# RNA.

- RNA is polymer of ribonucleotides.
- Linked together by 3’-5’ phosphodiester bond.
- Function of RNA-
- Protein synthesis.
- Genetic material.
- Ribozymes.
-

# *TYPES OF RNA.*

| | |
|---|---|
| mRNA | • Messenger RNA<br>• m RNA |
| t RNA | • Transfer RNA<br>• T RNA |
| r RNA | • Ribosomal RNA<br>• R RNA |

# *GENE REGULATION*.

- Gene regulation refers to the mechanism that act to induce or repress the expression of a gene.

# Level of Gene control.

- ***Gene on DNA***
- |
- - -Transcriptional control
- *Primary transcript*
- ( RNA processing control)
  m RNA
  ( RNA transport control )
- |
- -- Translation control.

*Protein*

# TYPES OF RNA.

| m – RNA- messenger. | Translation. |
|---|---|
| r-RNA- ribosomal | Protein synthesis. |
| t- RNA- transfer | translation |
| Sn-RNA-- small nuclear | m RNA processing poly a addition |
| Sno-RNA---small nucleolar | r- RNA processing/ maturation, methylation. |
| Regulatory RNA---siRNA and miRNA | Regulation of transcription and translation. |

# Regulatory RNAs.

| | |
|---|---|
| Sn RNA | • Small nuclear RNA<br>• Sn RNA |
| mi RNA | • micro<br>• RNA |
| Si RNA | • Small interferring<br>• RNA |

# REGULATORY RNA.

**siRNA**

- Inhibition of gene expression.

**mi RNA**

- Inhibition of gene expression.
- Tumour suppression and oncogenes.

