PACKAGE 2: NOTES AND PROBLEMS

Science 30

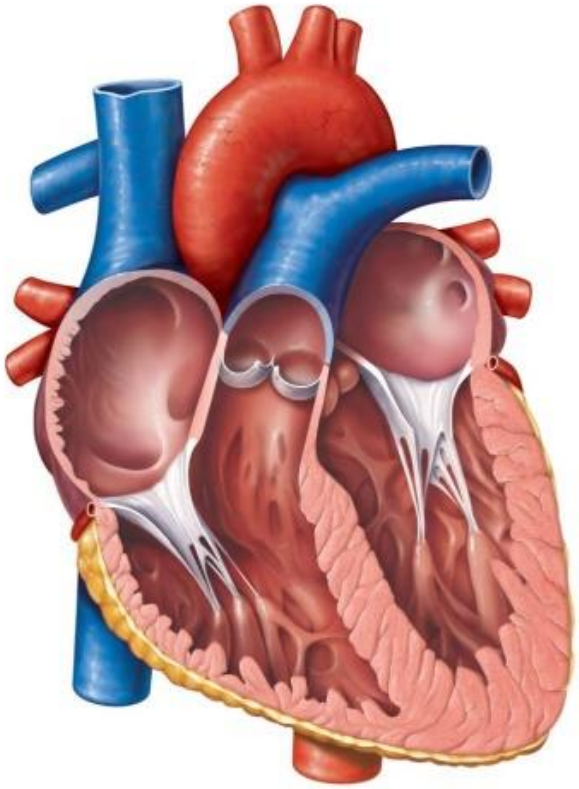
RTD EXAM PREP

Chapter A1: Heart, Circulation and Immunity (10 – 15% of Exam)

The Circulatory System

1 Heart Structure

- identify and describe the following structures in the heart: ventricles, atria, septum, valves (specific names of valves not required), aorta, vena cavae, pulmonary arteries and veins, coronary arteries



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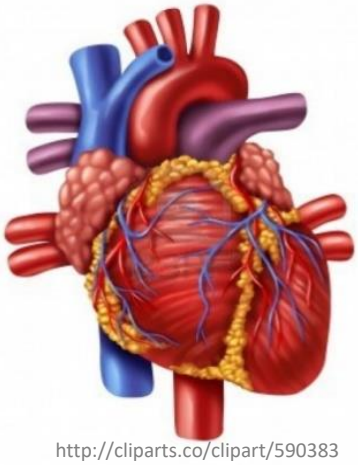
Label the coronary artery on the external view of the heart.



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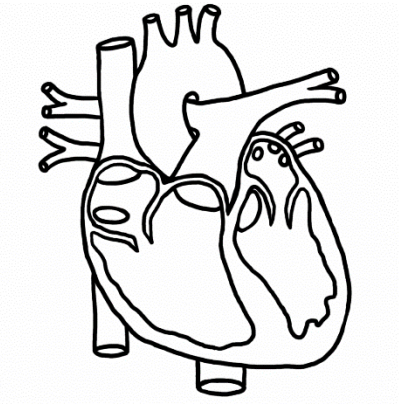
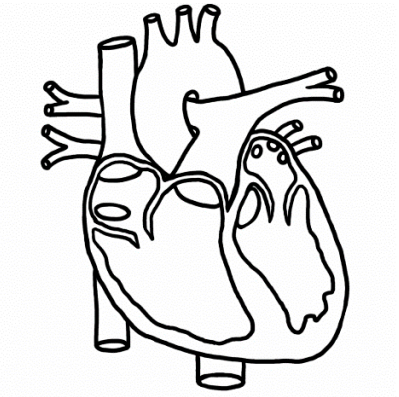
Draw arrows to indicate the flow of oxygen poor blood through the heart.



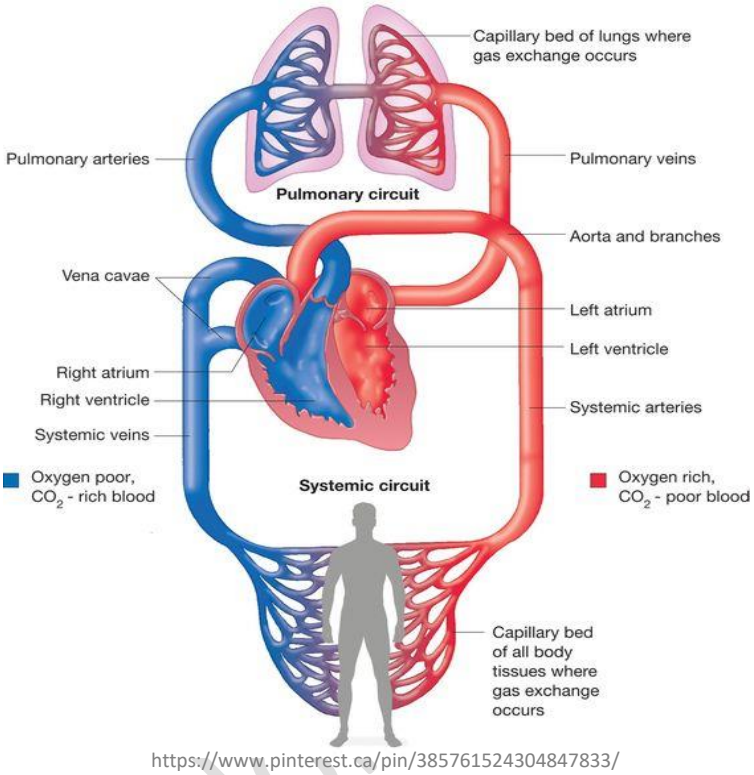
Draw arrows to indicate the flow of oxygen rich blood through the heart.



