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AP Biology Insta-Review

Unit 4/5: Cellular Communication & Cell Cycle

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AP Biology

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Today's Plan:

Special Thank You to Mrs. McClinton (Chat Q&A)

Cellular Communication

Cell Cycle

Mitosis & Meiosis

Practice Questions

Unit 4/5 Q&A

Cellular Communication

Reception

Ligand (signaling molecule) binds to receptor
Causes confirmational shape change
Ex: G protein coupled receptor

Steroid Hormone

Release: Simple Diffusion
Receptor: Intracellular
Example: Testosterone, Estrogen

Protein Hormone

Release: Exocytosis
Receptor: Extracellular
Example: Insulin

Transduction

Signaling cascades relay signals from receptors to cell targets, often amplifying the incoming signals

Phosphorylation Cascade

Protein Kinase
Phosphorylate relay molecules

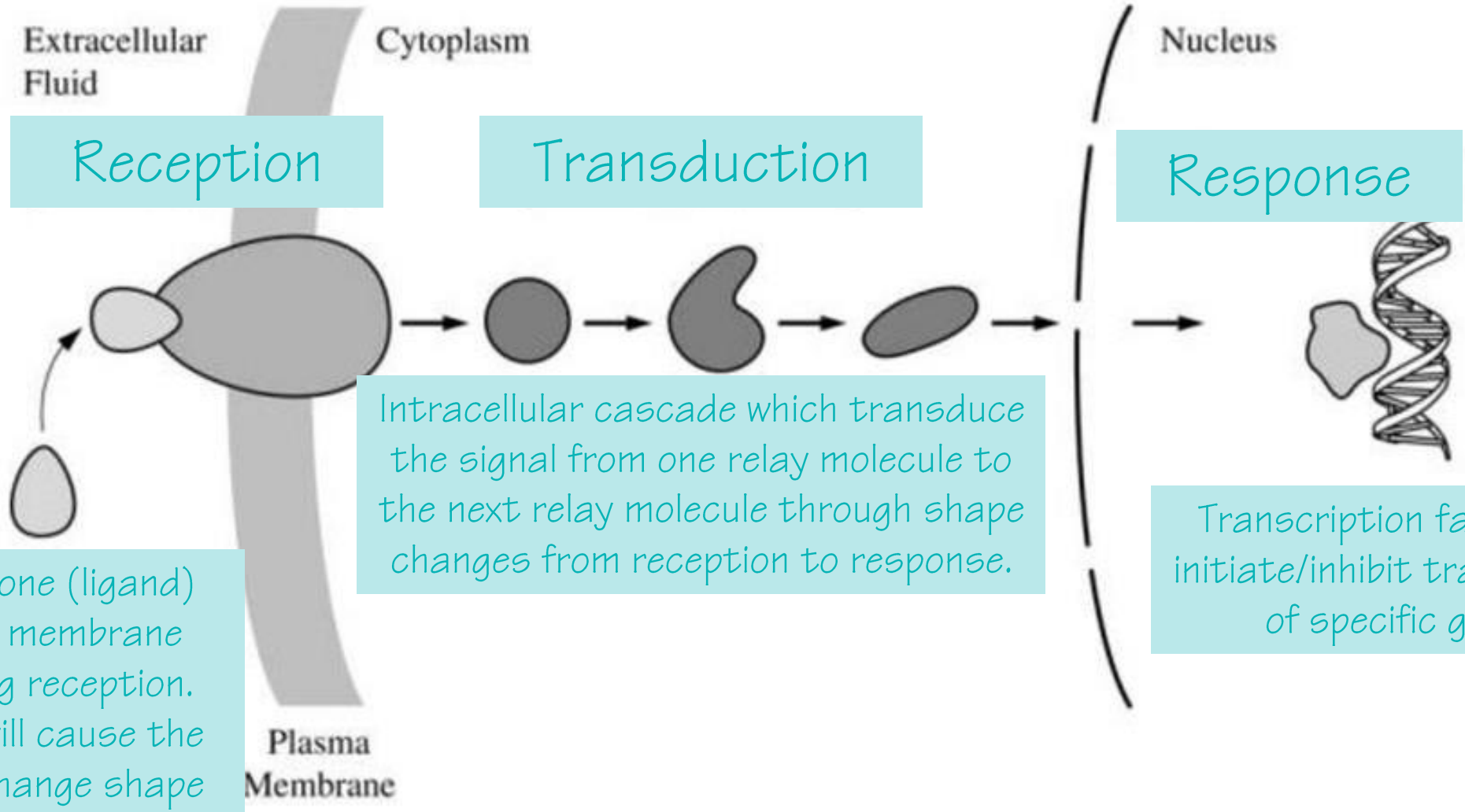
Secondary Messengers

Ca^{2+}
cAMP

Response

cell growth
secretion of molecules
gene expression
apoptosis

Cellular Communication



Reception

Protein hormone (ligand) binds to the membrane protein during reception. This binding will cause the receptor to change shape which initiates transduction.