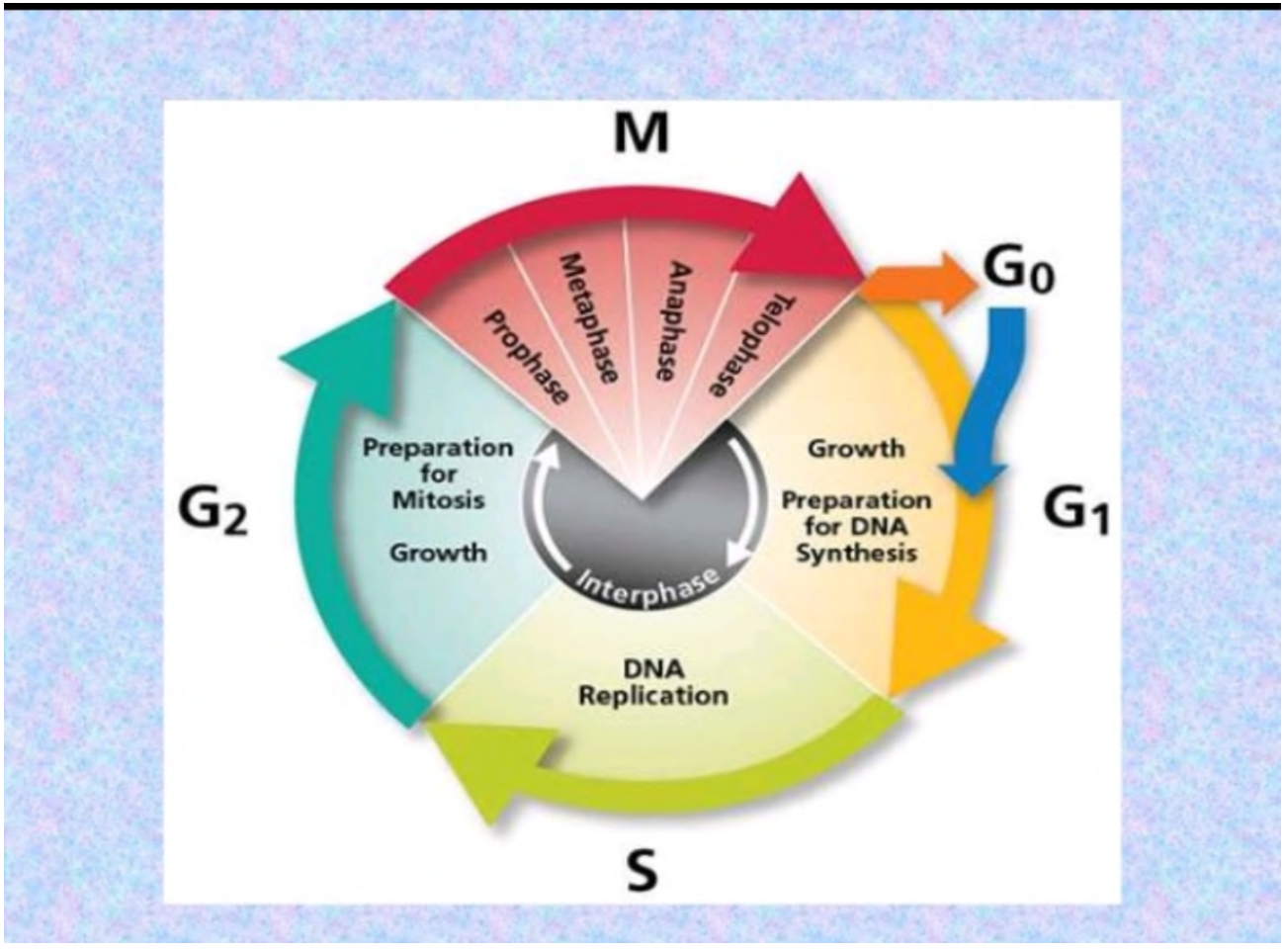
**Nascent RNA**

- Primary transcript RNA.
- Needs to be processed like—capping, RNA splicing.

# PHASE OF CELL CYCLE

- *G1---- (Gap-1)—Phase.*
- *S-------Synthetic phase.*
- *G2- --- Gap-2 Phase.*
- *M-------Mitotic phase.*
- *G1, S, and G2-----Interphase—cell prepare to divide.*
- *M phase---Both DNA and cytoplaslm divide to produce two daughter cells.*

# PHASE OF CELL CYCLE.



# *INTERPHASE.*

## Interphase

- The interphase is the preparation phase for the redivision of a cell.
- It is the longest phase of the eukaryotic cell cycle.
- The interphase is divided into THREE stages.

(G0/G1, S, G2)

# INTERPHASE- G1 PHASE.

- 1st growth stage after cell division.
- Cells matures by making more cytoplasm and organelles.
- Cells carries on its normal metabolic activity.
- S-STAGE-
- synthesis stage.
- DNA is copied or replicated.

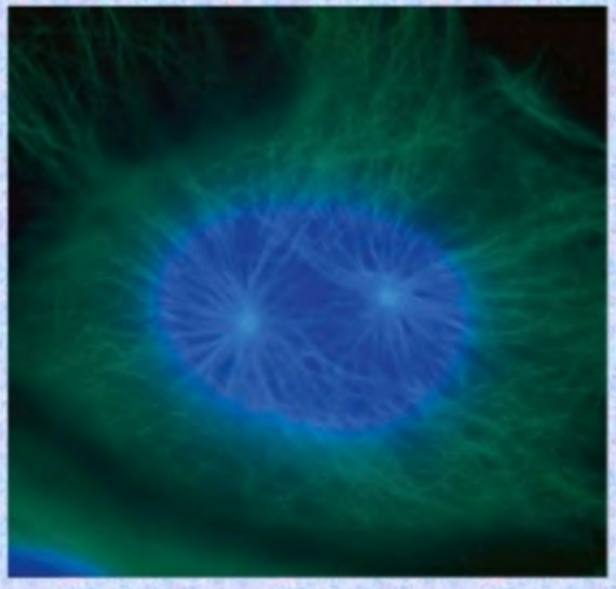
# *INTERPHASE --G2 - stage*

- 2nd growth stage.
- Occurs after DNA has copied.
- All cell structure needed for division are made.(eg-centriole).
- Both organelles and proteins are synthesized.
- DNA replicates, centriole if present replicate.
- cell prepares for division.

# *MITOSIS.*

## Prophase

- The nuclear membrane and endoplasmic reticulum disappear.
- The chromosomes shorten and thicken.
- Centrosomes move towards opposite poles.
- The nucleolus disappears.
- Spindle cells form from the poles to the center.



