

Observe the phenotypic traits of different dog breeds



Beagle

Keen sense of smell

Detective dogs



Husky

Endurance runners and pull sleds long distances

Sled dogs



German shepherd

Highly trainable

Service dogs

Dogs have traits that make them suited for different tasks.

Which trait makes the **Beagle** in the figure below suitable for his police tasks?



تتميز الكلاب بصفات تجعلها مناسبة لمهام مختلفة.
أي صفة تجعل **كلب البیغل** في الشكل أدناه مناسب لمهامه البوليسية؟

المخرجات التعليمية المرتبطة

BIO.3.2.04.010 °

☐ Endurance to run long distances

العدو لمسافات طويلة

☐ Shepherd—high trainability

القابلية للتدريب بدرجة كبيرة

☐ Keen sense of hear

حاسة السمع القوية

☒ Keen sense of Smell

حاسة الشم القوية

Dogs have traits that make them suited for different tasks.

Which trait makes the **Husky** in the figure below suitable for his tasks? أي صفة تجعل **كلب الهاسكي** في الشكل أدناه مناسب لمهامه؟



تتميز الكلاب بصفات تجعلها مناسبة لمهام مختلفة.

☐ Keen sense of hear

.a حاسة السمع القوية

☐ Keen sense of Smell

.b حاسة الشم القوية

☒ Endurance to run long distances

.c العدو لمسافات طويلة

☐ Shepherd—high trainability

.d القابلية للتدريب بدرجة كبيرة

Selective breeding

What selective breeding is ? (Definition)

The process by which desired traits of certain plants and animals are selected and passed on to their future generations.

What hybrids is ?

Offspring resulting from cross-breeding.

How can desired traits be passed on to future generation?

Through the processes of : hybridization, inbreeding .



Mastiff - large and strong but slow and not aggressive.

+



Bulldog - Aggressive and quick but small.



Bullmastiff - Large, quick, strong and aggressive

Perfect!

Which is an example of **selective breeding**?

ما الذي يُعد مثالاً على **الانتخاب الصناعي**؟

Crossing two plants with desirable traits

خلط نباتين لديهما سمات وراثية مرغوبة

.a

Inserting genes from one plant into another

إدخال جينات من نبات إلى آخر

.b

Returning bred plants to their natural habitat

إعادة النباتات التي تمت تربيتها إلى موطنها الطبيعي

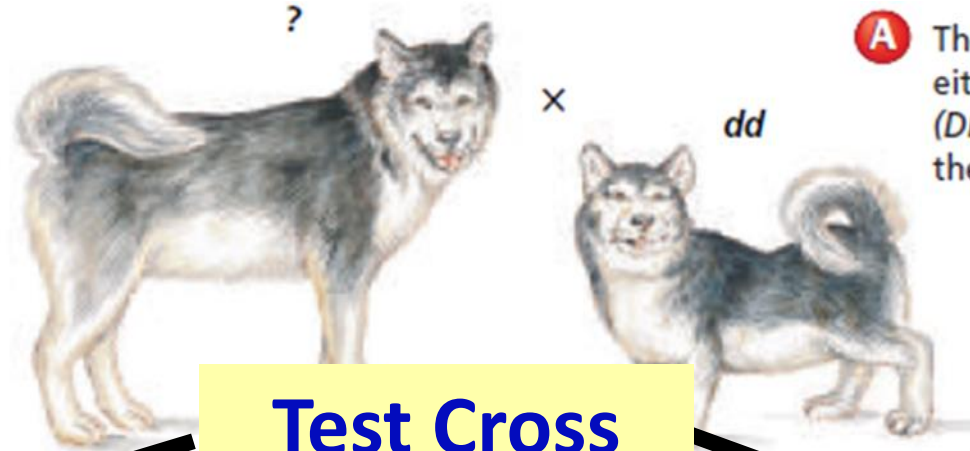
.c

Produce larger fruits and having shorter growing times

إنتاج ثمار أكبر حجمًا وذات فترات نمو أقصر

.d

In this test cross of Alaskan malamutes, the known test dog is homozygous recessive for a dwarf allele (dd), and the other dog's genotype is unknown.



A The unknown dog can be either homozygous dominant (DD) or heterozygous (Dd) for the trait.

Definition

It is Breeding an organism that has **unknown genotype** with other has **homozygous recessive** for the **desired trait**

Steps

1-Breeding

Between **Unknown dominant** genotype and **homozygous recessive** genotype

2-Observed the breeding result

 If **all** the offspring have **dominant** phenotype

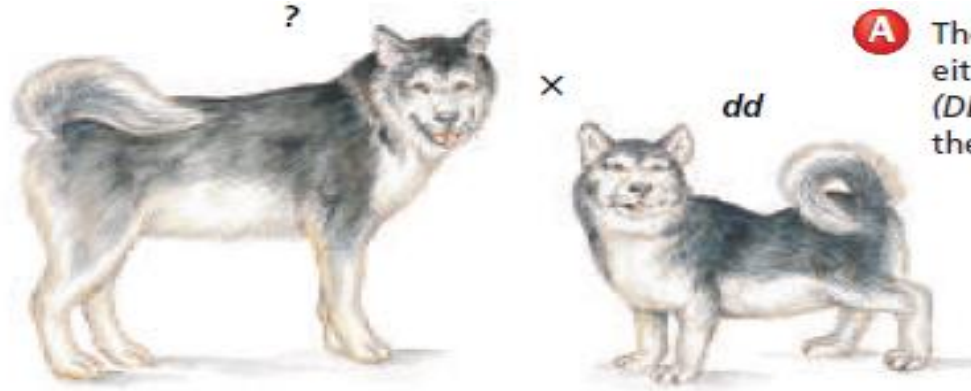
The parent's genotype is **dominant homozygous**

 If the offspring show **1:1** phenotypic ratio

The parent's genotype is **dominant heterozygous**

Example

In this test cross of Alaskan malamutes, the known test dog is homozygous recessive for a dwarf allele (dd), and the other dog's genotype is unknown.



A The unknown dog can be either homozygous dominant (DD) or heterozygous (Dd) for the trait.

B If the unknown dog's genotype is homozygous dominant, all of the offspring will be phenotypically dominant.

Homozygous x Homozygous

	DD	dd
d	Dd	Dd
d	Dd	Dd

Offspring: all dominant



C If the unknown dog's genotype is heterozygous, half the offspring will express the recessive trait and appear dwarf. The other half will express the dominant trait and be of normal size.

Heterozygous x Homozygous

	Dd	dd
d	Dd	Dd
d	dd	dd

Offspring: 1/2 dominant
1/2 recessive



Use the illustration below to answer questions 3 and 4.

3. B

4. C

		Heterozygous white grapefruit	
		W	w
Homozygous red grapefruit	W	Ww	ww
	w	Ww	ww

3. What is the genotypic ratio of the offspring in the cross above?
 - A. 1:2:1
 - B. 1:1
 - C. All are homozygous recessive.
 - D. All are heterozygous.
4. The cross above could be used to determine the genotype of a parent with a dominant phenotype. What is this type of cross called?
 - A. a homozygous cross
 - B. a heterozygous cross
 - C. a test cross
 - D. a parental cross

A test cross occurs when an individual with an unknown genotype is crossed with a homozygous recessive individual for the desired trait.

Homozygous dominant

Heterozygous v

Homozygous recessive

Polyploid

6. A breeder performs a test cross to determine the genotype of a black cat. He crosses the black cat (BB or Bb) with a white cat (bb). If 50 percent of the offspring are black, what is the genotype of the black cat?

6. The genotype of the black cat is Bb .

A method used to determine the genotype of a plant with a dominant genetic trait.

- Hybridization
- the transfer
- Test cross
- Open Reading Templates

DNA of one
organism



(DNA of another organism)
exogenous DNA

From the figure: **Infer** the definition of **Genetic Engineering**

**Process in which genes (sections of DNA) are taken
from one organism and transferred to another**

This organism called
Genetically engineered organisms



To study specific gene

DNA Tools

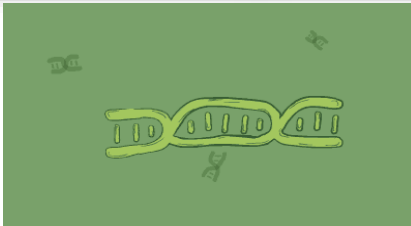
Scientists used to

Manipulate
(control)
DNA

Isolate
gene from
genome

- used in genetic engineering are:

Restriction enzymes



DNA from
suspect

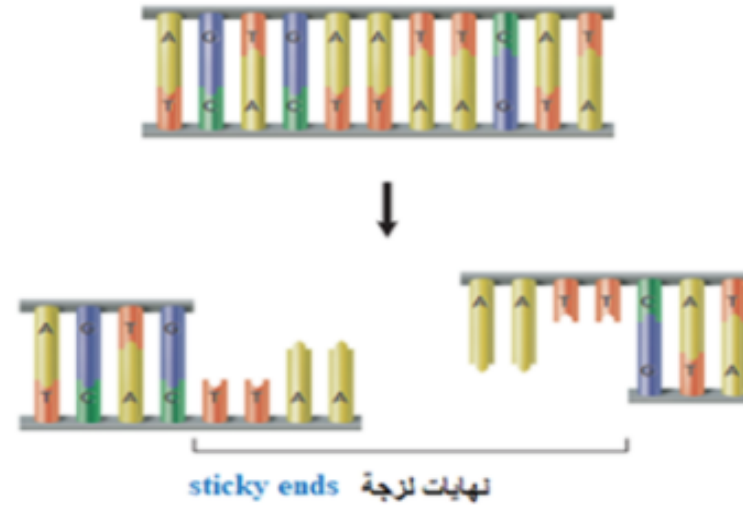
DNA from
blood stain

Gel

Gel electrophoresis

The figure below shows DNA containing the sequence **GAATTC**. Which of the following enzymes lead to the formation of these sticky ends?

الشكل أدناه يوضح الحمض النووي الذي يحتوي على التسلسل **GAATTC**. أي إنزيم مما يلي يؤدي إلى تكوين تلك النهايات اللزجة؟