Transduction

Intracellular cascade which transduce the signal from one relay molecule to the next relay molecule through shape changes from reception to response.

Response

Transcription factors will initiate/inhibit transduction of specific genes.

Example: 2021 #1

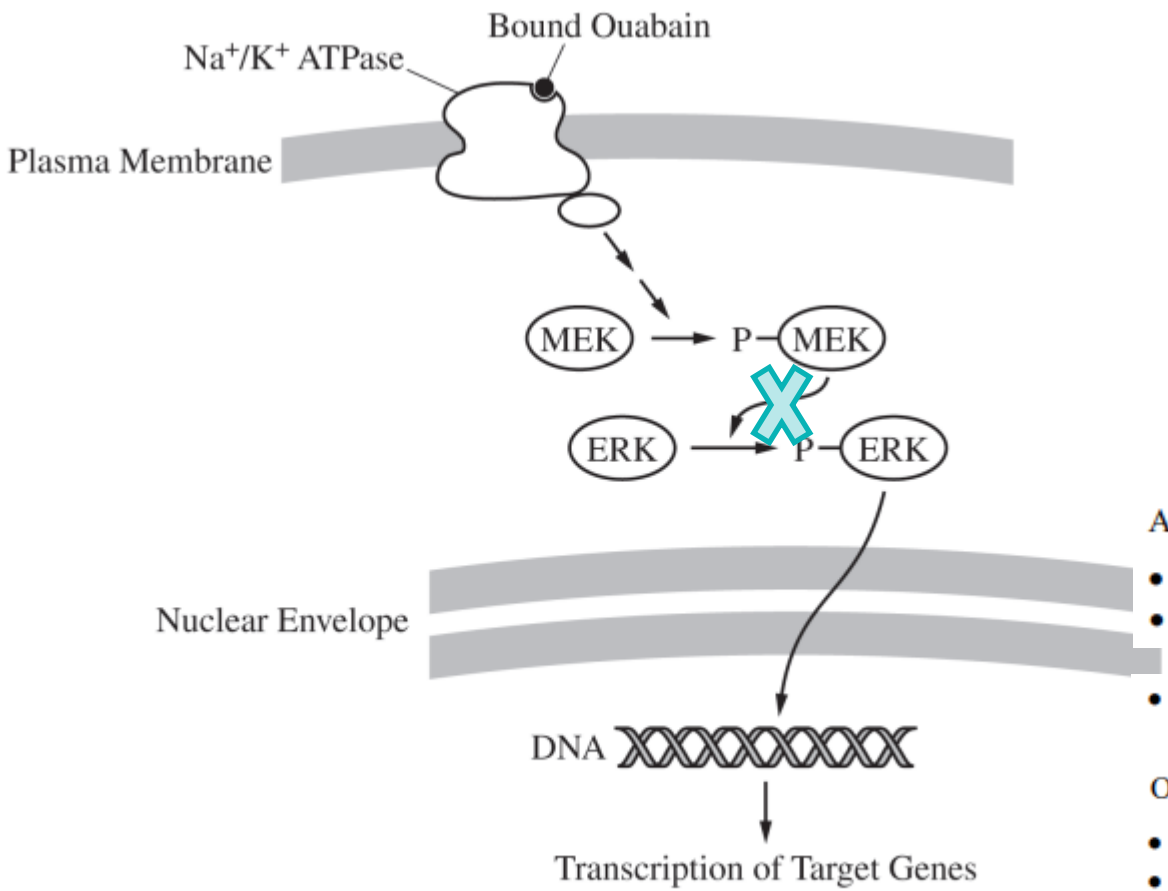


Figure 3. Signal transduction pathway hypothesized to play a role in the increased number o

In a third experiment, the scientists added an inhibitor of phosphorylated MEK (pMEK) to the PKD cells exposed to 10^4 ouabain. Based on Figure 3, **predict** the change in relative ratio of ERK to pERK in ouabain-treated PKD cells with the inhibitor compared with ouabain-treated PKD cells without the inhibitor. Provide reasoning to **justify** your prediction.

Accept one of the following:

- Option 1: The ratio of ERK to pERK will increase in the cells with the inhibitor.
- Option 2: The ratio of ERK to pERK will stay the same in the cells with the inhibitor.