# *MITOSIS*.

- Division of nucleus also called karyokinesis.
- Has four stages.
- ***Four mitotic stages*** are--
- Prophase.
- Metaphase.
- Anaphase.
- Telophase.
-

# Early prophase.

- Chromatin in nucleus condenses to form visible chromosome.
- Mitotic spindle forms.
- *Late Prophase*– nuclear membrane and nucleolus are broken down.
- Chromosome condenses and clearly visible.
- Spindle fibre called kinetochore attach to the centromere of each chromosome.
- Spindle finishes forming between the poles of the cell.
-

# *METAPHASE.*

- Chromosomes, attached to the kinetochores fibre, move to the centre of the cell.
- Chromosomes now lined up at the equator.
  *ANAPHASE* --
- occurs rapidly.
- Chromatids are pulled apart to opposite poles by kinetochores fibres.
-

# *TELOPHASE.*

- Sister chromatids at opposite poles.
- Spindle disasembles.
- Nuclear envelope forms.
- Nucleolus reappears.
- Cytokinesis occurs.
- Chromosome reappear as chromatin.

# *CYTOKINESIS*.

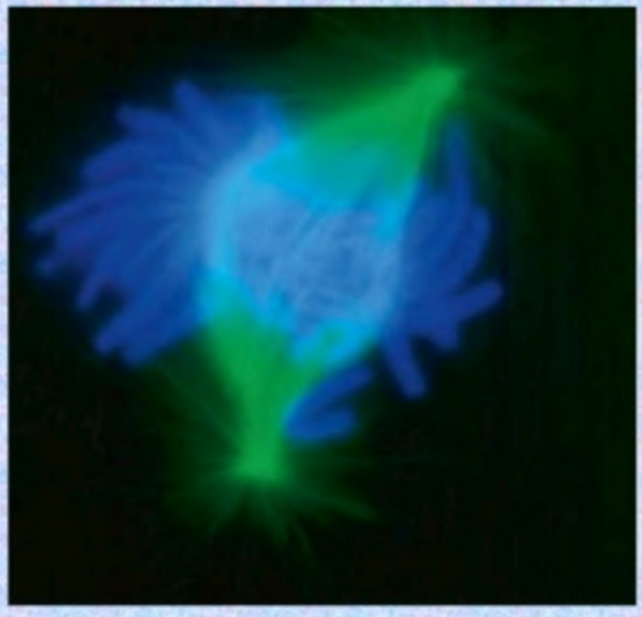
- Means division of cytoplasm.
- Division of cell into two identical half called daughter cells .

- Daughter cells of mitosis have same number of chromosomes that of parent cell.
- Must grow in size to become mature cells.( G1 of Interphase)

# *METAPHASE.*

## Metaphase

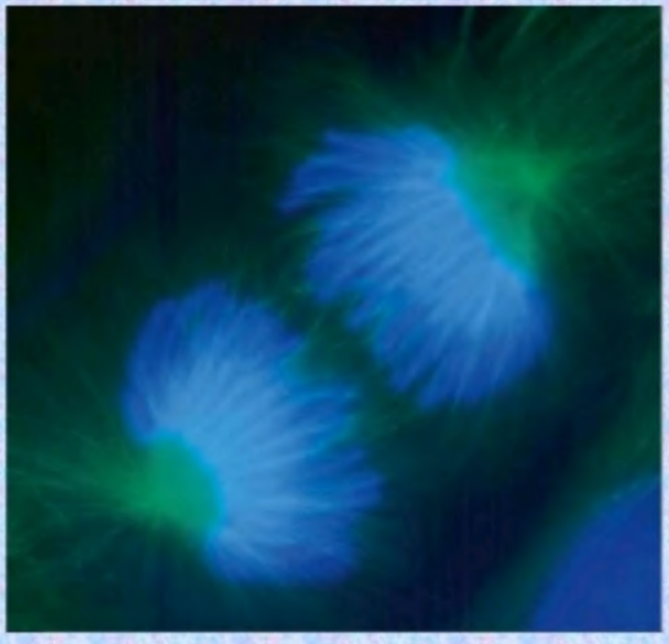
- The chromosomes shorten and thicken further.
- Sister chromatids are kept together using centromeres.
- The chromosomes are arranged side-by-side in a row in the equatorial plane.
- The chromosomes hold on to spindle cells with their centromeres.



