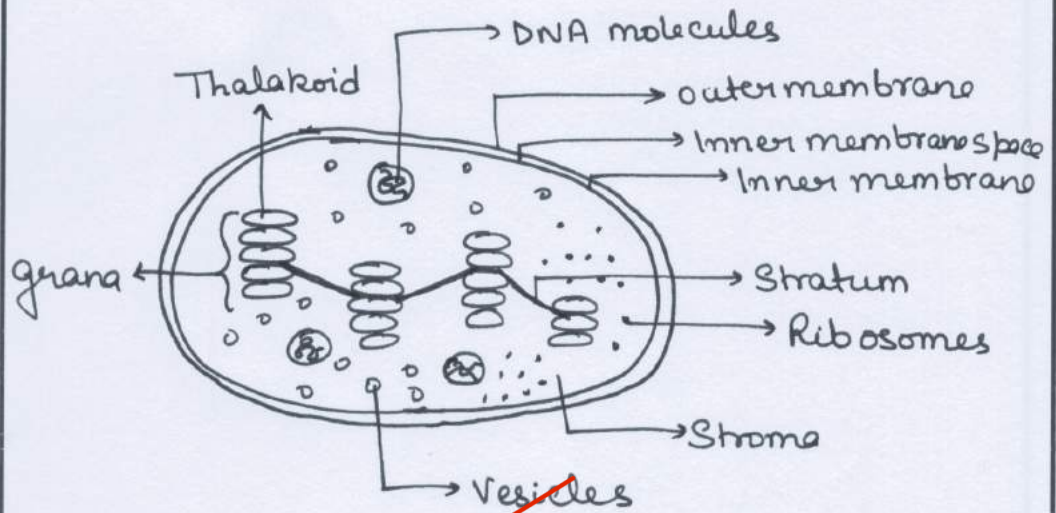
35

Question No.

Remarks

1.5

C. Draw a labeled diagram of prokaryotic and eukaryotic chloroplast and describe their functions. 20 marks.



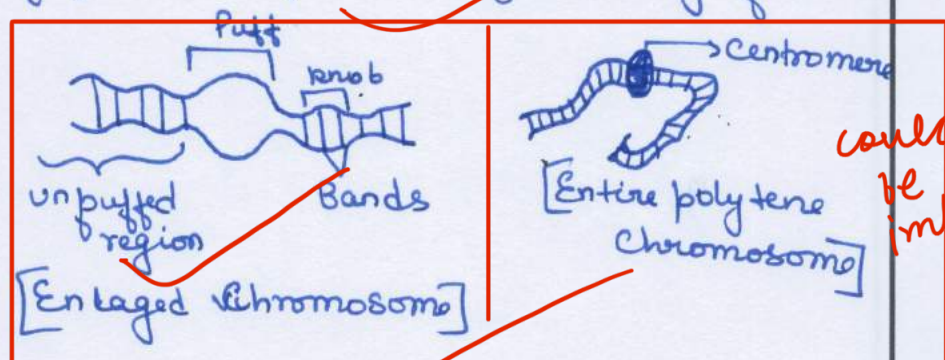


4

D. Polytene chromosome & Signal transduction in prokaryotes.

Polytene chromosome - found in salivary gland of *Drosophila* larval stage. It is largest, complex chromosome with numerous chromatids arranged in parallel. They are mostly found in Eukaryotic cell.

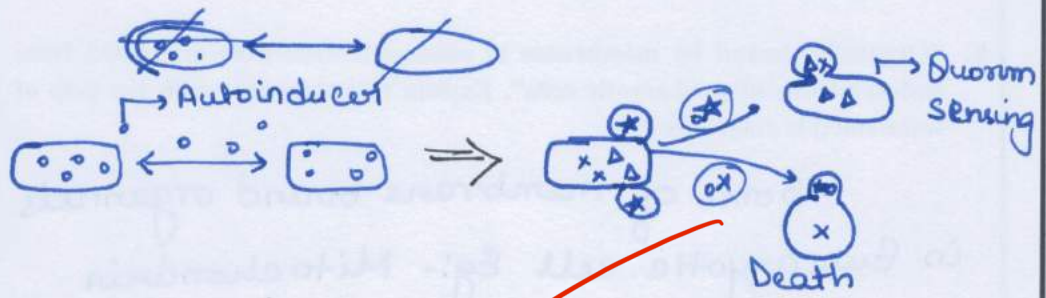
Polytene chromosome determine appearance of cell nucleus and are basis for organisation of cell from chromatin to chromosome to nucleoli to nucleosome. They are key for development & functioning of cell



They are result of simultaneous transcription of more than one gene allele of a gene

Signal transduction in prokaryotes

In prokaryotes mechanism of cell signaling is chemical communication which is referred as quorum sensing. It relies on chemical signalling molecules called auto inducers.



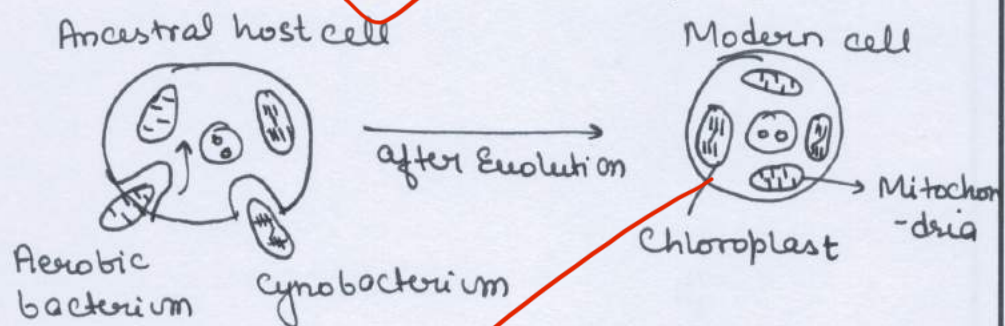
Autoinducers bind to specific receptors within same species of bacteria.



6

E. "Organelles bound by membranes in eukaryotic cells have originated from endosymbiosis of prokaryotic cells". Explain this statement with the help of some suitable diagrams.

Some of membrane bound organelles in Eukaryotic cell Eg:- Mitochondria and cytoplasm are originated from endosymbiosis of prokaryotic cell



Evidences :-

• Size :- Prokaryotic cell and size of chloroplast and mitochondria is same.

Division :- Mitochondria and chloroplast divide by binary fission similar to prokaryotic cell division.

Nuclear material

Mitochondria and chloroplast contain DNA which is circular in shape like prokaryotic cell. Eukaryotic cell have linear DNA

Ribosomes

Mitochondria and chloroplast have their own DNA ribosomes which is 70S type (30S & 50S) like prokaryotes. Eukaryotes ribosome 80S type (60S & 40S)

Date:

# KAVERI'S IAS | UPSC

47

Question No.

Remarks

Endosymbiotic theory states that mitochondria and chloroplast in modern eukaryotic cell are separated from ancestor prokaryotic microbes.

Comment :-

- content is excellent but diagram can be improved.