- The justification must indicate that the pMEK inhibitor blocks further phosphorylation of ERK AND one of the following:

Option 1:

- The amount of pERK will not increase as it does in cells without the inhibitor.
- The amount of ERK will not decrease as it does in cells without the inhibitor.
- The cell continues to synthesize ERK.
- Phosphorylated ERK is being dephosphorylated to ERK.

Option 2:

- No additional ERK is synthesized/pERK is not being dephosphorylated.

Example: 2018 #2

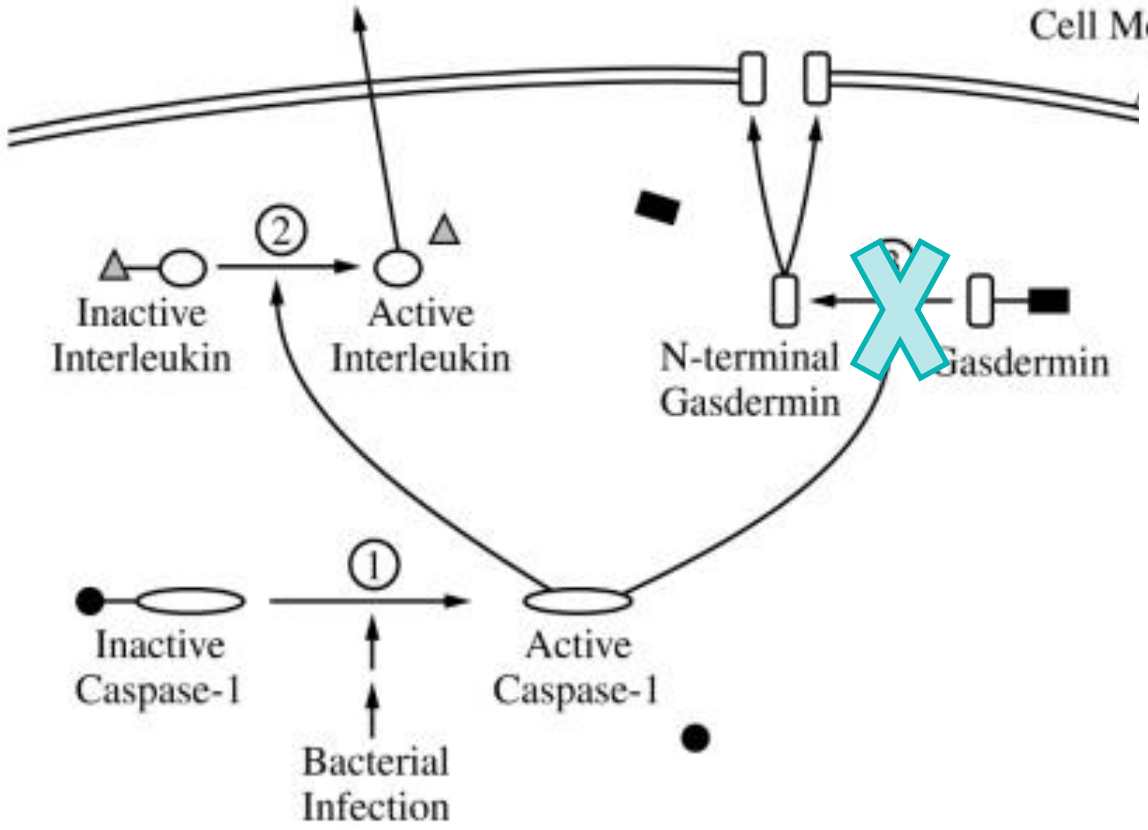


Figure 1. Cellular response to infection by pathogenic bacteria

In response to intracellular pathogens, the inactive caspase-1 is cleaved and forms an active caspase-1 (step 1). Active caspase-1 can cleave two other proteins. When caspase-1 cleaves an inactive interleukin (step 2), the active portion of the interleukin is released from the cell. An interleukin is a signaling molecule that can activate an immune response. When caspase-1 cleaves gasdermin (step 3), the N-terminal portions of several gasdermin proteins associate in the cell membrane to form large, nonspecific pores.

(a) **Describe** the effect of inhibiting step 3 on the formation of pores AND on the release of interleukin from the cell.

Description (2 points)

- Pores will not form.
- Interleukin release will not be affected/interleukin release continues.