- contraction of the heart occurs simultaneously on the left and right sides of the heart

- the right side of the heart pumps deoxygenated blood to the lungs and is known as the **pulmonary circuit** (from body tissues →vena cavae →right atrium →AV valve → right ventricle →semilunar valve →pulmonary artery →lungs

- the left side of the heart pumps oxygenated blood to the body and is known as the **systemic circuit** (from the lungs →pulmonary vein →left atrium →AV valve →left ventricle →semilunar valve →aorta →body tissues



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Practice Questions

Use the following information to answer the next question:

Four Parts of the Circulatory System	
1	Vena cava
2	Right atrium
3	Right ventricle
4	Pulmonary artery

1) During chemotherapy, a drug is injected into a vein in the patient's arm.
The sequence in which the drug moves through the four parts of the circulatory system listed above is _____, _____, _____, and _____.

*(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)*

Use the following information to answer the next 2 questions:

One type of artificial heart contains rotating components that help push a constant stream of blood through two separate compartments. As a result, a patient with this type of artificial heart will not have a pulse or heartbeat.

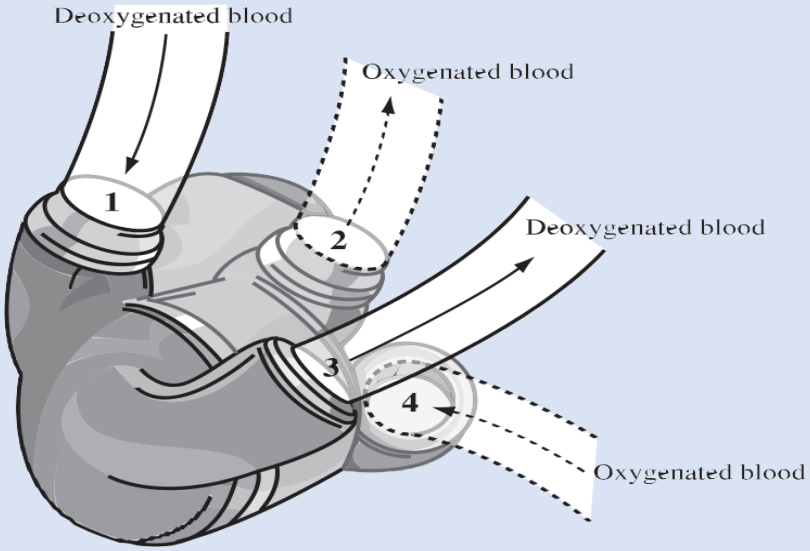


Diagram of Blood Flow Through a Two-compartment Artificial Heart

2) Which of the following structures prevent the backflow of blood within the normal human heart but are missing from the two-compartment artificial heart?

A. Atria
B. Valves
C. Ventricles
D. Coronary arteries

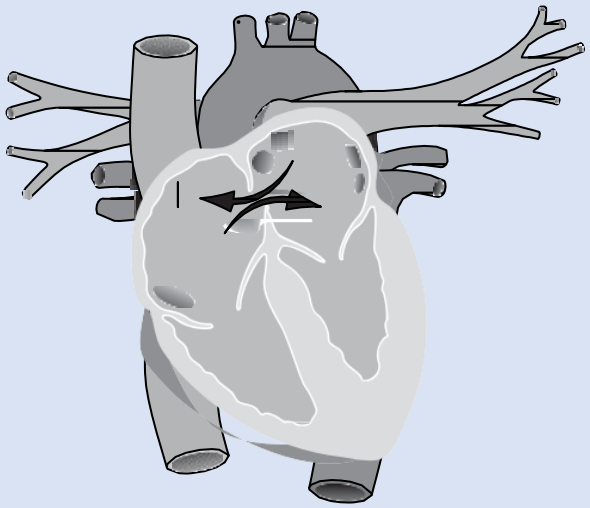
3) Match each structure numbered in the diagram of the artificial heart in the diagram above with a description below. (Use each number only once.)

Structure:				
Description:	Sends blood to the brain	Sends blood to the lungs	Attached to the vena cava	Attached to the pulmonary veins

*(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)*

Use the following information to answer the next question:

A common heart defect occurs when a hole between the left and right sides of the heart does not close before birth. The hole results in abnormal blood flow between chambers, as shown in the diagram to the right.

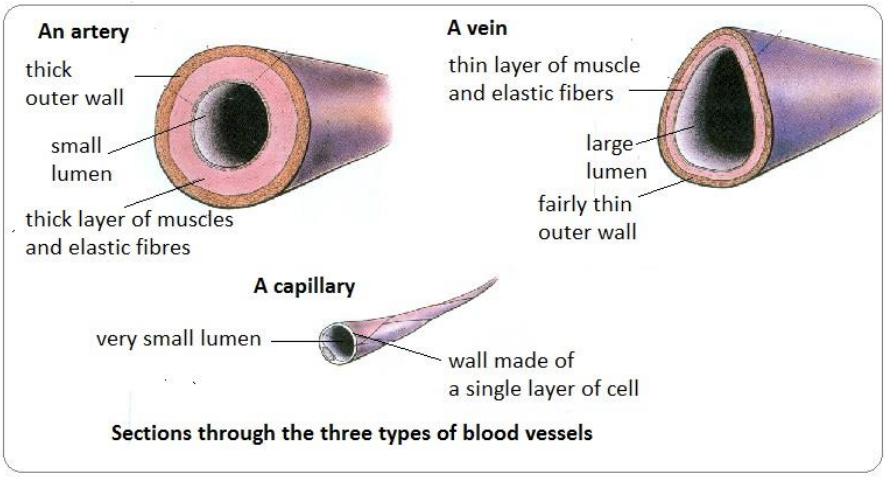


4) Which of the following rows identifies the affected heart chambers in the diagram above and describes a result of the heart defect?