Reverse transcriptase

إنزيم نسخ عكسي

.a

DNA ligase

إنزيم ربط

.b

ECORI Cut

إنزيم قطع

.c

Polymerization enzyme

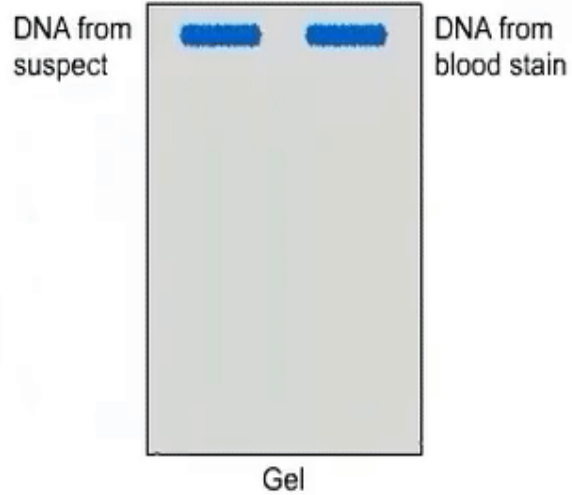
إنزيم بلمرة

.d

Gel Electrophoresis

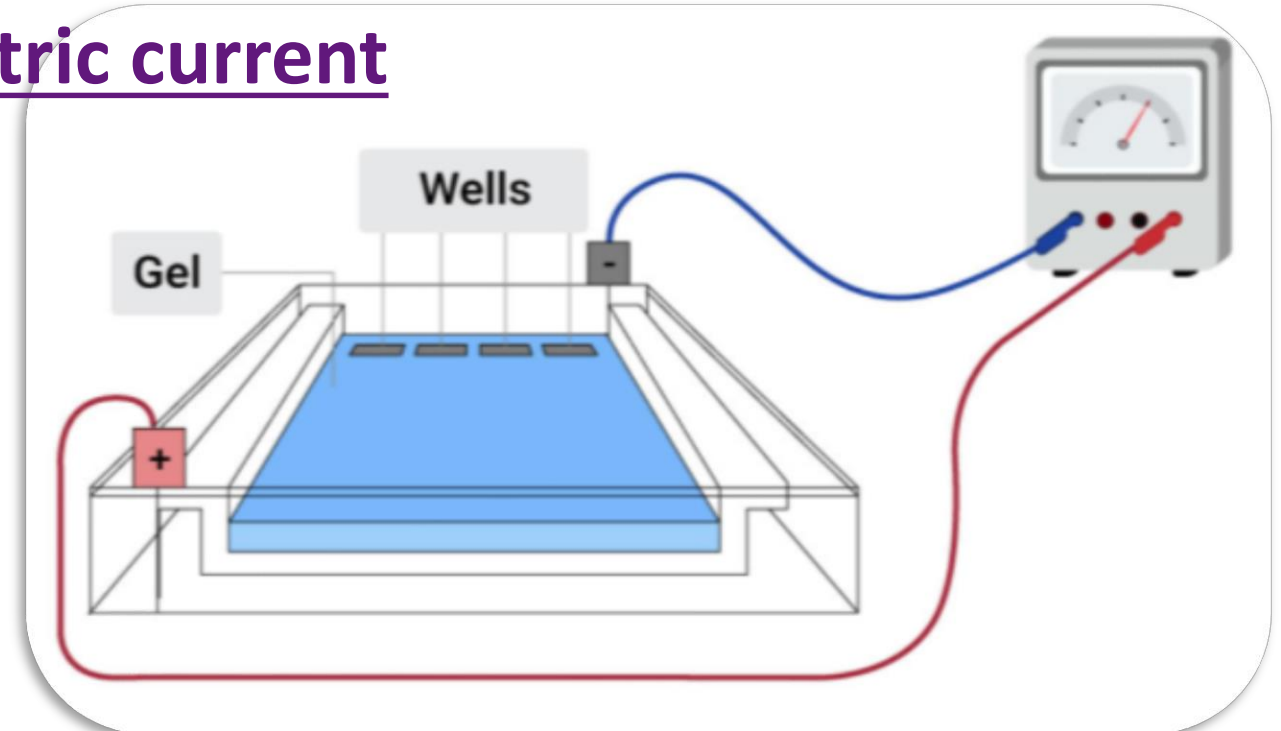
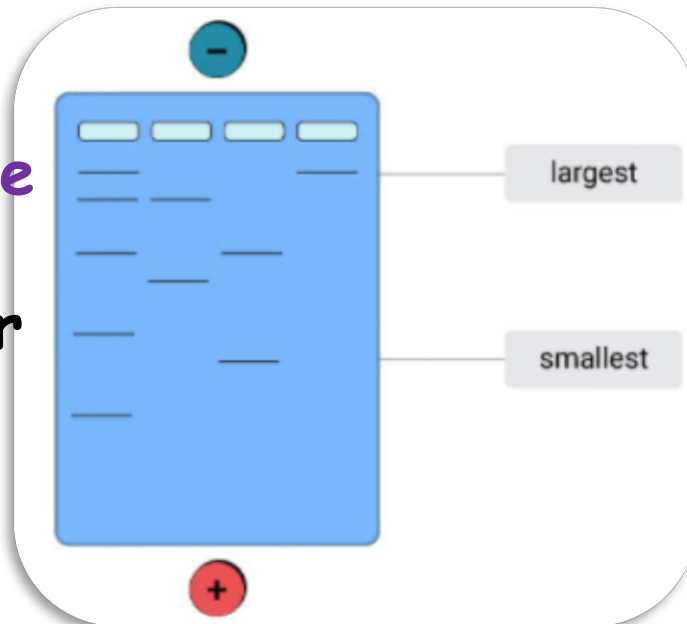
It is a process

DNA Tools



used to separate DNA fragments
according to the size of fragments
by an electric current

The **smaller** fragments **move faster** than the larger ones.



When an electric current is applied, the DNA fragments **move toward the positive** end of the gel

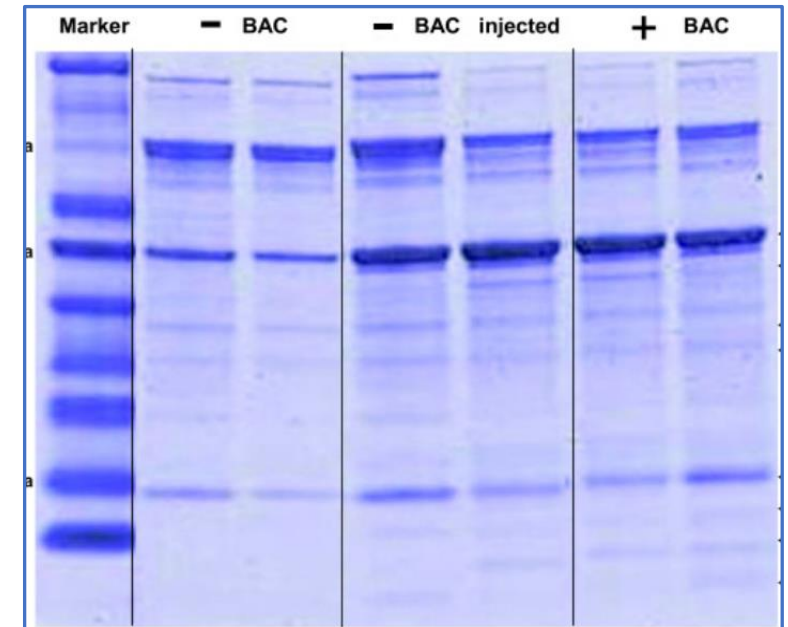
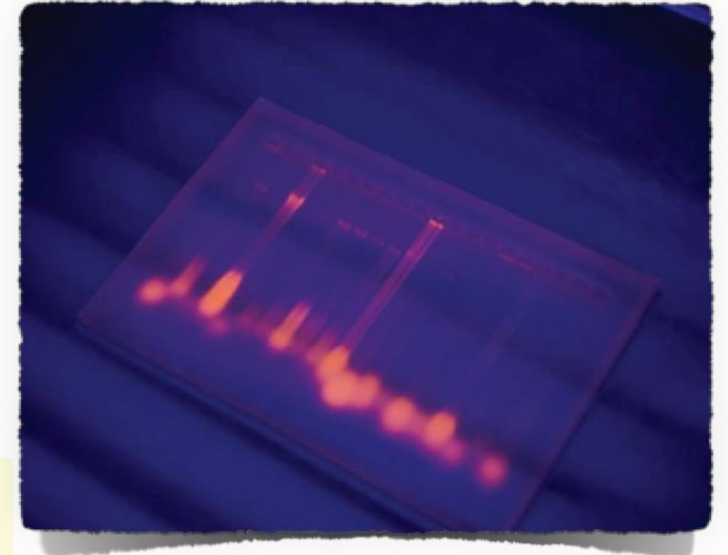
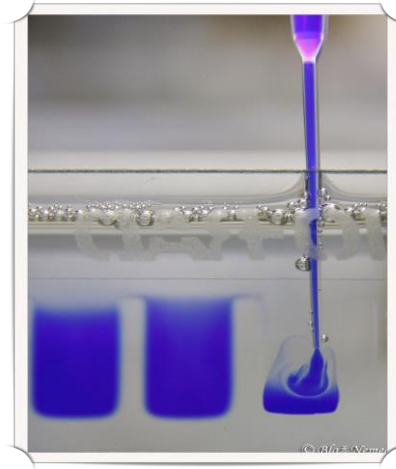
Solution containing DNA

is dropped on the gel by a pipette

A staining solution

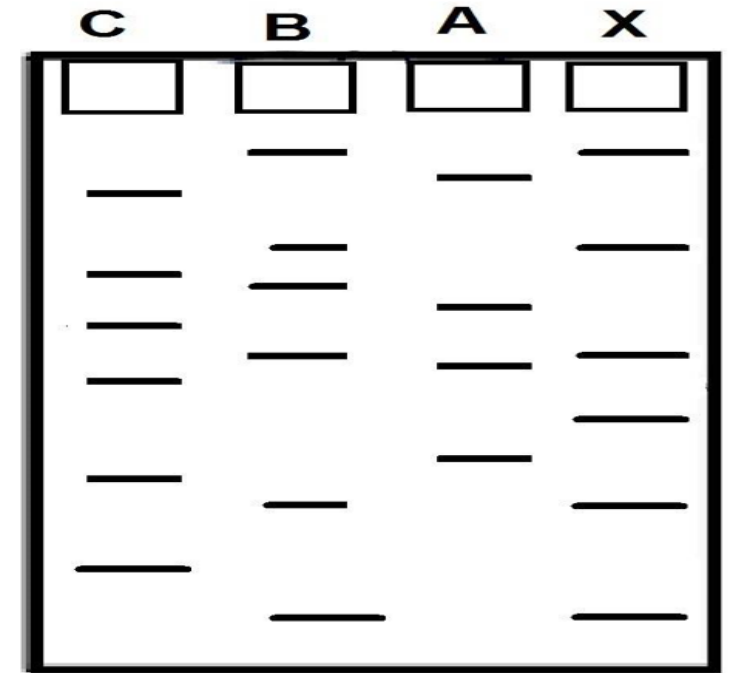
binds to the separated DNA fragments
in the gel making them visible under Ultraviolet light

- The unique pattern created based on the size of the DNA fragment can be compared to known DNA (marker) fragments for identification



- 13-The figure below shows the DNA fingerprints of four people. The fingerprint (X) was taken from a drop of blood at a crime scene belonging to the unknown criminal (X). *

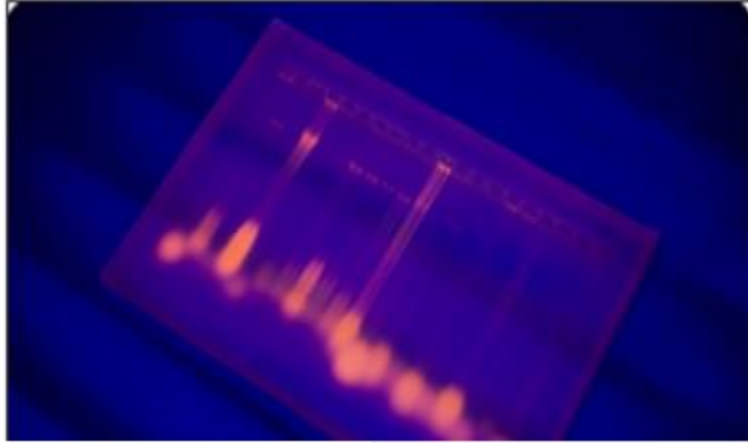
- A
- Both A, c
- C
- B



- Method by which DNA fragments are separated by size
- Open Reading Templates
- Genetic Engineering
- Gel electrophoresis

gel is placed in an electrophoresis
electric current are turned on, the DNA fragments
process does the figure below show?

عند وضع المادة الهلامية المعبأة في خزان الفصل الكهربائي
وتشغيل التيار الكهربائي، تنفصل أجزاء الحمض النووي.
ما العملية التي يوضحها الشكل أدناه؟



Cloning

الاستنساخ

.a

Polymerase chain reaction

تفاعل البلمرة المتسلسل

.b

Recombinant DNA technology

تقنية الحمض النووي معاد التركيب

.c

Gel electrophoresis

الفصل الهلامي الكهربائي

.d

Recombinant DNA Technology

What is?

Specific size of DNA fragments combined with DNA fragments from another source.

Recombinant DNA

Importance

Studying individual genes.

Quantities

Need large quantities of DNA molecules.

Materials used

Plasmids and viruses

Vector(Carrier)