Cell Cycle

G_1

Duplication of cell organelles
Synthesis of proteins, RNA, and building blocks

S

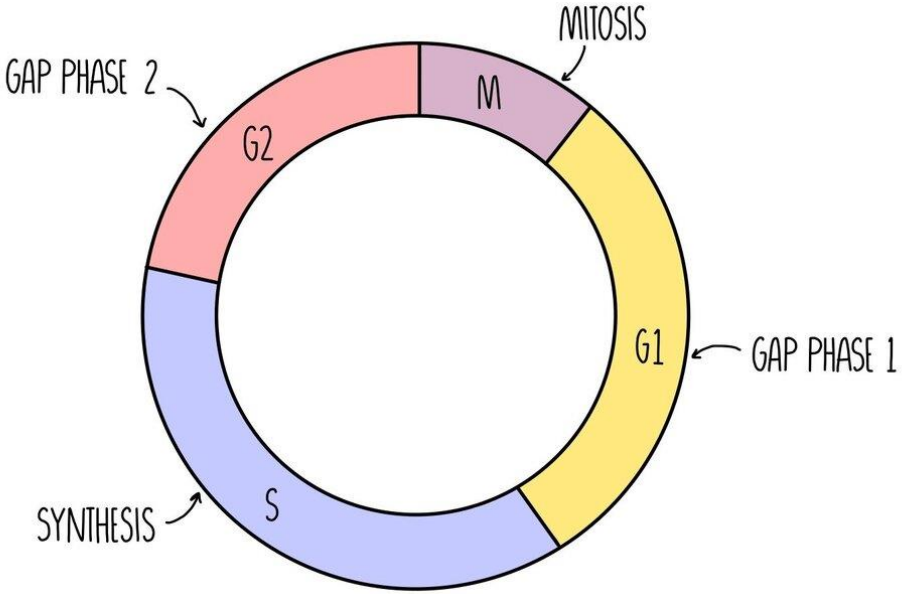
Replication of genetic material and centrosomes

G_2

Synthesis of proteins and RNA
Makes organelles
Reorganizes cellular contents

Interphase

The cell grows through all the different phases of interphase



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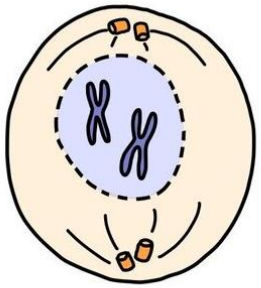
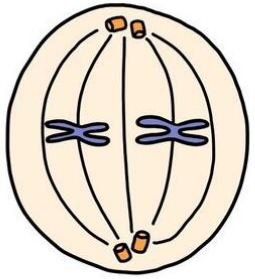
PREPARE to divide