Row	Affected Heart Chambers	Result
A.	Atria	Lower heart rate
B.	Atria	Mixing of oxygenated and deoxygenated blood
C.	Ventricles	Lower heart rate
D.	Ventricles	Mixing of oxygenated and deoxygenated blood

2 Identify structure and function of blood vessels

Blood Vessel	Structure	Function	Blood Flow
arteries	thick elastic muscle layer; small lumen diameter	carries blood away from the heart	highest pressure (100 mmHg)
arterioles	smaller branches of arteries	connect arteries to capillaries; vasoconstrict and vasodilate to regulate blood flow	high pressure (40-80 mmHg)
capillaries	thin, one cell thick walls; very small lumen diameter	allows for the exchange of nutrients, gases, and waste products between the blood and the tissue	medium pressure (15-25 mmHg)
venules	venules fuse to form veins	collects blood from capillaries and merges to form veins	low pressure (less than 15 mmHg)
veins	thin elastic muscle layer; contains valves; largest lumen diameter	collects and carries blood towards the heart	lowest pressure (near zero mmHg)



Sections through the three types of blood vessels

Practice Questions

Use the following information to answer the next question:

	Blood Vessel		Description of Blood Vessel		Function of Blood Vessel
1	Pulmonary artery	**4**	Walls are only one cell thick	**7**	Carries blood from the heart to the lungs
2	Aorta	**5**	Carries blood with a relatively high pressure and high oxygen content	**8**	Allows nutrients and wastes to be exchanged
3	Capillary	**6**	Carries blood with a relatively high pressure and a low oxygen content	**9**	Carries blood from the heart to the rest of the body

5) Using the numbers above, choose **one blood** vessel and match it with the description of that blood vessel and the function of that blood vessel. (There is more than one correct answer.)

Blood vessel _____ (Record in the **first** column)

Description _____ (Record in the **second** column)

Function _____ (Record in the **third** column)

*(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)*

Use the following information to answer the next question:

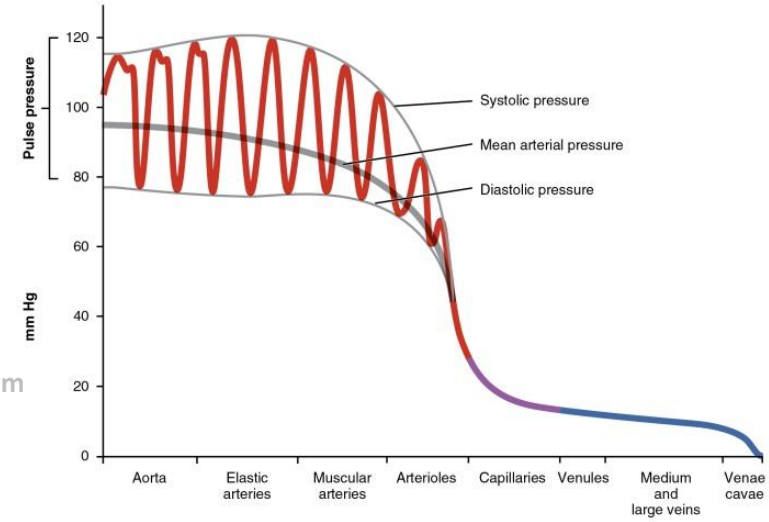
Some Blood Vessels in the Human Circulatory System

1 Vein
2 Artery
3 Venule
4 Arteriole

6) A flu vaccination is typically administered into arm muscle and diffuses into blood capillaries. The pathway of the vaccine once it enters a capillary is numbered _____, _____, heart, _____, _____ .

*(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)*

- Blood pressure is the pressure blood exerts on the walls of the blood vessel. When taking blood pressure, there are two measurements: systolic and diastolic pressure
  - **Systolic pressure** is the highest pressure and results from **systole** (ventricles contract)
  - **Diastolic pressure** is the lowest pressure and results from **diastole** (ventricles relax)
  - Average blood pressure for an adult is **120/80 mmHg**
  - High blood pressure occurs above 140/90 mmHg and is called hypertension
  - Low blood pressure occurs below 90/60 mmHg and can lead to dizziness and fainting



https://opentextbc.ca/anatomyandphysiology/chapter/20-2-blood-flow-blood-pressure-and-resistance/

Use the following information to answer the next question:

One hundred girls of the same age participated in a study to determine the effect of exercise on blood pressure. Fifty girls exercised for 60 min each day for one month.

The other 50 girls did not participate in any exercise for one month. The blood pressure of each participant was taken at the beginning and at the end of the month.

7) Which of the following rows identifies the responding variable and the control group from the study above?

Row	Responding Variable	Control Group
A.	Exercise	Girls that exercised
B.	Exercise	Girls that did not exercise
C.	Blood pressure	Girls that exercised
D.	Blood pressure	Girls that did not exercise

Use the following information to answer the next question:

In a study investigating the effects of caffeine on the circulatory system, heart rate and blood pressure readings of study participants were measured after the participants were given either a caffeine pill or a placebo (sugar pill).