bacterial cell

The host cell

Restriction enzyme

Joins DNA fragments

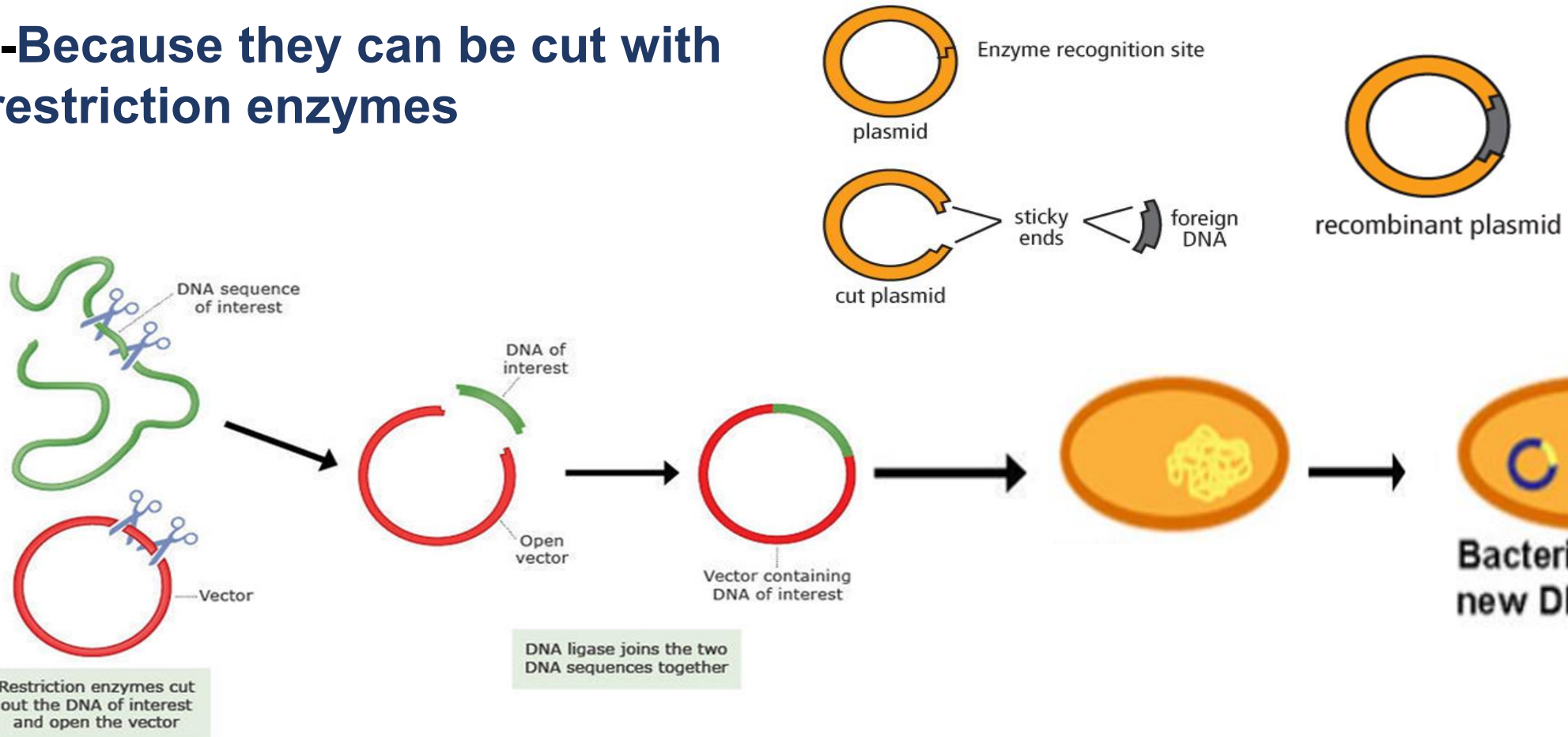
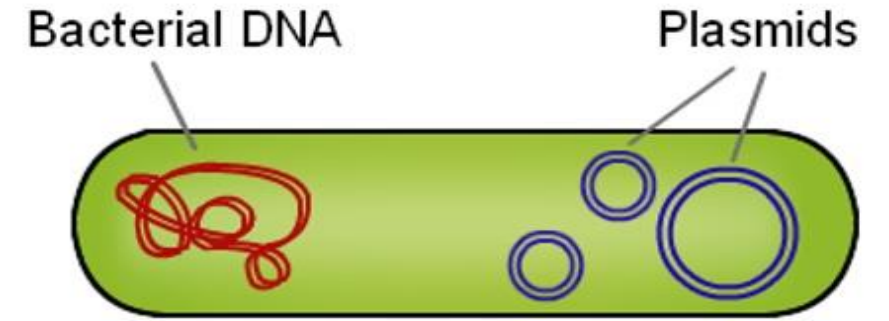
DNA ligase

What is a plasmid?

-Small, circular, double-stranded DNA molecules that occur naturally in bacteria and yeast cells

Why are the plasmids use as vectors?

-Because they can be cut with restriction enzymes



In figure below, what is the role of the vector in DNA cloning?

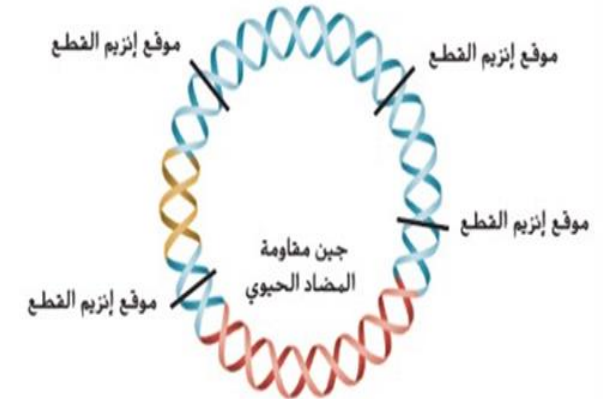
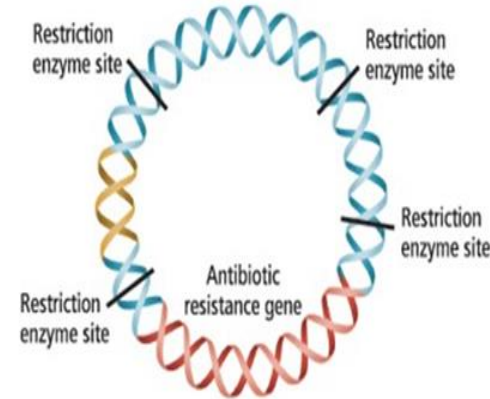


Plasmid DNA (vector)

الحمض النووي البلازميدي (متجه)

في الشكل أدناه، ما دور المتجه في استنساخ الـ DNA؟

What is the role of the molecule below in DNA cloning?



ما دور الجزيء الوارد أدناه في استنساخ الـ DNA؟

a.

نقل الـ DNA الدخيل إلى داخل الخلية المضيفة

To carry the foreign DNA into the host cell

b.

تحديد مصدر الـ DNA على أنه دخيل

To identify the source of DNA as foreign

c.

تحديد الخلية المضيفة التي استقبلت الجين المعني

To identify the host cell that has taken up the gene of interest

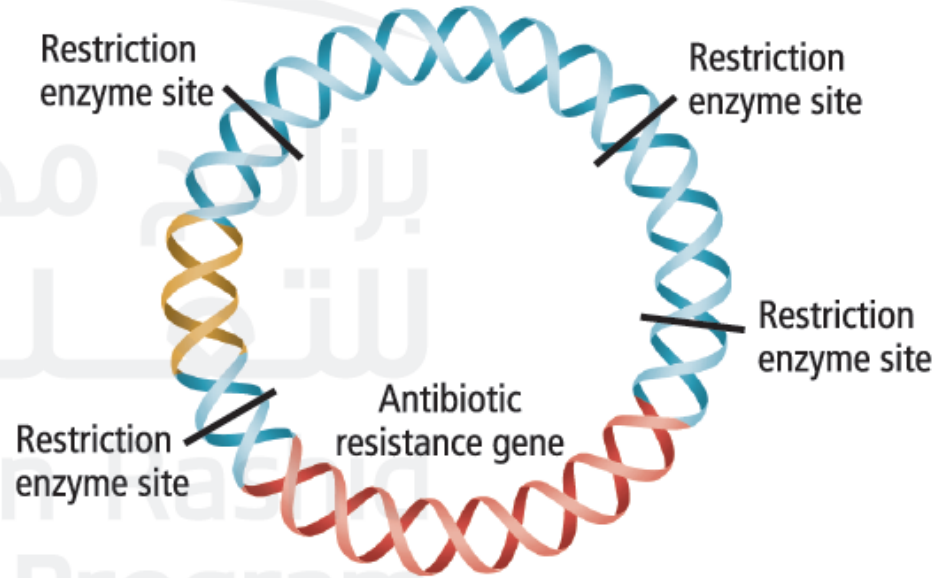
d.

جعل الـ DNA الدخيل قابلاً للهضم عن طريق الإنزيمات

To make the foreign DNA susceptible to digestion with enzymes

Understand Main Ideas

Use the illustration below to answer question 14.



14. What is the role of the molecule above in DNA cloning?
- A. to carry the foreign DNA into the host cell
 - B. to identify the source of DNA as foreign
 - C. to identify the host cell that has taken up the gene of interest
 - D. to make the foreign DNA susceptible to digestion with enzymes

Understand Main Ideas

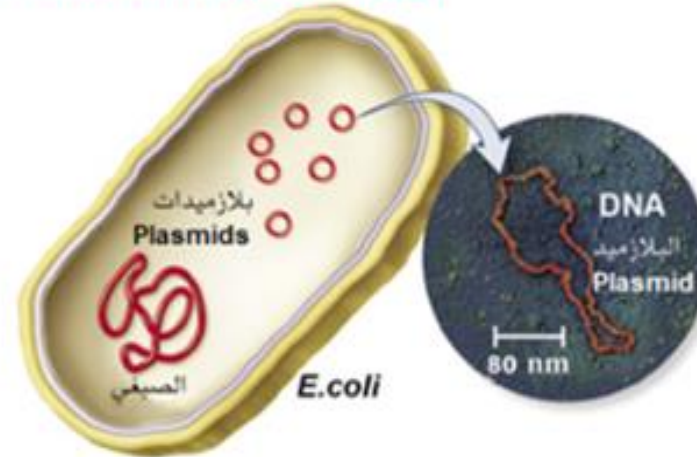
14. A

Recombinant DNA

- A. results from the ligation of an isolated gene and plasmid DNA.
- B. is inserted into a living cell in the transformation process.
- C. is screened for in the selection process.
- D. all of the above

The figure below shows a recombinant nucleic acid plasmid,
What is the role of the molecule below in DNA cloning?

الشكل أدناه يوضح بلازميد حمض نووي معاد التركيب.
ما دور هذا الجزيء في استنساخ الـ DNA؟



To make the foreign DNA susceptible to digestion with enzymes

جعل الـ DNA الدخيل قابلاً للهضم عن طريق الإنزيمات

.a



To identify the host cell that has taken up the gene of interest

تحديد الخلية المضيفة التي استقبلت الجين المعني

.b



To identify the source of DNA as foreign

تحديد مصدر الـ DNA على أنه دخيل

.c



To carry the foreign DNA into the host cell

نقل الـ DNA الدخيل إلى داخل الخلية المضيفة

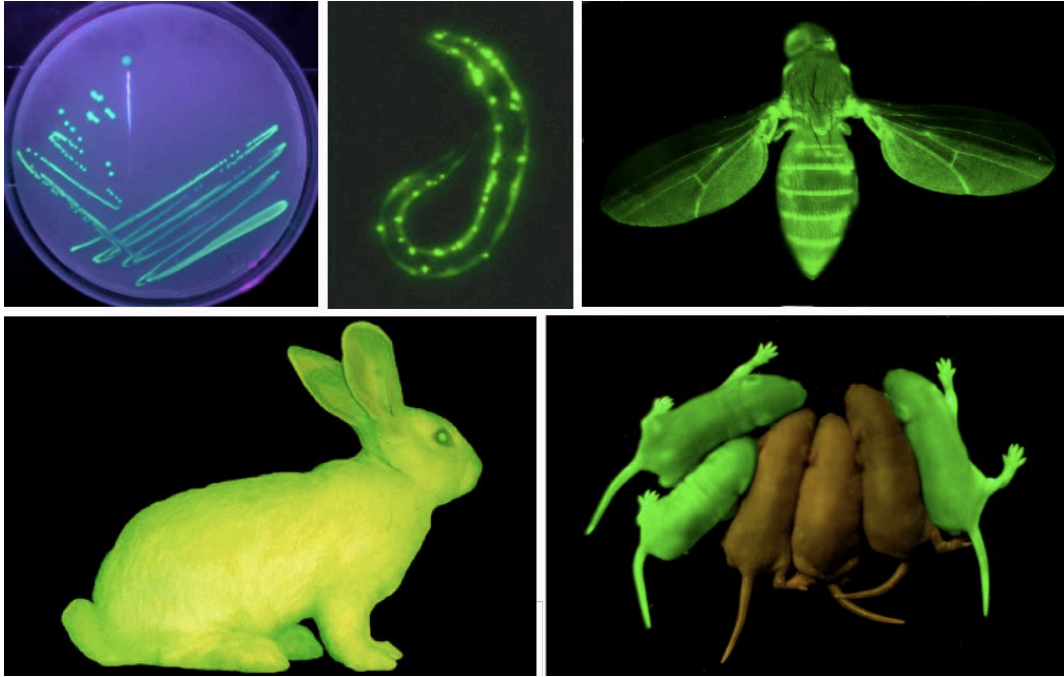
.d

Table 1**Genetic Engineering**

Tool/Process	Function	Applications
Restriction enzymes Ex: <i>EcoRI</i>	Cut DNA strands into fragments	Used to create DNA fragments with sticky ends or blunt ends that can join with other DNA fragments
Gel electrophoresis	Separates DNA fragments by size	Used to study DNA fragments of various sizes
Recombinant DNA technology	Combines a DNA fragment with DNA from another source (exogenous DNA)	Used to create recombinant DNA to be used to study individual genes and genetically engineered organisms, and in the treatment of certain diseases
Gene cloning	Produces large numbers of identical recombinant DNA molecules	Used to create large amounts of recombinant DNA to be used in genetically engineered organisms
DNA sequencing	Identifies the DNA sequence of cloned recombinant DNA molecules for further study	Used to identify errors in the DNA sequence, to predict the function of a particular gene, and to compare to other genes with similar sequences from different organisms
Polymerase chain reaction (PCR)	Makes copies of specific regions of sequenced DNA	Used to copy DNA for any scientific investigation, including forensic analysis and medical testing

Biotechnology

The use of **Genetic engineering** to find solution to problem



Genetically Engineered organisms

Organisms that have a gene from another organism

Transgenic organisms

-For medical and agriculture purposes
- For research

Transgenic animals

Transgenic plants

Transgenic bacteria

Transgenic **animals**

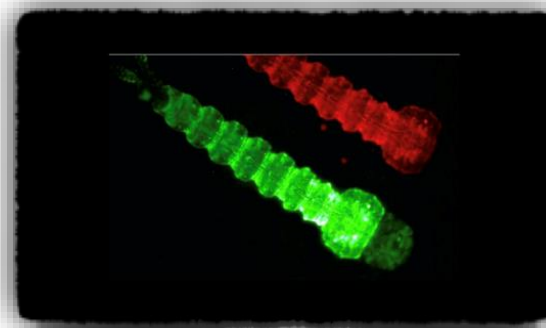
To study diseases, and
develop ways to treat them



Fruit flies



Mice



Mosquito Larva



Roundworm

Species of **fish**
Grow faster



Transgenic Growth-Enhanced Tilapia



Transgenic **Goats**

To secrete a protein called
antithrombin III
To prevent human blood
from forming clots
during surgery



Transgenic
Livestock

To resistant to disease



Transgenic
**Chicken and
Turkeys**



Transgenic organisms
might be used as a
source of **organs** for
organ transplants

To improve the
food supply and
human health

Transgenic **animals**

- Scientists produce most transgenic animals in laboratories for biological research.