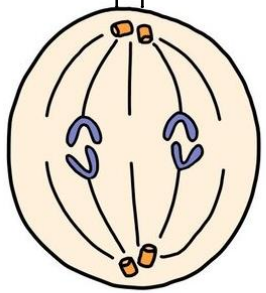
PROPHASE

Sister Chromatids line up in the MIDDLE

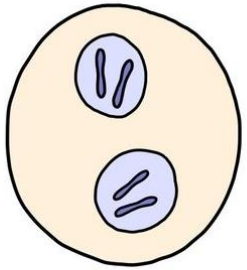


METAPHASE

Sister Chromatids pulled APART to opposite poles



ANAPHASE

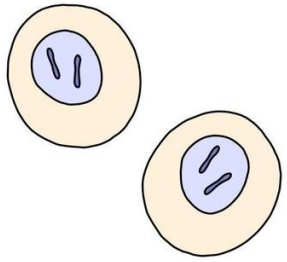


TELOPHASE

TWO new nuclei are formed

Cytokinesis

Division of the cytoplasm



CYTOKINESIS

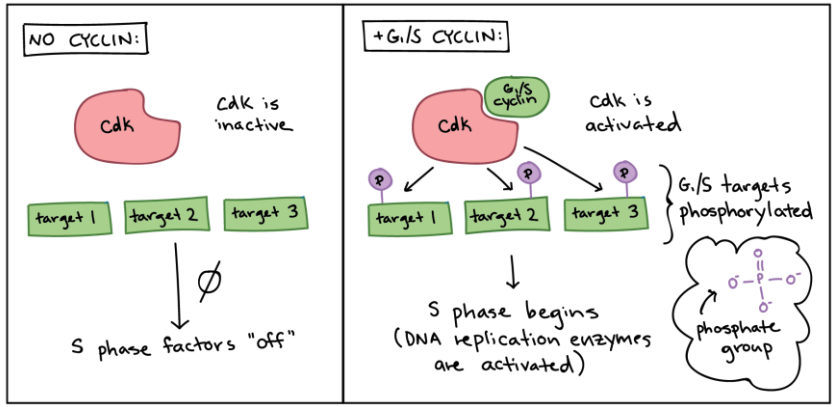
Checkpoints

G_1

During G_1, determines whether to complete the cell cycle

- Growth factor
- Adequate reserves
- Check for DNA damage

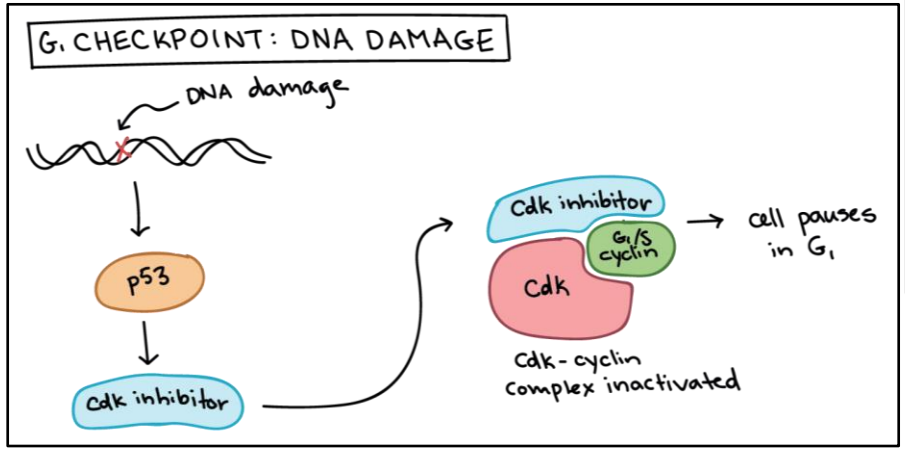
If do not pass, enter G_0 (nondividing state)



G_2

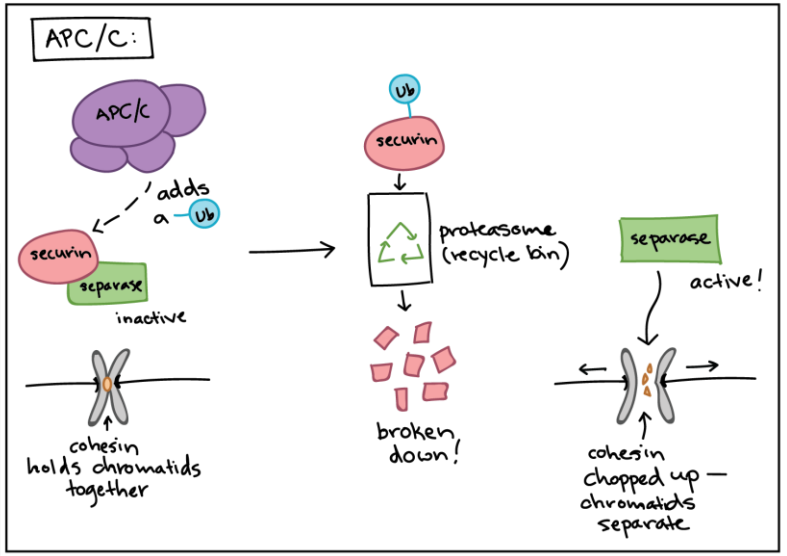
Check all DNA replicated and not damaged.

If detect problems with DNA, the cell cycle is halted, to complete DNA replication or repair the damaged DNA.



M

Check sister chromatids attached to the spindle microtubules



Meiosis

Meiosis I – Homologous Chromosomes
Meiosis II – Sister Chromatids

Prophase I

Chromatin condenses
Sister chromatids/ homologous chromosomes align
CROSSING OVER

Metaphase I

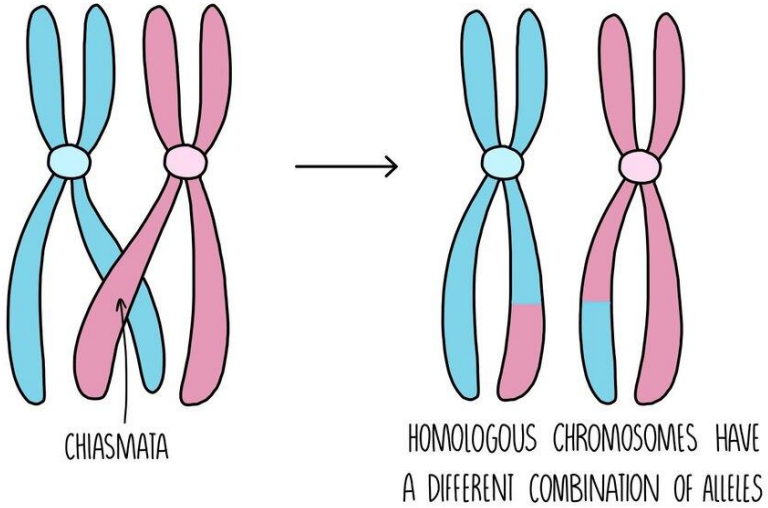
HOMOLOGOUS CHROMOSOMES align on the metaphase plate
INDEPENDENT ASSORTMENT