Effects of Caffeine on the Circulatory System

	Time (h)				
	0	**1**	**3**	**5**	**8**
Average Heart Rate (beats/min)					
Caffeine	72	77	72	72	72
Placebo	72	72	71	71	72
Average Systolic Pressure (mmHg)					
Caffeine	121	128	126	126	123
Placebo	120	119	120	120	120
Average Diastolic Pressure (mmHg)					
Caffeine	80	83	81	81	80
Placebo	79	80	79	80	80

8) The data from the study suggest that:

A. caffeine has the longest-lasting effect on diastolic blood pressure
B. caffeine has the longest-lasting effect on systolic blood pressure
C. people with high blood pressure should not consume sugar
D. people with low blood pressure should not consume sugar

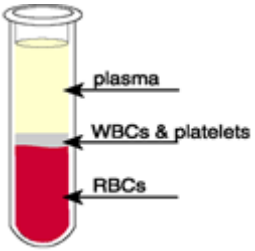
9) For an average adult, the first number in a blood pressure measurement is __***i***__ mm Hg, which refers to the __***ii***__ pressure measured when the __***iii***__ of the heart contract.

The statement above is completed by the information in row:

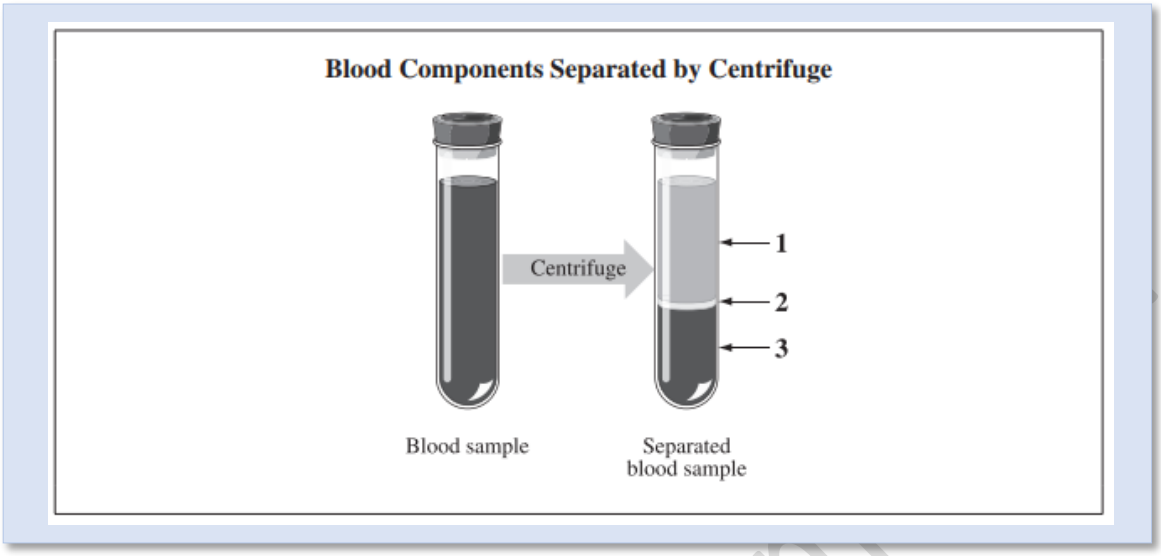
Row	***i***	***ii***	***iii***
A.	80	diastolic	ventricles
B.	80	systolic	atria
C.	120	systolic	ventricles
D.	120	diastolic	atria

❖ Blood is a fluid connective tissue composed of:

- ➢ plasma (mainly water, dissolved nutrients, and blood proteins that include clotting factors, antibodies, hemoglobin and hormones)
- ➢ red blood cells
- ➢ white blood cells
- ➢ platelets

Blood component	Structure	Function	Diagram
red blood cells	▪ biconcave disc ▪ no nucleus ▪ contains hemoglobin molecules	▪ hemoglobin molecules help RBCs to carry oxygen from lungs to body tissues	
white blood cells	▪ contain nuclei ▪ largest blood component	▪ defends the body against infection by foreign pathogens ▪ includes macrophages, B-cells and T-cells from the immune response	
platelets	▪ smallest, irregularly shaped cell fragment	▪ clots blood with the help of proteins found in the blood plasma	
plasma	▪ liquid component of blood ▪ mainly water, dissolved salts, nutrients, metabolic waste products, hormones, and proteins	▪ suspends the cellular components of blood ▪ transports dissolved compounds throughout the body ▪ helps distribute heat throughout the body	

Use the following information to answer the next question:



10) Match each section of the separated blood sample numbered above with its corresponding blood component below.

Number:			
Component:	Plasma	Red blood cells	Platelets and white blood cells

*(Record all **three digits** of your answer in the numerical-response section on the answer sheet.)*

Use the following information to answer the next question:

Some pesticides that target rats and mice contain a chemical that disrupts an animal's ability to use vitamin K. Without vitamin K, an animal is unable to produce blood clots and may die from internal bleeding.