Transgenic Animals	Genetic engineering
Mice, fruit flies, and the roundworm <i>Caenorhabditis elegans</i>	Study disease and develop ways to treat them
Transgenic livestock	Improve the food supply and human health.
Transgenic goats	Secrete blood from forming clots during surgery.
Transgenic chickens and turkeys	Resistant to diseases.
Fishes	Grow faster.
Transgenic animals	Might be used as a source of organ transplants.

Which is an example of a transgenic organism?

ما الذي يقدم مثالاً على الكائن الحي المعدل وراثيًا؟

- a. دجاجة تمت هندستها وراثيًا لتقاوم الأمراض
Chicken genetically engineered to resist diseases



- b. سلالة كلب الراعي الألماني الذي تم تدريبه على اكتشاف المتفجرات
German shepherd bred to identify explosives

- c. حبوب أرز هجينة تنتج محاصيل أكثر
Hybrid rice grain that produces higher yields

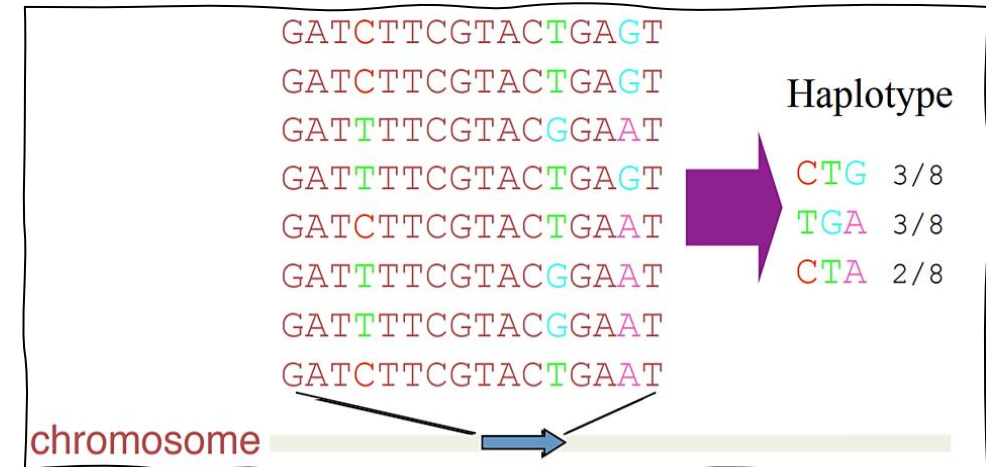
- d. تربية حشرات السرعوف لتقتل حشرات الحقائق
Praying mantises raised to kill garden pests

Biotechnology

- a. is the use of technology to change the genetic makeup of living things for human purposes. b. has raised many ethical questions.
- c. can make food taste better.
- d. all of the above

-Genetic variations (SNPs) located together tend to inherited together

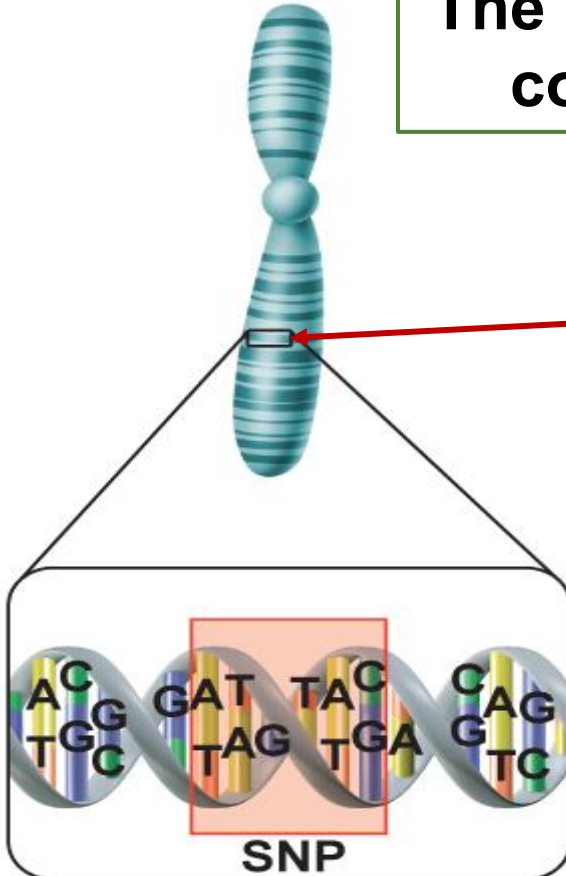
The region of linked variations in the human genome called **haplotypes**



The HapMap project

The project to create catalog of common genetic variation

- Assembling the HapMap involves identifying groups of SNPs in a **specific region** of DNA.
- The HapMap will enable geneticists to take advantage of how SNPs and other genetic variations are organized on chromosomes.



Help researchers to find genes that:

1-cause disease

2-and affect an individual's response to drugs

What are variations in specific nucleotides that are linked to human diseases called?

ماذا تسمى التنوعات الموجودة في النيوكليوتيدات المحددة وترتبط بالأمراض التي تصيب الإنسان؟

a. Proteomes علم المحتوى البروتيني

b. Haplotypes الأنماط الفردانية

c. Genomes الجينومات

d. Single nucleotide polymorphisms تعدد أشكال النيوكليوتيدات الفردية

-Project Identifying All Individual Patterns in the Human Genome

- Proteomics
- HapMap
- Genetic Pharmacology
- Gene therapy

The primary goal of the HapMap project is to:

يتمثل الهدف الرئيسي من مشروع Hap Map في:

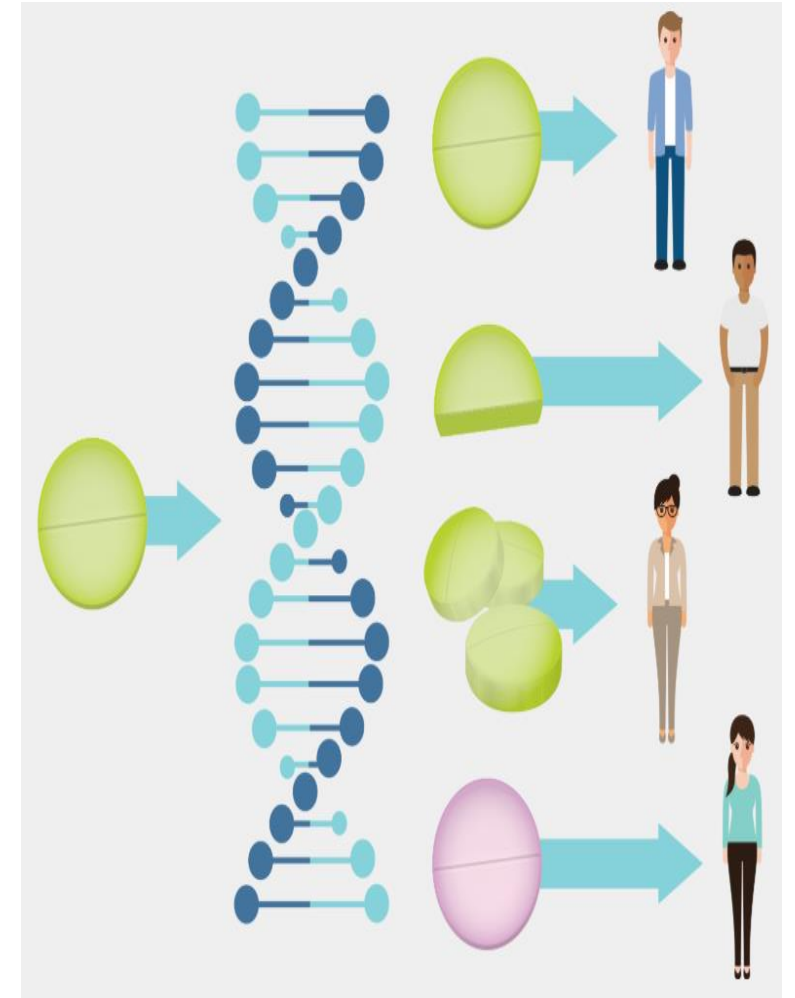
- a. وضع دليل للتسلسلات الجينية لحمض DNA منفرد
Catalog the genetic sequences of individual DNA
- b. وضع قاعدة بيانات للمعلومات الجينية البيولوجية
Create a database for genetic biological information
- c. وضع مخطط للنوكليوتيدات في DNA بشري
Map the sequence of nucleotides in human DNA
- d. تحديد الجينات التي تؤدي إلى أمراض بشرية خطيرة
Identify genes that cause serious human diseases

What is pharmacogenomics?

- The study of how genetic inheritance affects the body's response to drugs .

Write the benefits of pharmacogenomics

- The benefits of pharmacogenomics include:
 - 1-more **accurate dosing** of drugs that are safer and more **specific**.
 - 2-will allow for drugs to be custom-made for individuals **based on their genetic** makeups.
 - 3-will increase **safety**, speed **recovery**, and reduced **side effects**.



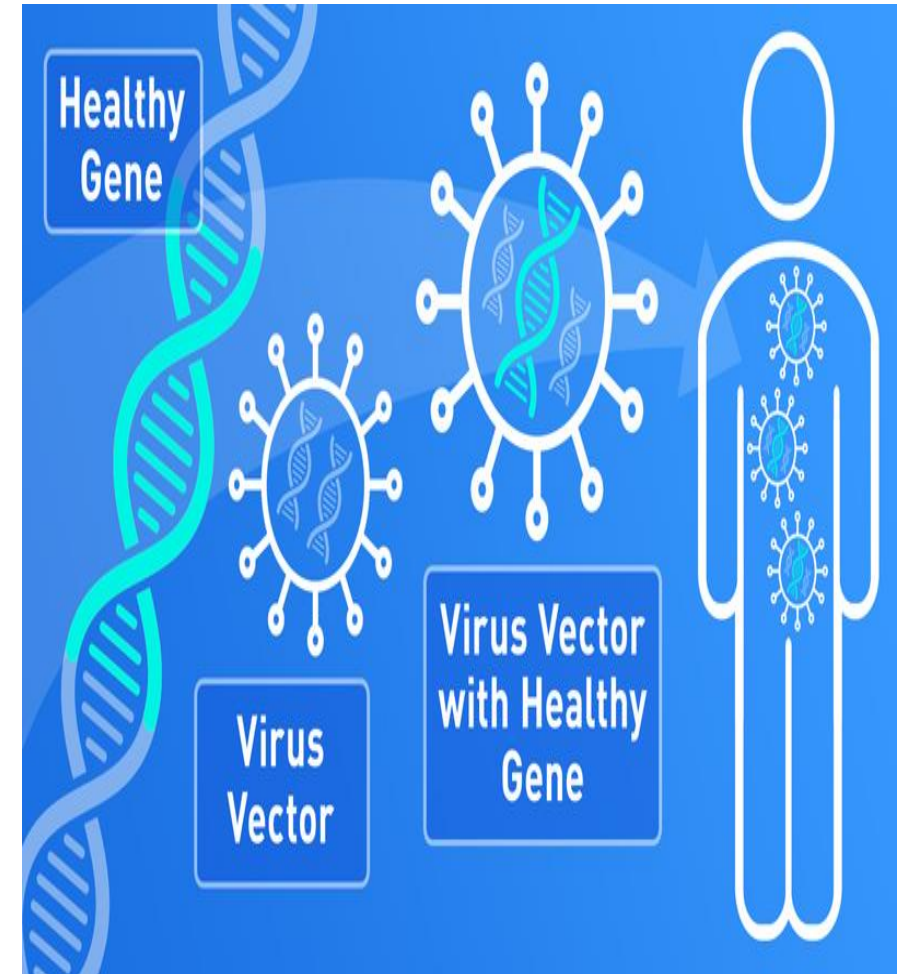
Gene therapy

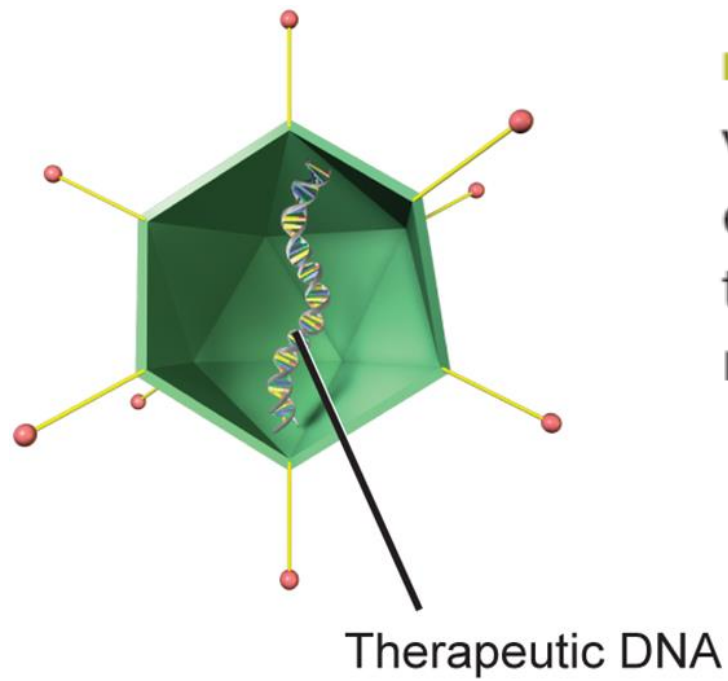
- A technique aimed at **correcting mutated** genes that cause human diseases .
- Scientists **insert a normal** gene into a chromosome to replace a dysfunctional gene.
- Scientist insert a normal gene into **a viral vector**.