# *ANAPHASE.*

## Anaphase

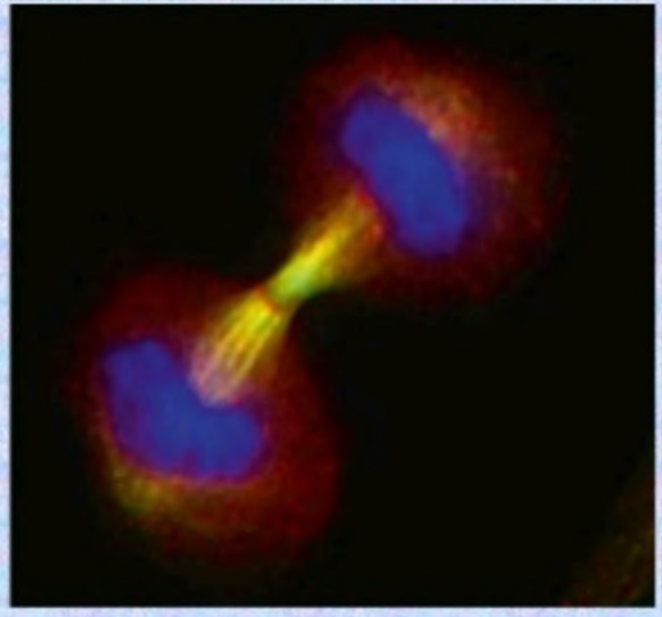
- The contraction and relaxation movements of spindle cells break the centromeres that lock the chromatids together.
- The sister chromatids are separated from each other and are moved to opposite poles.



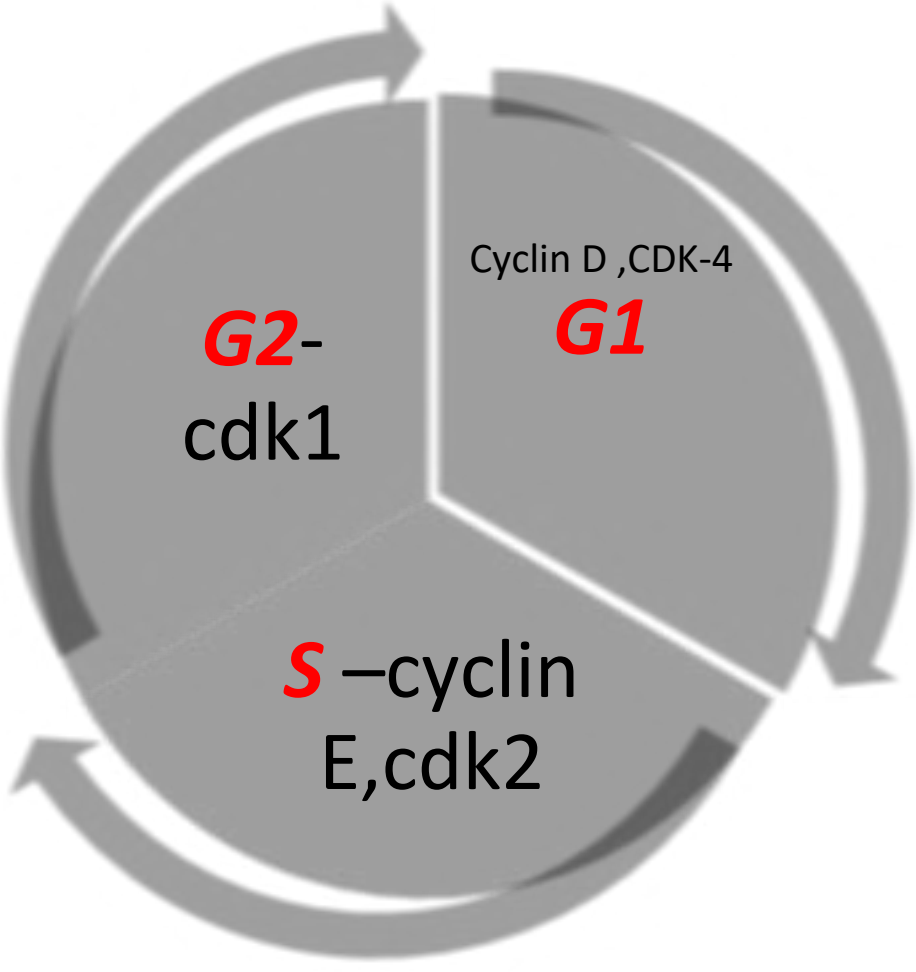
# *TELOPHASE.*

## Telophase

- The chromosomes stop moving.
- The chromosomes unwind their helices and become chromatins.
- The nucleolus reappears.
- RNA and protein syntheses start.
- Spindle cells disappear.
- The nuclear membrane forms, and the endoplasmic reticulum takes on a shape again.
- Vital events restart in the cell.
- Cytogenesis occurs, and division finishes.