11) The blood components **most directly** affected by the pesticide described above are:

A. red blood cells only
B. plasma and platelets
C. white blood cells and platelets
D. white blood cells and red blood cells

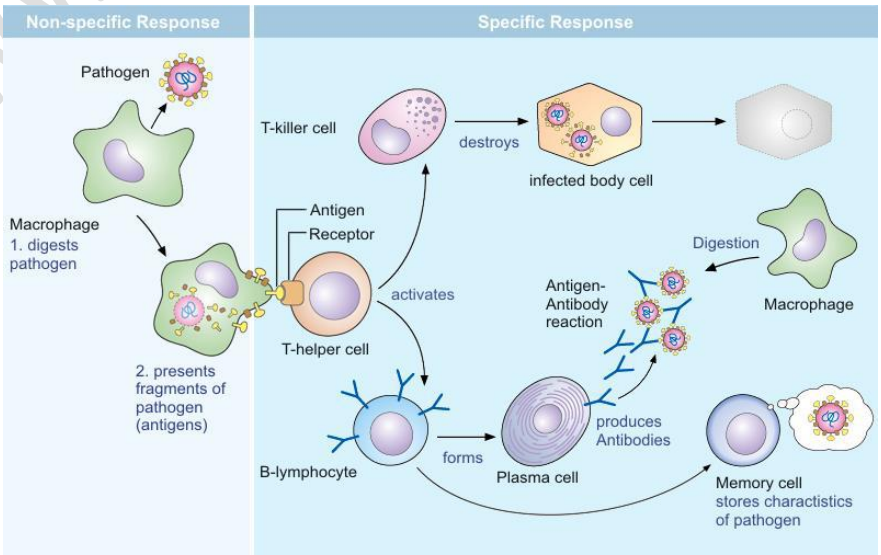
3 Defense against infection

- Fighting infection: your body has 3 lines of defence against infection:
  1. **First Line of Defence** are **barriers** that prevent the pathogen from entering the body. These include tears, sweat, skin, stomach acid, eyelashes, ear wax, cilia lining bronchioles.
  2. **Second Line of Defence** occurs when the pathogen has entered the body. A general mechanism occurs where inflammation occurs to bring more blood flow to the site of infection resulting in redness and swelling. Fever also occurs to help slow down invading pathogens.
  3. **Third Line of Defence** is the **immune response**. This is a specific response built against every invading pathogen.

A **macrophage** ingests the foreign invader and presents the foreign antigen on its surface → **Helper T-cells** recognize the antigen as a foreign invader and activates the **B-cells** to produce proteins called **antibodies** and **killer T- cells** which directly kill infected host cells or cancer cells → Each unique **antibody** binds to one specific antigen on the bacteria or virus immobilizing the pathogen and allowing macrophages to ingest them

Once the infection is under control, **suppressor T-cells** signals the B-cells and killer T-cells to stop multiplying → **Memory B-cells** and **memory T-cells** remain to remember the invader and to allow for a faster immune response (3 to 5 days instead of 5-10 days) if the body is again exposed to the same foreign antigen. This leads to the development of **immunity**

- autoimmune diseases occur when the body recognizes its own cells and tissues as foreign and launches an immune response in its own body.
  - *examples include multiple sclerosis (MS) – the immune system attacks neurons; arthritis – the immune system attacks the joints; lupus – the immune system attacks multiple organ systems in the body.*
- vaccines prevent infection by stimulating the immune system to produce memory cells against specific foreign invaders we have identified as being harmful. Once a primary immune response has occurred, upon infection with the same pathogen, full production of killer T-cells and antibodies occurs faster.



http://www.intactschools.eu/node/361

12) An example of a person's non-specific or first line of defence against pathogens is:

A. Tears
B. Antigens
C. Antibodies
D. Killer T cells

13) Foreign matter that enters the body at the site of a scrape or cut contains ___*i*___ and will be engulfed by ___*ii*___

The statement above is completed by the information in row:

Row	*i*	*ii*
A.	antigens	killer T cells
B.	antigens	macrophages
C.	antibodies	killer T cells
D.	antibodies	macrophages

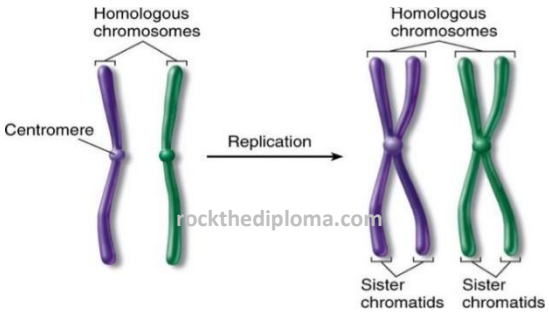
Use the following information to answer the next question:

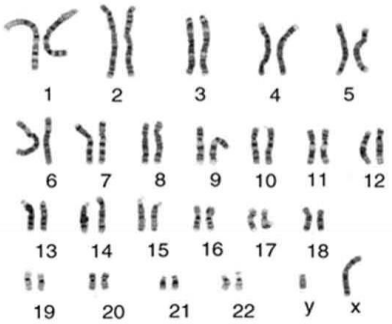
After a person has been vaccinated against a particular pathogen, he or she often needs to receive injections of the same vaccine, called booster shots, in the future in order to maintain a sufficient level of immunity against that pathogen. Booster shots increase the length of time that the person is immune to that particular pathogen.

14) Each booster shot increases the number and concentration of a person's:

A. amino acids and memory cells
B. amino acids and macrophages
C. antibodies and memory cells
D. antibodies and macrophages

Describe, in general, the behaviour of chromosomes during mitosis, meiosis and fertilization