Produces recombinant DNA

✓ **Reading Check** Compare and contrast pharmacogenomics to gene therapy.

✓ **Reading Check** Gene therapy is a technique that attempts to correct mutated genes. Pharmacogenomics is the study of how genetic inheritance affects the response to drugs.





■ **Figure 17** DNA can be encapsulated in a virus and delivered into a patient to replace a defective gene. Once the virus enters the cells, the genetic information is released into the nucleus and inserted into the genome.

The process of using a viral vector to insert a normal gene into a chromosome to replace a dysfunctional gene is called _____

Correct Answer

Blank 1: gene

Blank 2: therapy

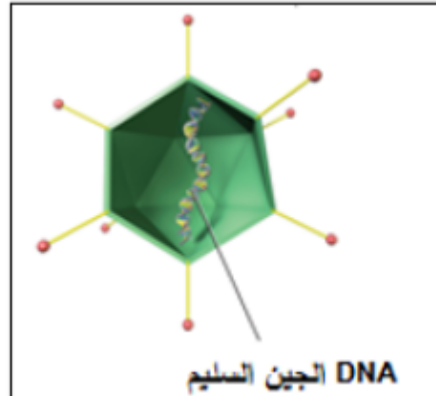
6-The process in which an incorrect gene is replaced by another healthy gene for the same genetic status *

- Gene therapy
- Recombinant DNA
- Production of plasmid
- Bioinformatics

The figure below shows DNA encapsulated in a virus and delivered into a patient to replace a defective gene.

Once the virus enters the cells, the genetic information is released into the nucleus and inserted into the genome.

What is this technique called?



يبين الشكل أدناه تضمين الـ DNA في فيروس وتوصيله بأحد المرضى لاستبدال جين معيب. وبمجرد أن يدخل الفيروس إلى الخلايا، تطلق المعلومات الجينية داخل النواة وتدخل في الجينوم. ماذا تسمى هذه التقنية؟

Pharmacogenomics

a. علم الصيدلة الجيني

Bioinformatics

b. المعلوماتية الأحيائية

DNA microarrays

c. مصفوفة DNA الدقيقة

Gene therapy

d. العلاج الجيني

From

Gene

To

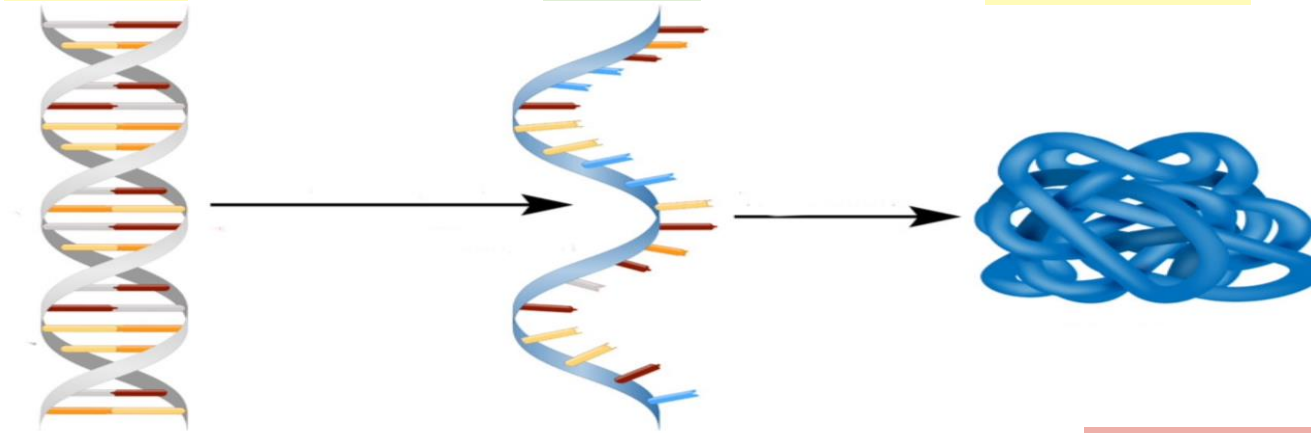
RNA

To

Protein

=

Central dogma



Study of human genes(structure and function) Genomic

What is the importance of Genomics?

Identifying human genes and interpreting their functions.

Investigating the mass of data obtained from sequencing the genomes of multiple organisms.

Investigating the proteins produced by the genes.

Genes are the primary information storage units, whereas **proteins** are the machines of a cell.

What is **Proteomics** ?

The large-scale study and cataloging of the structure and function of **proteins** in the human body is called **proteomics**.

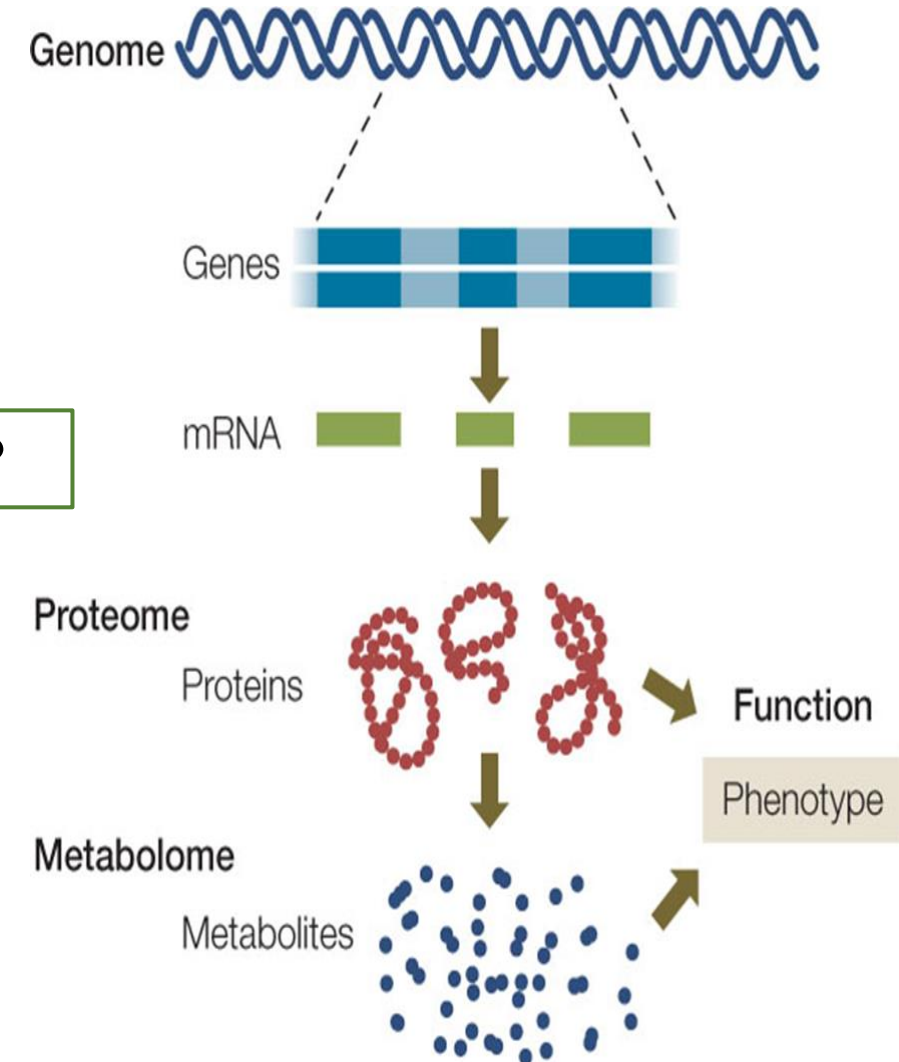
What is the importance of **Proteomics**?

Proteomics allows researchers to

Look at thousands of proteins at the same time.

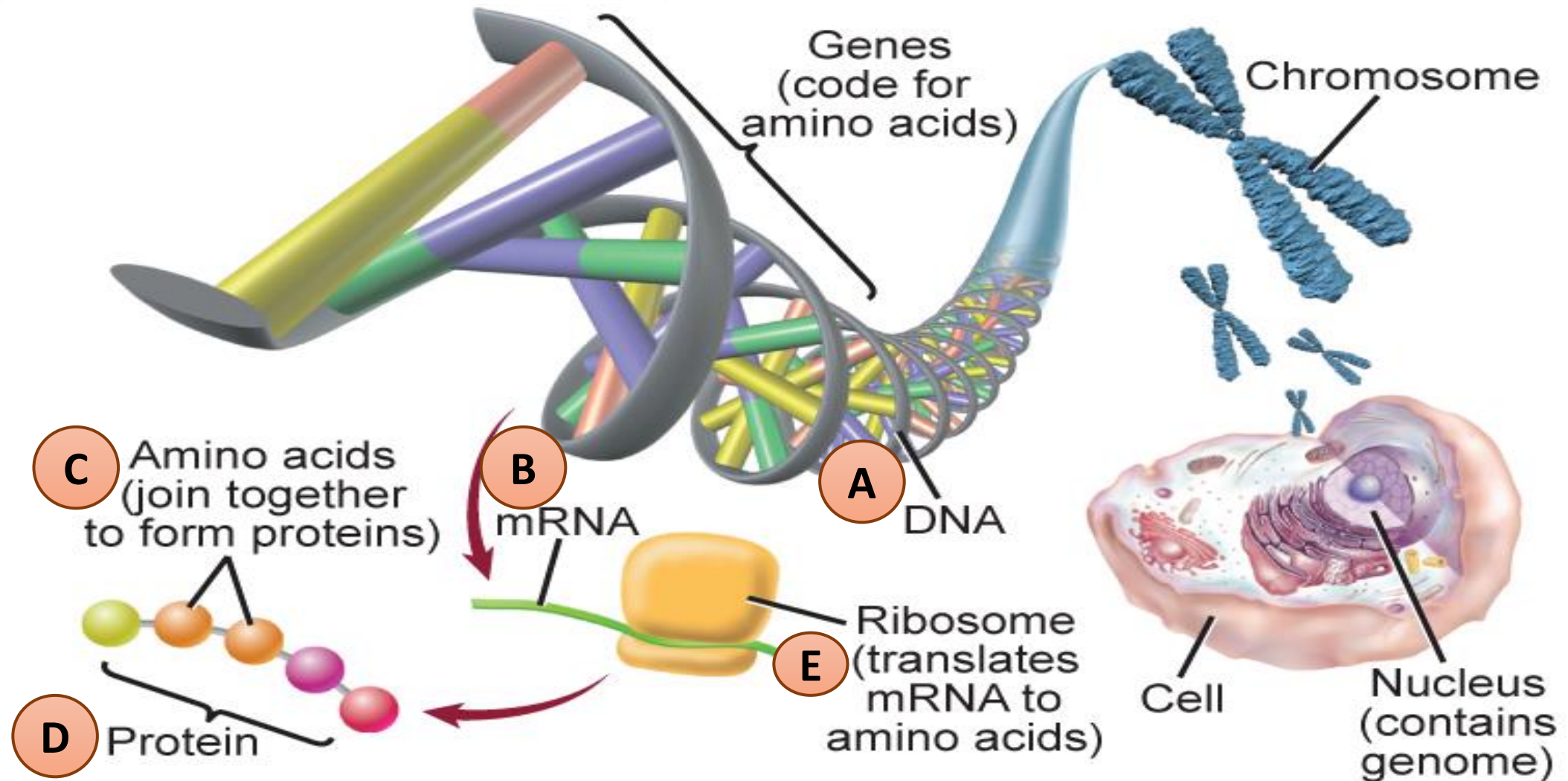
Analysis will better define both normal and disease states.