Anaphase I

HOMOLOGOUS CHROMOSOMES separate to opposite poles

Telophase I

Nuclear envelope forms around the HAPLOID daughter cells



Prophase II

Chromatin condenses
Sister chromatids align

Metaphase II

SISTER CHROMATIDS align on the metaphase plate

Anaphase II

SISTER CHROMATIDS separate to opposite poles

Telophase I

Nuclear envelope forms around the HAPLOID daughter cells

	Parent Cell Ploidy	Rounds of DNA Replication	Rounds of Nuclear Division	Daughter Cell Ploidy	Number of Daughter Cells
Mitosis	Diploid	1	1	Diploid	2
Meiosis	Diploid	1	2	Haploid	4

Mitosis vs. Meiosis

	Compare to Parent Cell	Crossing Over	Independent Assortment
Mitosis	Identical	Does not occur	Does not occur
Meiosis	Genetically Distinct	Occurs in Prophase I	Occurs in Metaphase I

Multiple Choice Practice

Insulin is a protein hormone that is secreted in response to elevated blood glucose levels. When insulin binds to its receptors on liver cells, the activated receptors stimulate phosphorylation cascades that cause the translocation of glucose transporters to the plasma membrane.

Based on the information provided, which of the following best describes the role of insulin in this liver cell signal transduction pathway?

a. It acts as a ligand.
b. It acts as a receptor.
c. It acts as a secondary messenger.
d. It acts as a protein kinase.

Multiple Choice Practice

The endocrine system incorporates feedback mechanisms that maintain homeostasis. Which of the following demonstrates negative feedback by the endocrine system?

a. During labor, the fetus exerts pressure on the uterine wall, inducing the production of oxytocin, which stimulates uterine wall contraction. The contractions cause the fetus to further push on the wall, increasing the production of oxytocin. Positive Feedback

b. After a meal, blood glucose levels become elevated, stimulating beta cells of the pancreas to release insulin into the blood. Excess glucose is then converted to glycogen in the liver, reducing blood glucose levels. Negative Feedback

c. At high elevation, atmospheric oxygen is more scarce. In response to signals that oxygen is low, the brain decreases an individual's rate of respiration to compensate for the difference.

d. A transcription factor binds to the regulatory region of a gene, blocking the binding of another transcription factor required for expression.

Multiple Choice Practice

Humans have a diploid number ("2n") of 46. Which of the following statements best predicts the consequence if meiosis did not occur during gametogenesis?

a. The gametes would get larger from one generation to the next.

b. The chromosome number would double with each generation.

c. The chromosome number would be halved with each generation.

d. The chromosome number would triple with each generation.

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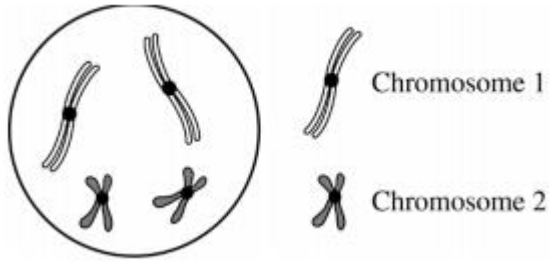


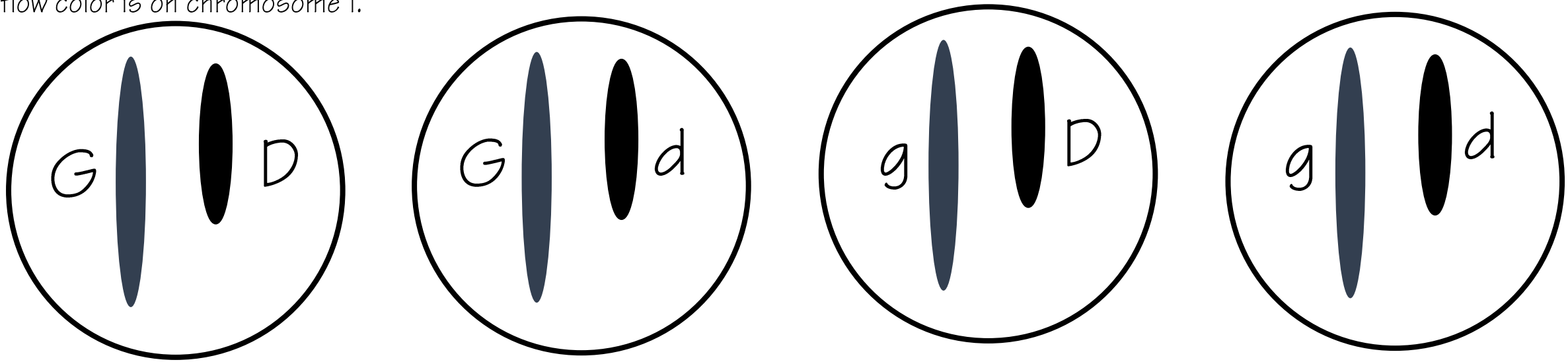
FRQ Practice (2016 #7a)

Free Response Practice:

In a certain species of plant, the diploid number of chromosomes is 4 (2n = 4). Flower color is controlled by a single gene in which the green allele (G) is dominant to the purple allele (g). Plant height is controlled by a different gene in which the dwarf allele (D) is dominant to the tall allele (d). Individuals of the parental (P) generation with the genotypes GGDD and ggdd were crossed to produce F1 progeny.