# *PHASE OF CELL CYCLE AND REGULATION.*



# *ROLE OF CDK-1 COMLEX IN G2 CHECK POINT REGULATION.*

- CYCLIN B—CDK-P ---INACTIVE
- **<- Active protein kinase <- DNA strand break.**
- |
- CYCLIN –B CDK-1 ---ACTIVE
- |

- Phosphorylation of several protein.
- |
- Bipolar spinle formation -----***MITOSIS.***

# *Cyclin and cdk molecule.*

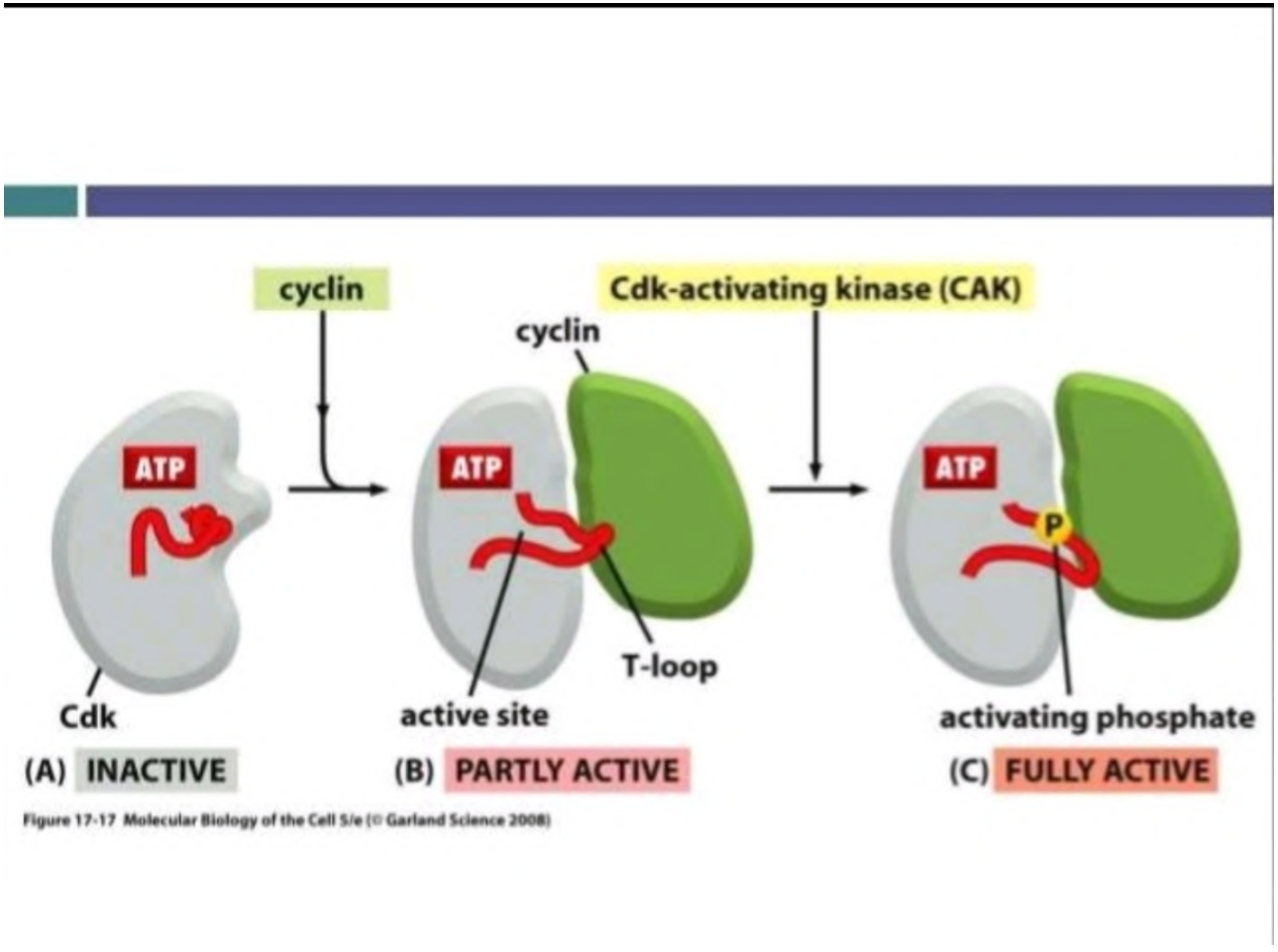


Figure 17-17 Molecular Biology of the Cell 5/e (© Garland Science 2008)

# *FIVE PHAGES OF THE CELL CYCLE*.

- G1—Primary growth phase.
- S---synthesis, DNA replicated.
- G2—secondary growth phase.
- Collectively these 3 stages are called interphase.
- M—mitosis.
- C—cytokinesis.