Revolutionize the development of new drugs to treat diseases such as Type II diabetes, obesity, and atherosclerosis.

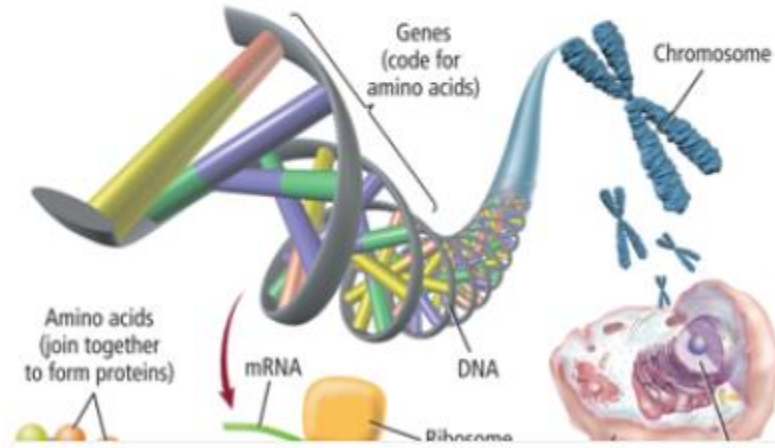


■ **Figure 18** The central dogma is that the information in genes flows from DNA to RNA and RNA to proteins.

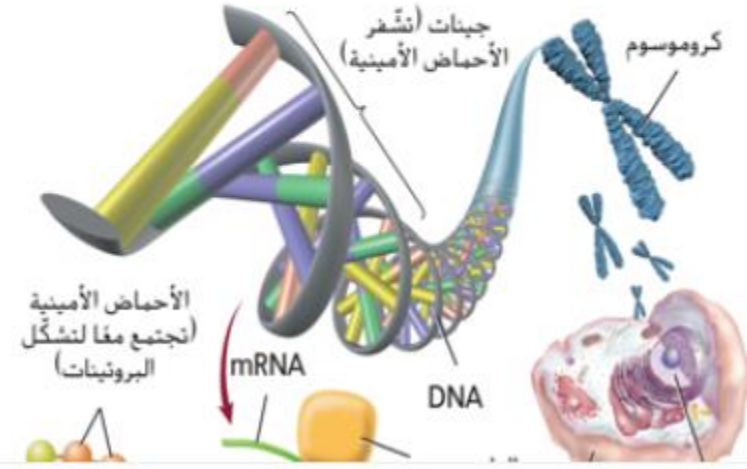
Which letter refer to



The information in genes flows from DNA to RNA and RNA to proteins. Which of the following is **the right concept** that applies to the figure below?



المعلومات الموجودة في الجينات تتدفق من الـ DNA إلى الحمض النووي الرايبوزي ومنه إلى البروتينات. أي مما يلي يعتبر **المفهوم الصحيح** الذي ينطبق على الشكل أدناه؟



Genomics

علم الجينوم

.a

The HapMap project

مشروع هاب ماب

.b

Sequencing the genome

ترتيب تسلسل الجينوم

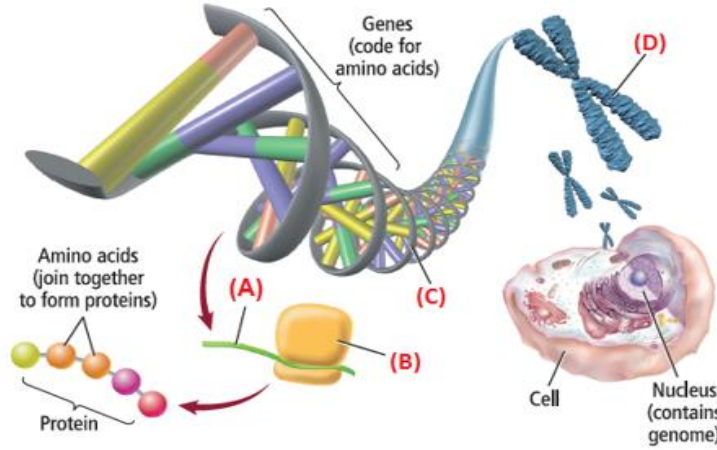
.c

The central dogma

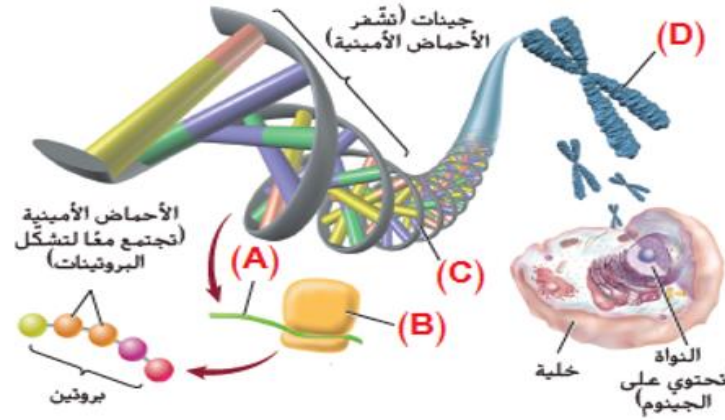
المبدأ المركزي

.d

The central dogma is that the information in genes flows from DNA to RNA and RNA to proteins. In the figure below, which letter refers to the mRNA?



يعني المبدأ المركزي أن المعلومات الموجودة في الجينات تتدفق من الـ DNA إلى الحمض النووي الرايبوزي ومنه إلى البروتينات. في الشكل أدناه، أي حرف يشير إلى الـ mRNA؟



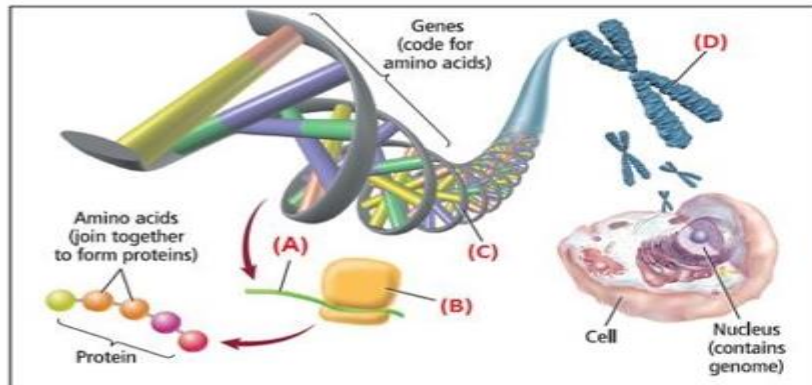
A .a

B .b

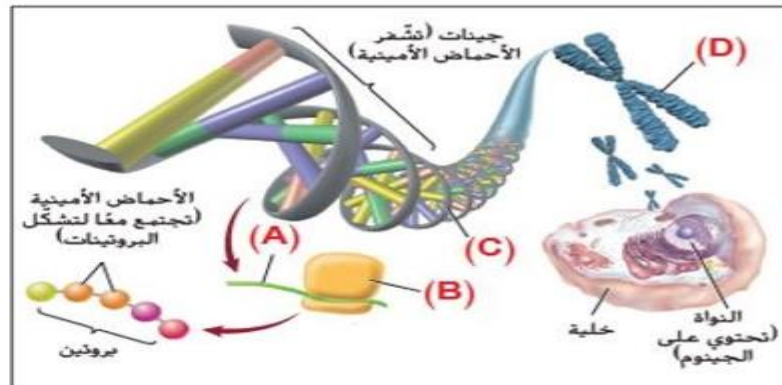
C .c

D .d

The central dogma is that the information in genes flows from DNA to RNA and RNA to proteins. In the figure below, which letter refers to the DNA?



يعني المبدأ المركزي أن المعلومات الموجودة في الجينات تتدفق من الـ DNA إلى الحمض النووي الرايبوزي ومنه إلى البروتينات. في الشكل أدناه، أي حرف يشير إلى الـ DNA؟



a. A

b. B

c. C

d. D

Which correctly lists the terms in order from smallest to largest?

أي مما يلي هو الترتيب الصحيح من الأصغر إلى الأكبر؟

- a. الكروماتين والكروموسومات والـ DNA والنيوكليوتيدات
Chromatin, chromosomes, DNA, nucleotides
- b. الكروموسومات والـ DNA والكروماتين والنيوكليوتيدات
Chromosomes, DNA, chromatin, nucleotides
- c. الـ DNA والنيوكليوتيدات والكروماتين والكروموسومات
DNA, nucleotides, chromatin, chromosomes
- d. النيوكليوتيدات والـ DNA والكروماتين والكروموسومات
Nucleotides, DNA, chromatin, chromosomes

Which statement about the human genome is false? أي من العبارات التالية المتعلقة بالجينوم البشري خاطئة؟

- a. يحتوي الجينوم البشري على ما يقرب من 25,000 جين
The human genome contains approximately 25,000 genes
- b. يحتوي الجينوم البشري على امتدادات طويلة للحمض النووي (DNA) من دون وظيفة معروفة
The human genome contains long stretches of DNA with no known function
- c. قام علماء من كل أنحاء العالم بترتيب تسلسل الجينوم البشري
The human genome was sequenced by scientists from around the world
- d. يحتوي الجينوم البشري على تسلسلات نيوكليوتيدات ترمز كلها إلى بروتينات
The human genome contains nucleotide sequences that all code for proteins

25. Which statement about the human genome is false?
- A. The human genome contains approximately 25,000 genes.
 - B. The human genome contains long stretches of DNA with no known function.
 - C. The human genome was sequenced by scientists from around the world.
 - D. The human genome contains nucleotide sequences that all code for proteins.
26. What are variations in specific nucleotides that are linked to human diseases called?
- A. proteomes
 - B. haplotypes
 - C. single nucleotide polymorphisms
 - D. genomes
27. For what purpose is DNA fingerprinting used?
- A. to sequence DNA from bacteria
 - B. to separate DNA fragments
 - C. to identify individuals who have committed crimes

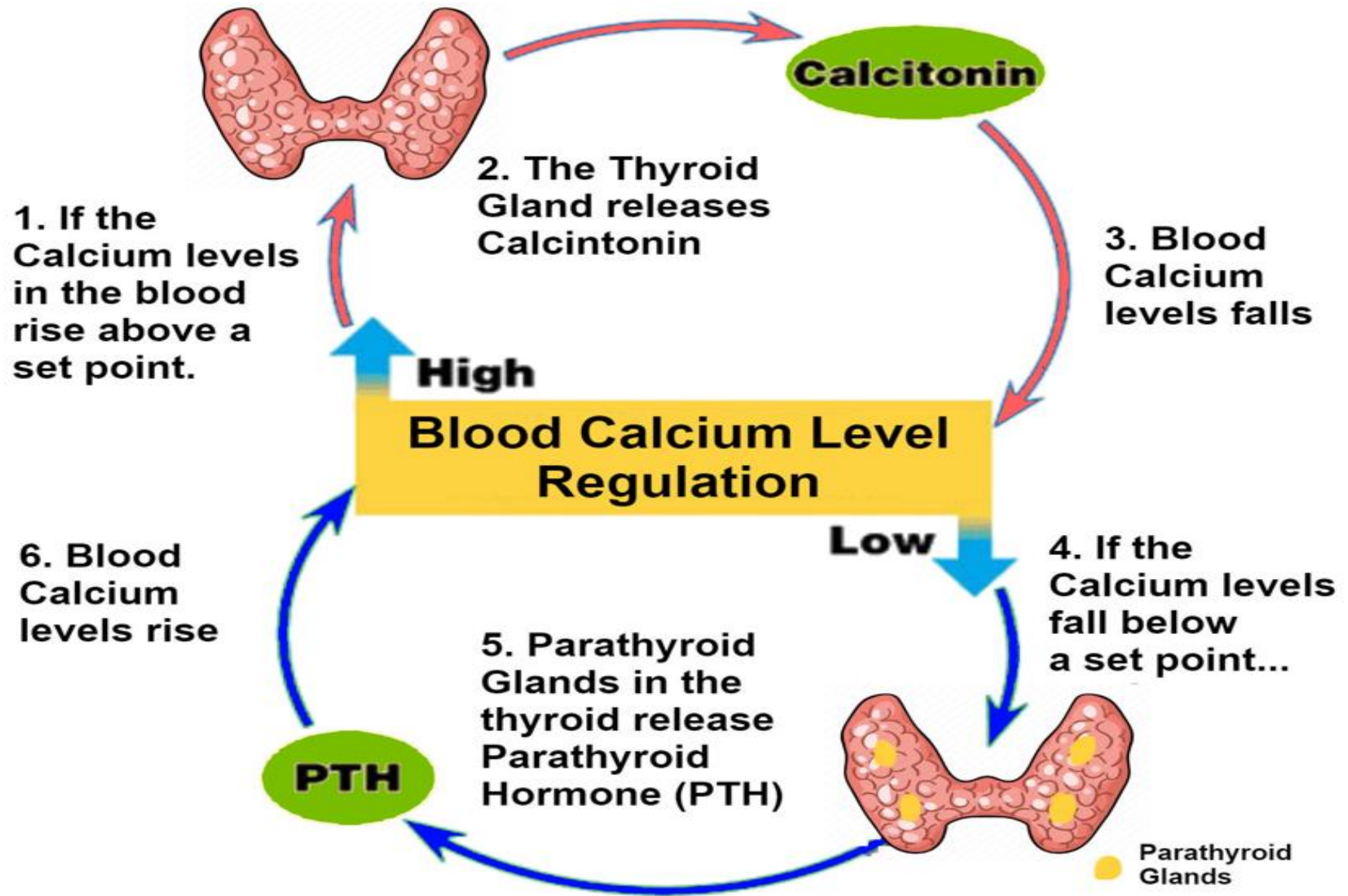
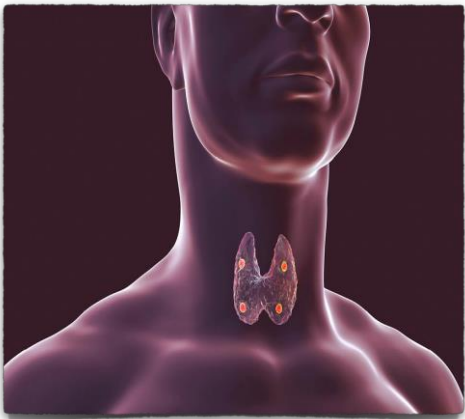
Understand Main Ideas