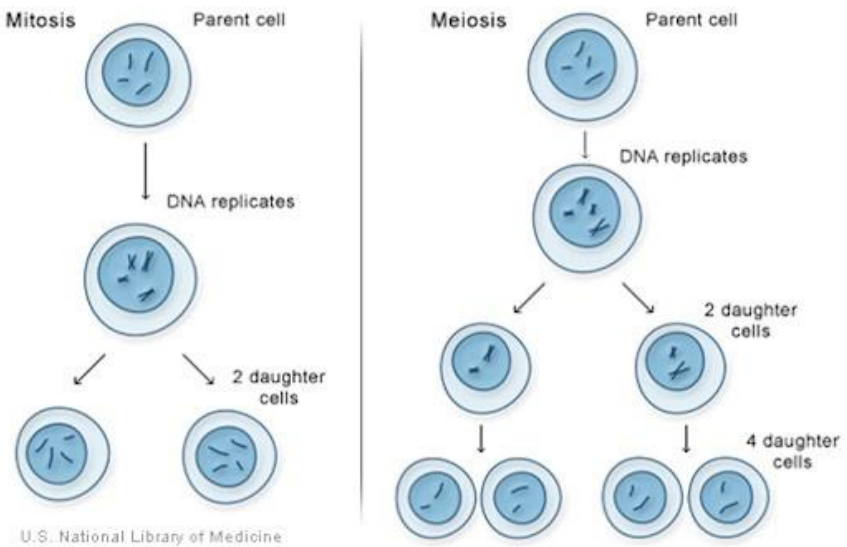
1 Chromosomes

- human body cells are **diploid** (2n=46) and contain 23 pairs or 46 chromosomes
- human sex cells (egg and sperm) are **haploid** (1n) and contain 23 chromosomes
- homologous chromosomes are alike in size, shape and gene arrangement (exception are the sex chromosomes XX female, XY male)
- a karyotype is an arrangement of chromosomes that allows chromosome disorders to be diagnosed

2 Cell Replication

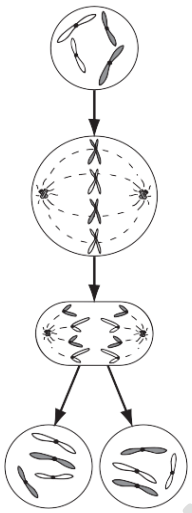
- cells reproduce in two ways:

	mitosis	meiosis
where in the body it takes place	body cells	sex cells in the gonads (testes & ovaries)
number of cell divisions involved		
chromosome number (haploid or diploid)		
name of daughter cells	body cells	gametes (sperm & eggs)
comparison of daughter cells to mother cell		
importance in the body	development of multicellular adult; production of cells for growth and tissue repair	production of gametes; reduces chromosome number by ½ and introduces genetic variability



Use the following information to answer the next question:

A Type of Cell Division



15) The change in chromosomal content from the parent cell to a daughter cell, as illustrated above, can be described as:

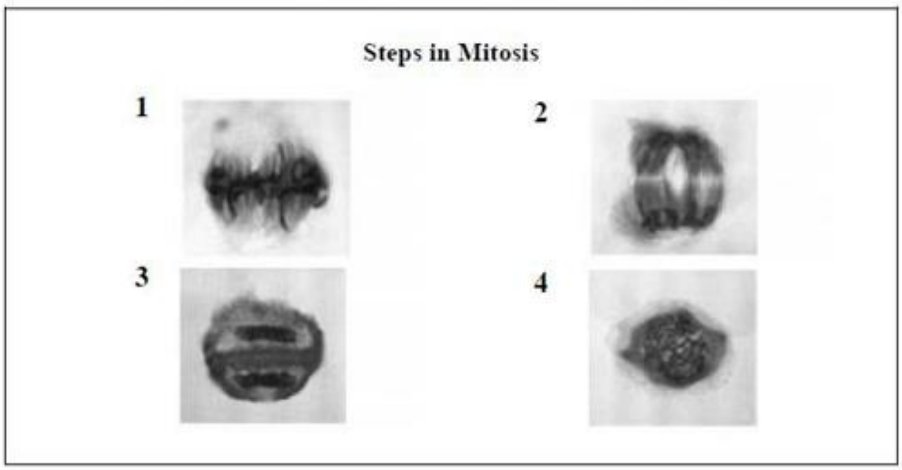
A. 4*n* → 1*n*
B. 4*n* → 2*n*
C. 2*n* → 2*n*
D. 2n → 1n

16) A diploid cell produces new diploid cells through the process of _____***i***_____. Some diploid cells produce new haploid cells by undergoing the process of _____***ii***_____.

The statements above are completed by the information in row:

Row	*i*	*ii*
A.	meiosis	mitosis
B.	meiosis	fertilization
C.	mitosis	fertilization
D.	mitosis	meiosis

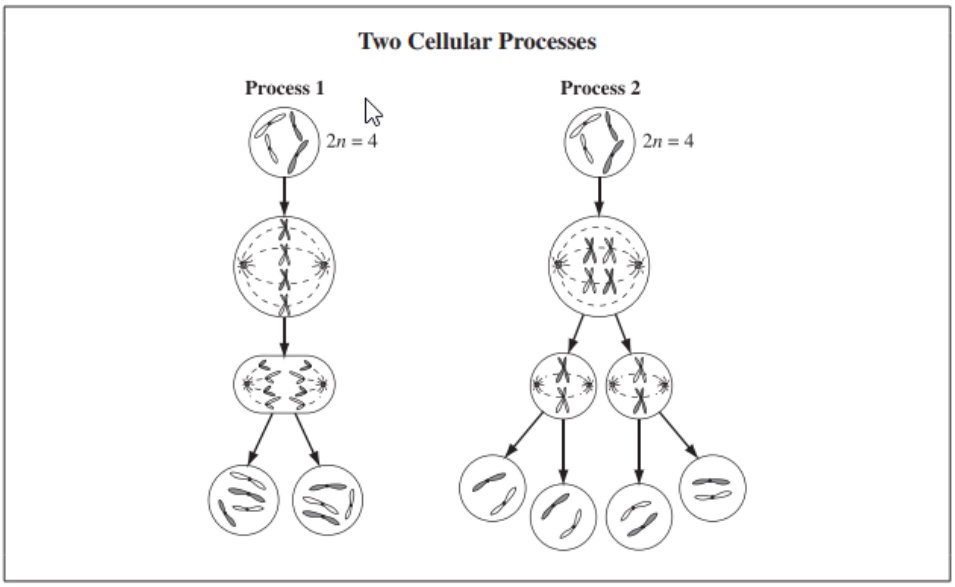
Use the following information to answer the next question:



17) The sequence in which these mitotic steps occur is ____, ____, _____, and ____.