F1 = GgDd

(a) Construct a diagram below to depict the four possible normal products of meiosis that would be produced by the F1 progeny. Show the chromosomes and the allele(s) they carry. Assume the genes are located on different chromosomes and the gene for flow color is on chromosome 1.



Free Response Practice:

Both mitosis and meiosis are forms of cell division that produce daughter cells containing genetic information from the parent cell.

(a) Describe TWO events that are common to both mitosis and meiosis that ensure the resulting daughter cells inherit the appropriate number of chromosomes.

Description (1 point each; 2 points maximum)

- Spindle elements (microtubules) form/attach to chromosomes
- Chromatin condenses
- Alignment of chromosomes across center of cell prior to chromosome separation
- Separation of chromatids/centromeres to daughter cells
- G2/M checkpoint occurs in both processes
- Replication or synthesis of DNA precedes mitosis/meiosis
- Cytokinesis separates daughter cells after mitosis/meiosis

Free Response Practice:

Both mitosis and meiosis are forms of cell division that produce daughter cells containing genetic information from the parent cell.

(b) The genetic composition of daughter cells produced by mitosis differs from that of the daughter cells produced by meiosis. Describe TWO features of the cell division processes that lead to these differences.

Feature	**Description (1 point each row; 2 points maximum)**	
	Mitosis	**Meiosis**
Number of divisions/ number of resulting cells	1 division/ 2 cells result	2 divisions/ 4 cells result
Ploidy of daughter cells	• Same as parent cell • Diploid • (2n-->2n or n-->n)	• Half of parent cell • Haploid • (4n-->2n; 2n-->n)
Chromatids separate	Occurs	Not in meiosis I/only in meiosis II
Crossing over	Does not occur	Occurs
Homologous chromosomes separate/independently assort	Does not occur	Occurs

Q & A

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Cellular Communication

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Steroid Hormone

Release: Simple Diffusion
Receptor: Intracellular
Example: Testosterone, Estrogen

Protein Hormone

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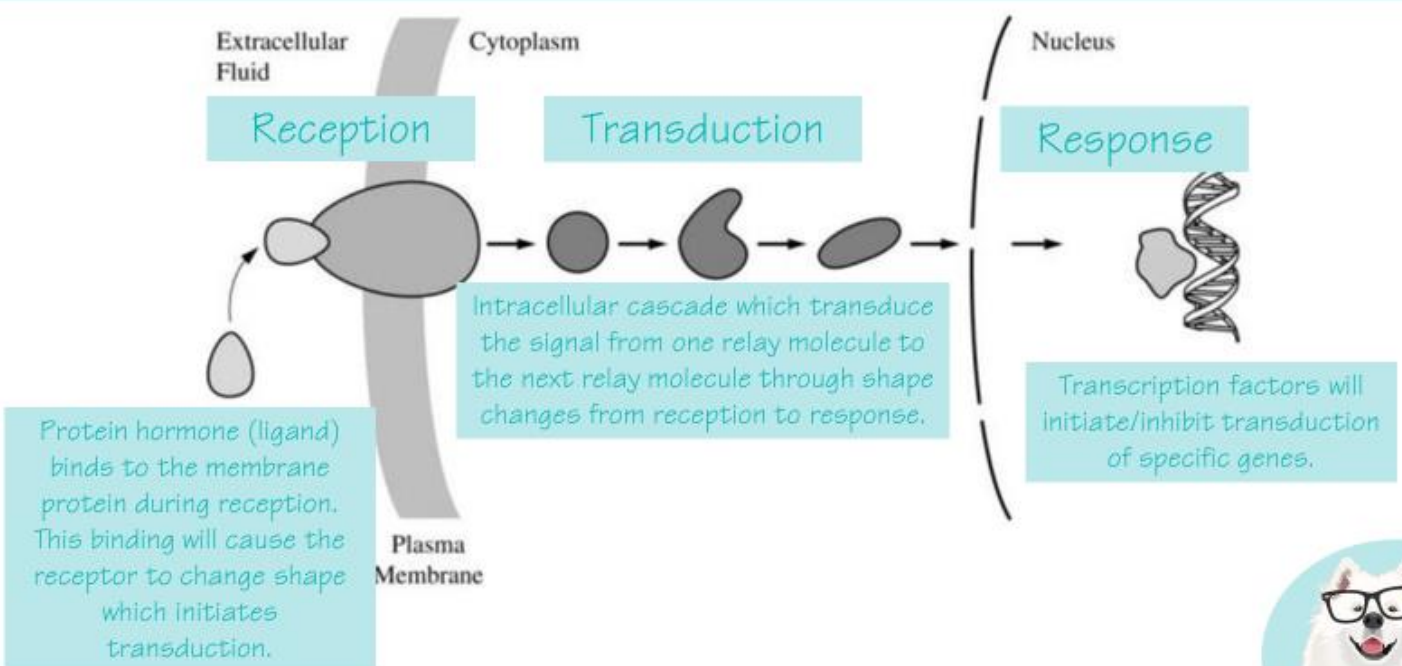
Cellular Communication