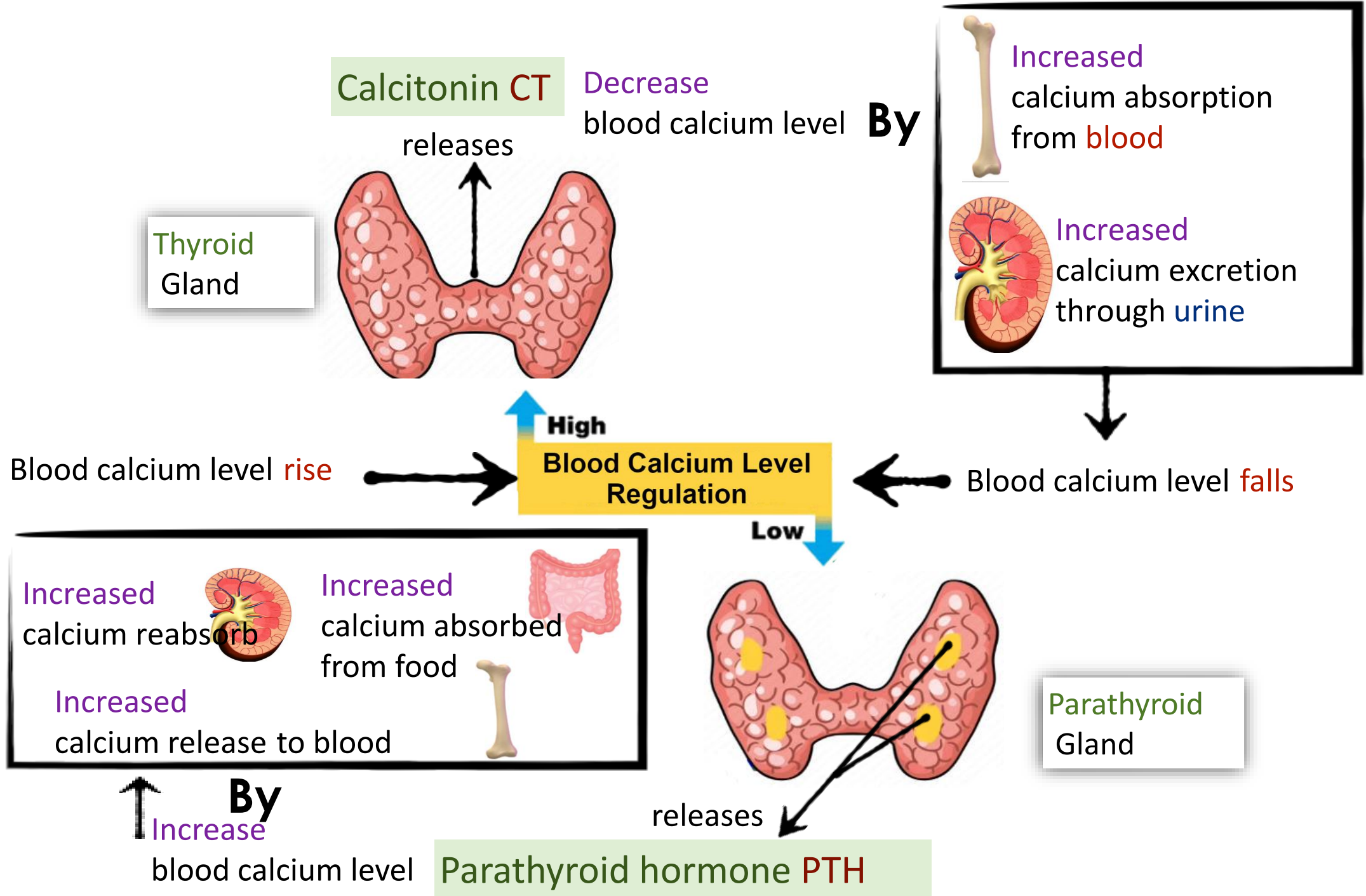
25. D

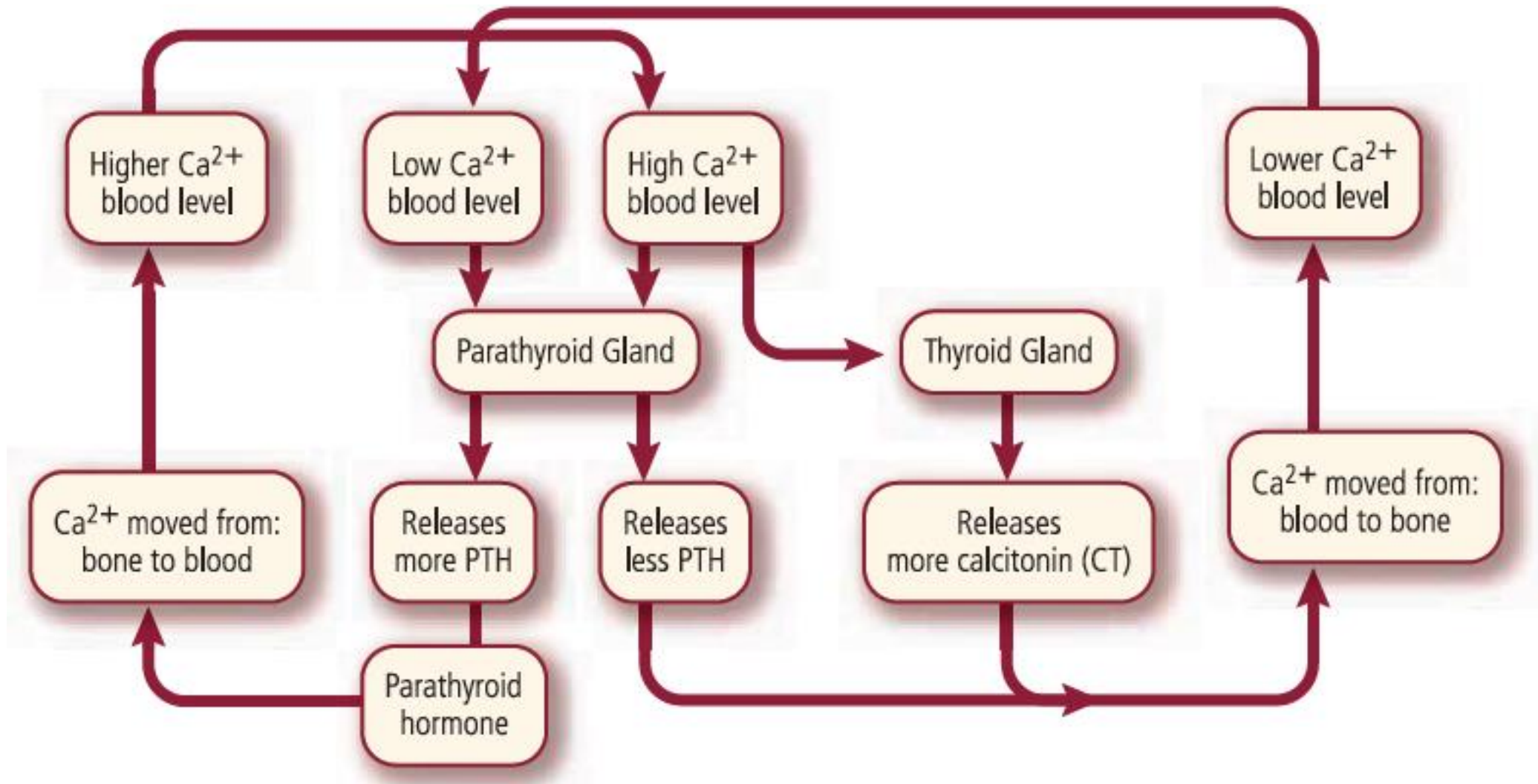
26. C

27. C

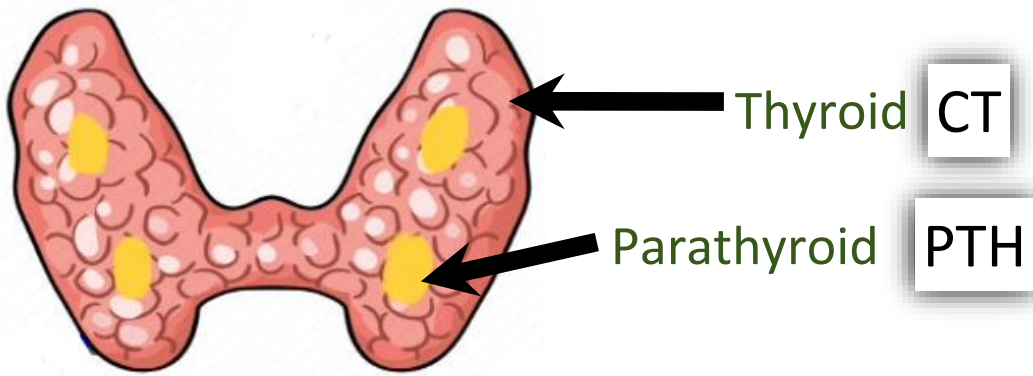
Thyroid and parathyroid Gland







Parathyroid hormone (PTH) and calcitonin (CT) regulate the level of calcium in the blood.