*(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)*

Use the following information to answer the next question:

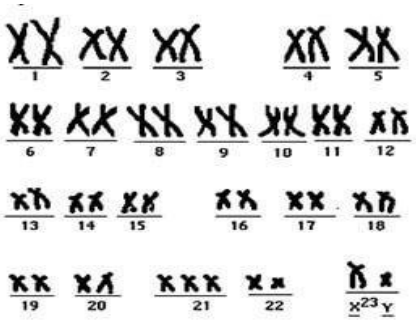


18) Which of the following rows identifies the **final** chromosome content in each of the cells produced by the two processes illustrated above?

Row	Cells Produced by Process 1	Cells Produced by Process 2
A.	$2n = 4$	$2n = 4$
B.	$2n = 4$	$1n = 2$
C.	$1n = 2$	$1n = 4$
D.	$1n = 2$	$2n = 2$

3 Non-disjunction

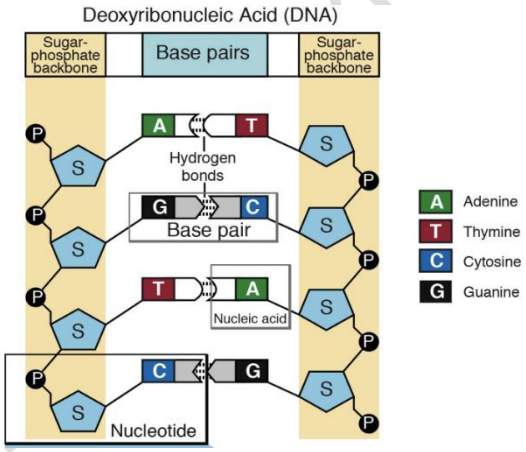
- occurs when chromosomes fail to separate correctly
- occurs during meiosis resulting in egg or sperm with too many or too few chromosomes
- can lead to chromosomal disorders like Down's syndrome, Turner's syndrome and Klinefelter's syndrome



Is this karyotype for a male or female?

4 DNA Structure

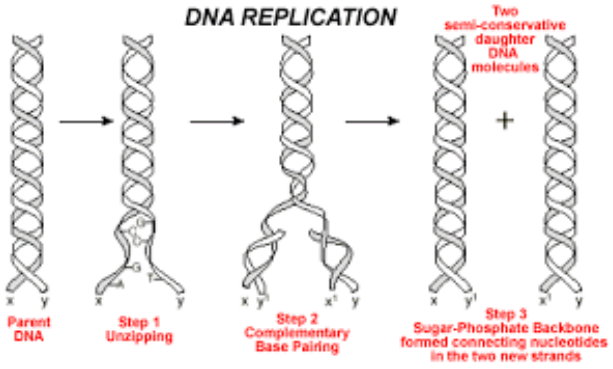
- double helix
- made of nucleotides (sugar, phosphate, nitrogen base)
- sugar phosphate backbone
- 4 different nitrogenous bases: adenine (A), thymine (T), guanine (G), cytosine (C)



http://knowgenetics.org/nucleotides-and-bases/

5 DNA Replication

- one strand of DNA is used as a template
- semi-conservative
- DNA replicates using the base pairing rule: A bonds with T and C bonds with G



6 DNA Function

- the sequence of nucleotides on DNA is read in groups of 3 known as **DNA triplets**.
- these triplets form **genes** which encode for the order of **amino acids** in a **protein**.
- **Be able to use the data booklet to translate DNA into protein**

  DNA sequence: ATG TTA CGA CCT TAG

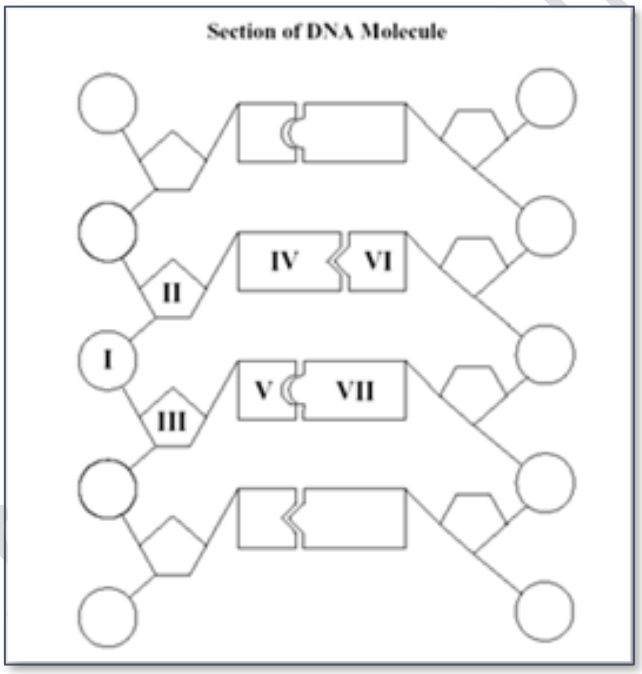
  Protein sequence: methionine-leucine-arginine-proline-stop
- Be able to identify the different roles of protein in the human body