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Cell Cycle

G_1

The cell grows through all the different phases of interphase

Duplication of cell organelles
Synthesis of proteins, RNA, and building blocks

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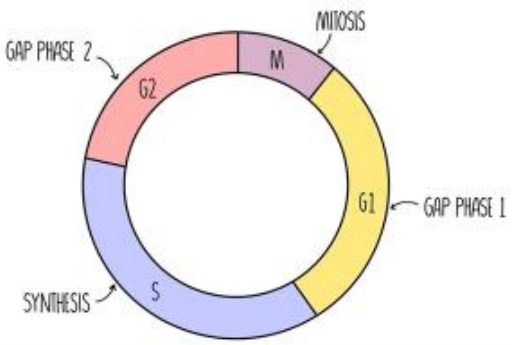
Replication of genetic material and centrosomes

G_2

Synthesis of proteins and RNA
Makes organelles
Reorganizes cellular contents

Interphase



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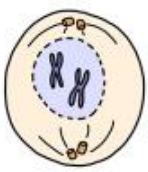

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METAPHASE
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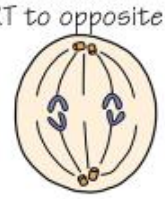

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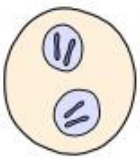


TELOPHASE
TWO new nuclei are formed

Cytokinesis

Division of the cytoplasm

CYTOKINESIS

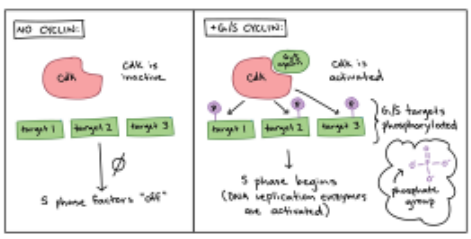
Checkpoints

G_1

During G_1, determines whether to complete the cell cycle

- Growth factor
- Adequate reserves
- Check for DNA damage

If do not pass, enter G_0 (nondividing state)



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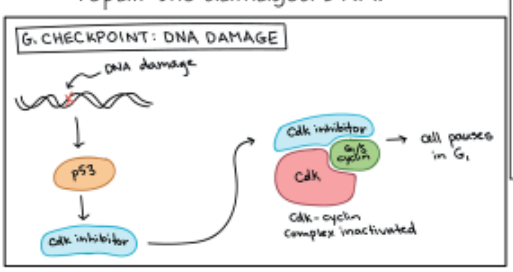

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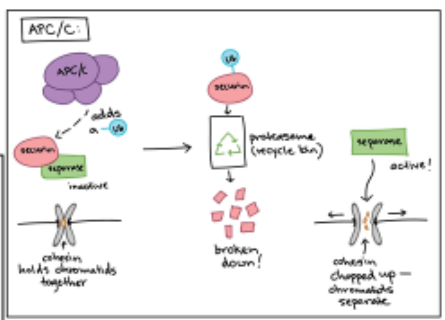

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Sister chromatids/ homologous chromosomes align
CROSSING OVER

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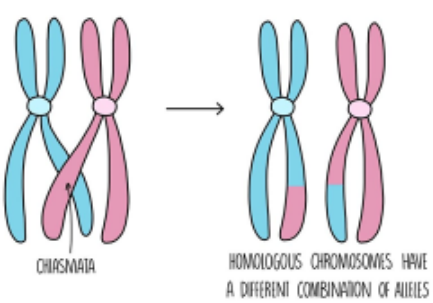

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Nuclear envelope forms around the HAPLOID daughter cells

Prophase II

Metaphase II

Anaphase II

Telophase I