# *CELL CYCLE REGULATION*.

- Why cell cycle cycle regulation-------
- cell division is expensive process.
- Maintain integrity of genome.
- Proper cellular homeostasis.
- Prevent onset of mutation.

# *KEY REGULATOR*.

Cdk/cyclin dependent protein,catalytic protein.

- Cyclin, regulatory protein.

Apart from these , two other important regulator....

- (Rb protein and p53 protein.)-Tumours suppressor protein.

# Oncogenes also disrupt cell cycle.

- P53 is a tumor suppressor gene –
- p53 gene produces a protein with a molecule mass of 53kDa.This protein suppresses the tumour formation. it arrest the cell cycle at G2/M check point. Mutation in p53 gene are found in 50% of all cancer.
- It distrupts cell cycle both at G1/S and G2/M check point by coding for a CDK inhibitors called p21 which binds to several cyclin CDK comlexes influencing the cell cycle.

# *BCL2 GENE*.

- *BCL2 gene* associated with beta – cell lymphoma appears to induce cyclin D gene. Excess cyclin D expression could result in unrestained cell division leading to cancer.
- ***CDK INHIBITORS-***---------
- CDK are inhibited by CDK inhibitors which are produced in response to signal like DNA damage. These inhibitor lead to arrest of cell cycle.

# *CYCLINS*.

- They named because they undergo a cycle of synthesis of degradation in each cycle.
- It is a regulatory protein of cell cycle and shows continuous rise and fall during the various stages of cell cycle.
- Synthesis of cyclins proteins begins during G1 phase and they increases their concentration till Metaphases but in anaphase they are degraded by the actvated by the actIvity of APC.

# *FOUR CLASSES OF CYCLINS*.

- *G1 CYCLINS---*
- *Help to promote passes through " start" .*
- *G1/S CYCLINS----*
- *Bind to Cdks at the end of G1 and commit cell to DNA replication.*
- *S-CYCLINS----*
- *Bind Cdks durindg S phase cand are required for initiator of DNA replication.*
- *M CYCLINS —Promote the event of mitosis.*

# Cyclin.

Cyclin is the important key regulator of cell cycle.

- Cyclin.....

Also regulate the activity of cdk.(cyclin dependent kinase.)

- Regulator of both cell cycle and cdk.

# CYCLIN DEPENDENT KINASE.

| | |
|---|---|
| KINASE | • Progression of cell cycle is controlled by a conserved set of protein called --<br>• KINASE. |
| CDK | • Regulate the progression of cell cycle in association with another group of protein called as--<br>• Cyclins. |
| CYCLINS | • Concentration of cyclins fluctuates throughout the cell cycle<br>• Cyclins. |

# *DIFFERENT TYPES OF Cdk.*

**Cdk1**

- G2 to M phase.
- G2 to M

**Cdk2**

- G1 to S.
- G1 to S phase.

**cdk4**

- G1 to S.
- Gap 1 to Synthetic phase.
  ***Cdk 20***—Metaphase to Anaphase....

# *THREE MAIN TRANSITION CHECK POINTS IN CELL CYCLE.*

G1 TO S.

G2 TO M.

METAPHASE TO ANAPHASE.

# *G1 CHECK POINT.*

- Checks conditions are favouring for cell division.
- Checks for genomic DNA damage at G1,adequate energy reserves, DNA damage.
- Synthesis of G1 cyclins must reach specific level to cross the start point.

# Rb protein.(Retinoblastoma protein).

- Classic tumour suoppressor.
- Its product called Rb protein prevents the cell to migrate from G1 to S Phase.
- Master regulator of biological pathway like---
- Cell Growth, cell cycle checkpoints, differentiation, replication, genomic stability and apoptosis.

# P53 protein.
# (GUARDIAN OF GENOME.)

| | |
|---|---|
| P53 PROTEIN. | • Tumour suppressor gene.<br>• P53. |
| P53 | • Preventing tumour developement<br>• p53 |
| P53 | • Inhibit over expression of cell.<br>• Regulate the cell cycle. |