Homeostasis

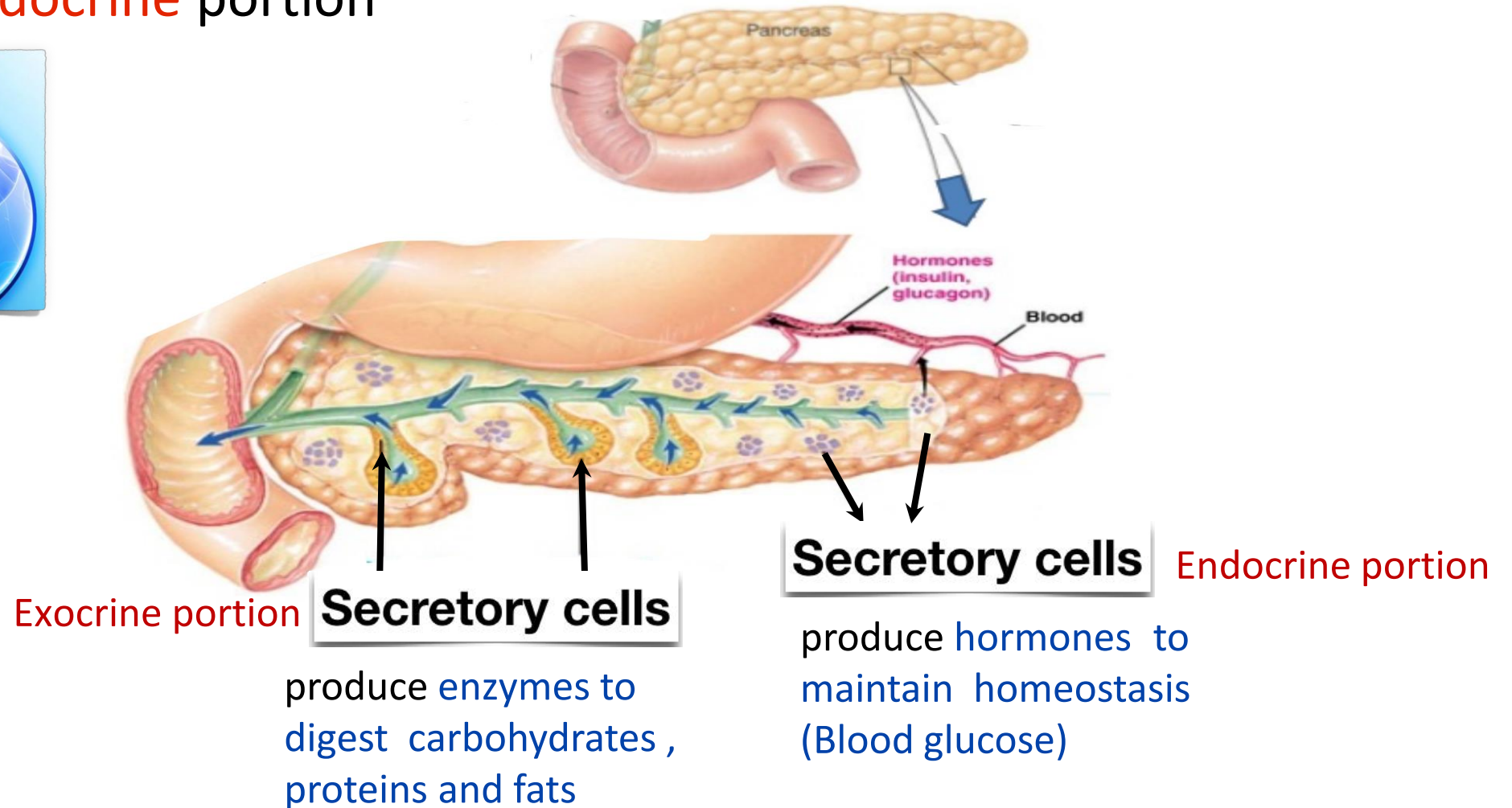
Maintain the level
of **calcium** in
blood

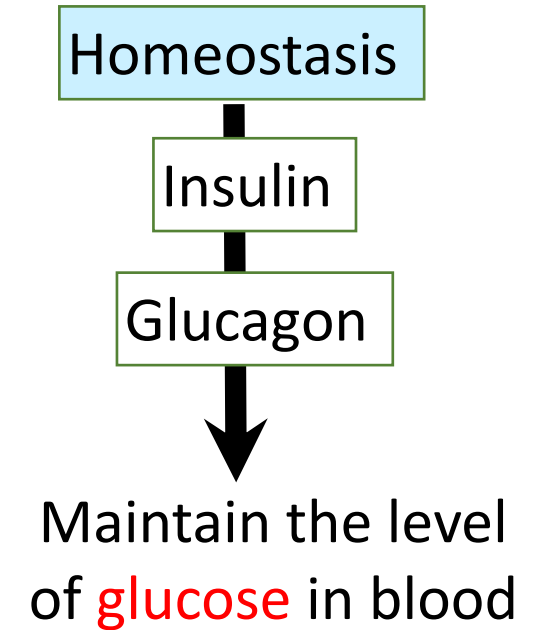
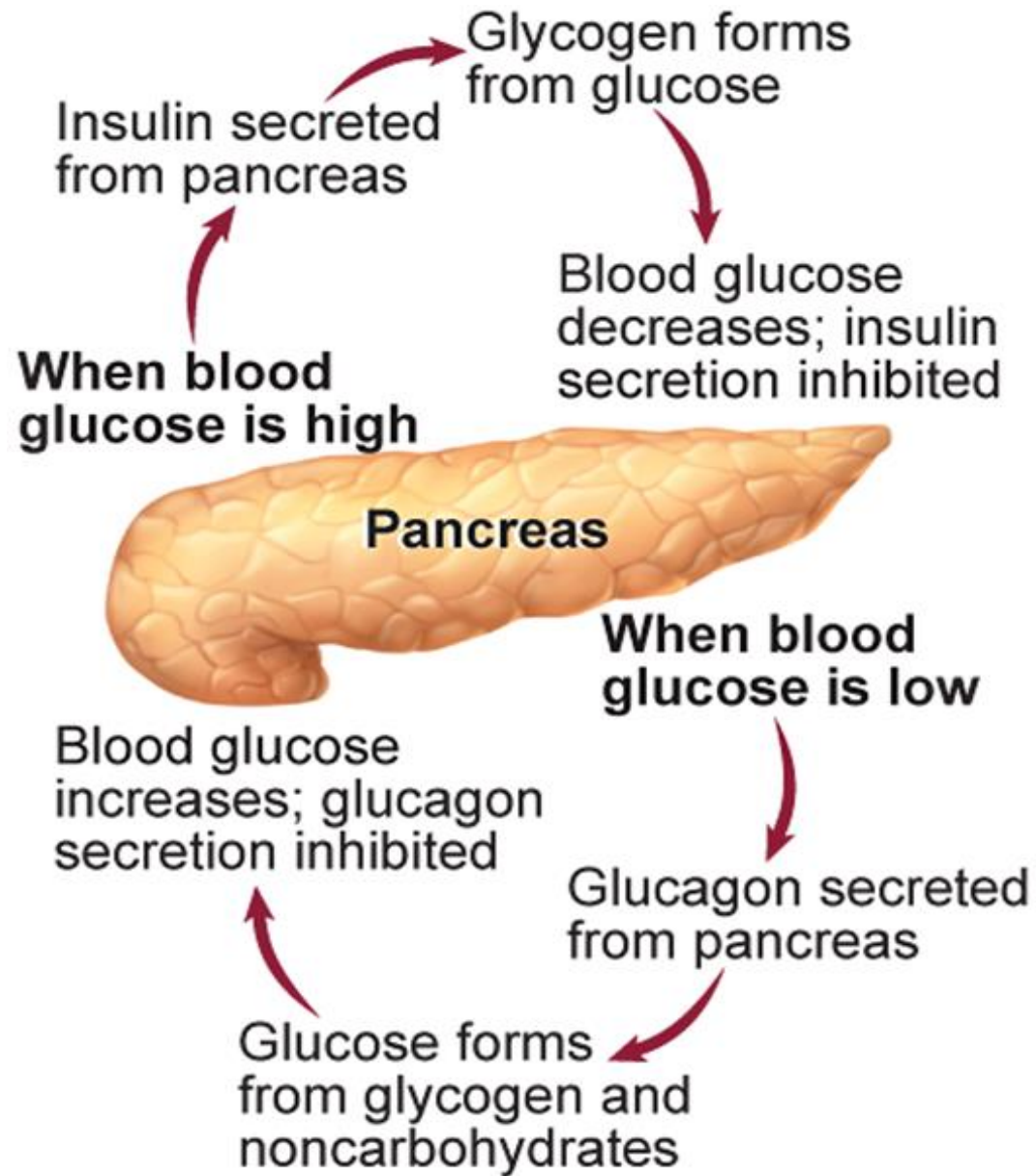
Complete the table

	CT	PTH
refer to	Calcitonin	Parathyroid hormone
The hormone producing glands	Thyroid gland	Parathyroid gland
When is the hormone secreted ?	When blood calcium levels rise	When blood calcium levels fall
It is function	Decrease blood calcium level	Increase blood calcium level
Organs which hormone stimulate it	Bone-kidney	Bone-kidney-intestine

Pancreas

Pancreas is a mixed gland, that mean it has an **exocrine** portion and an **endocrine** portion





■ **Figure 18** Glucagon and insulin work together to maintain the level of sugar in the blood.

Which pairs of hormones have opposite effects?

أي من المجموعات التالية من الهرمونات التالية لها تأثيرات متضادة؟

- a. **الكالسيتونين وهرمون الباراثورمون**
Calcitonin and parathyroid hormone
- b. **الإبينفرين والنورإبينفرين**
Epinephrine and norepinephrine
- c. **هرمون النمو والثيروكسين**
Growth hormone and thyroxine
- d. **الألدوستيرون والكورتيزول**
Aldosterone and cortisol

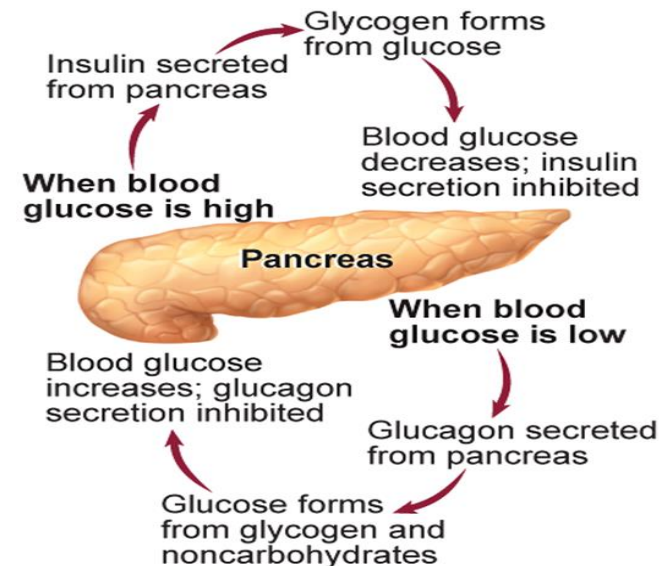
Which hormone is released by the pancreas?

ما الهرمون الذي يفرزه البنكرياس؟

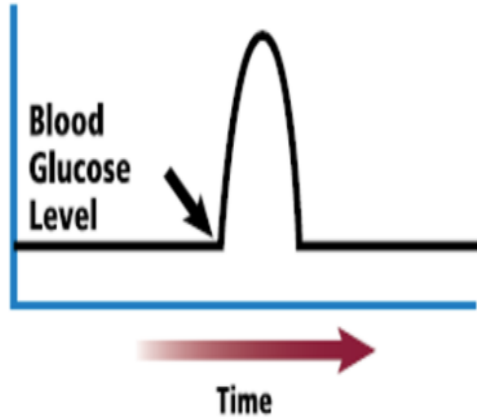
- a. **الكالسيتونين**
Calcitonin
- b. **الكورتيزول**
Cortisol
- c. **الثيروكسين**
Thyroxine
- d. **الأنسولين**
Insulin

Which hormone is more likely to be secreted by the pancreas during intense exercise?

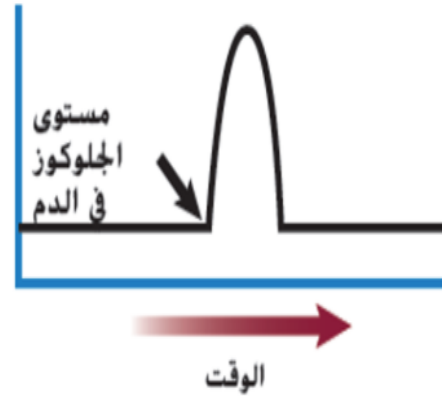
- A. glucagon**
- B. insulin**



The graph below shows the blood glucose levels over a period of time. Which hormone might have caused a sudden surge as indicated by the arrow?



يوضح التمثيل البياني أدناه مستويات الجلوكوز في الدم على مدى فترة من الزمن. أي من الهرمونات التالية قد يكون السبب في الارتفاع المفاجئ المشار إليه بالسهم؟

☐

Growth hormone

هرمون النمو .a

☐

Insulin

الأنسولين .b

☐

Antidiuretic hormone

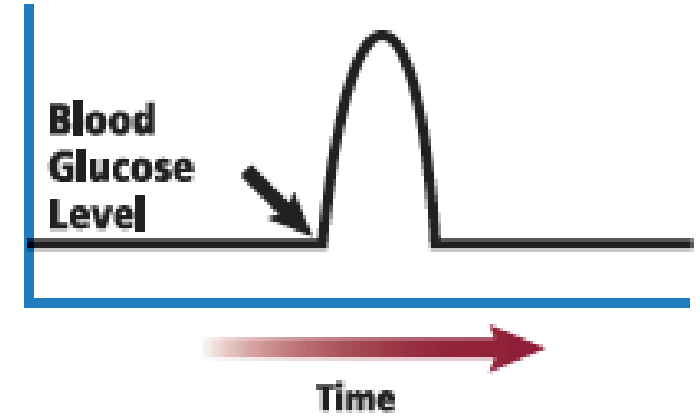
الهرمون المضاد لإدرار البول .c

☒

Glucagon

الجلوكاجون .d

The graph shows blood glucose levels over a period. Which hormone might have caused a sudden surge as indicated by the arrow?



A. antidiuretic hormone

B. growth hormone

☒ C. glucagon

D. insulin

تمنياتنا لجميع الطالبات بالتوفيق والنجاح في الاختبارات