Some Proteins and Their Roles

Type of Protein	Role of Protein
Enzymes	Speed up chemical reactions in the body
Hormones	Act as signals to coordinate and regulate activities in the body
Structural	Support cells and provide frameworks for other proteins to attach to
Transport	Allow the movement of materials within cells or the body (for example, hemoglobin)
Defensive	Protect the body from pathogens (for example, antibodies)
Energy	Decomposition of certain proteins can serve as a source of energy

Practice Questions

Use the following information to answer the next question:



19) In the diagram above, structures that represent the nitrogenous base pairs responsible for the coding of gene sequences are:

A. I and II
B. II and III
C. II and IV
D. V and VII

Use the following information to answer the next question:

One strand of a small segment of DNA has the sequence

A - A - T - C - T - C - G - T – A

20) The sequence of the complementary strand is:

A. G - G - C - T - C - T - A - C - G
B. T - T - A - G - A - G - C - A - T
C. C - C - G - A - G - A - T - G - C
D. A - A - T - C - T - C - G - T – A

Use the following information to answer the next question:

Biological Molecules

1 Proteins
2 Enzymes
3 Hormones
4 Amino acids
5 Nitrogen bases
6 Deoxyribose sugars
7 Phosphate molecules

21) The three molecules in the list above that make up a DNA strand are numbered _____, _____, and _____ .

*(Record all **three digits** of your answer **in any order** in the numerical-response section on the answer sheet.)*

Use the following information to answer the next question:

Protein	**Function**	**Classification**
1 Antibody	3 Delivers oxygen	6 Defensive
2 Hemoglobin	4 Speeds up reactions	7 Enzyme
	5 Attaches to pathogens	8 Transport

22) Using the numbers above, choose one protein and match it with its corresponding function and the classification of that protein. (There is more than one correct answer.)

Protein _____ (Record in the **first** column)

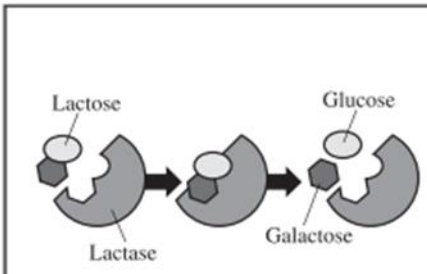
Function _____ (Record in the **second** column)

Classification _____ (Record in the **third** column)

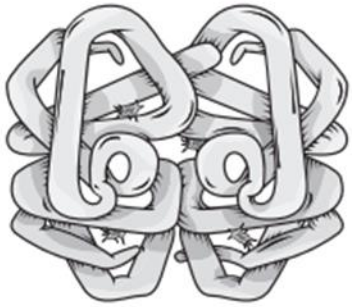
(Record your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question:

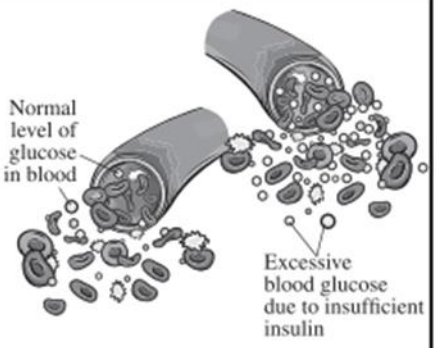
Some Important Proteins in the Human Body



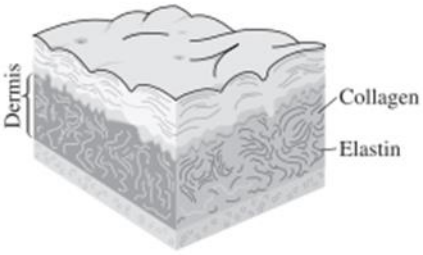
1 Lactase speeds up the rate at which lactose is broken down.



2 Hemoglobin carries gases in the body.



3 Insulin helps to regulate blood glucose level and maintain homeostasis.



4 Collagen provides a framework for skin.

23) Match the descriptions of each protein numbered above with its classification below. (Use each number only once.)

Structural protein _____ (Record in the **first** column)

Transport protein _____ (Record in the **second** column)

Hormone _____ (Record in the **third** column)

Enzyme _____ (Record in the **fourth** column)

(Record your answer in the numerical-response section on the answer sheet.)

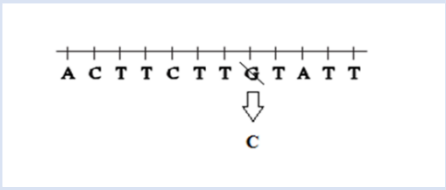
7 DNA mutation

- changes in the sequence of DNA may cause changes to the proteins produced resulting in human diseases *(e.g., sickle-cell anemia, hemophilia, Huntington's disease, cystic fibrosis)*

Use the following information to answer the next question:

The DNA strand fragment depicted below, when read from left to right, provides the code for part of an amino acid chain.

Fragment of DNA



24) If a mutation occurs to the DNA sequence above causing the guanine (G) nitrogen base to be replaced by a cytosine (C) nitrogen base, which of the following rows identifies the correct change to the amino acid sequence?

A.	cysteine to tyrosine	**C.**	leucine to phenylalanine
B.	cysteine to serine	**D.**	leucine to serine

8 Inheritance

- a **dominant** trait can mask the expression of a **recessive** trait
- dominant and recessive alleles **segregate** from each other during meiosis
- organisms having two different alleles are **heterozygous**; ie. Pp
- organisms having two of the same alleles are **homozygous**; PP or pp
- the organism's appearance is known as it's **phenotype**; purple flowers
- the organism's genetic makeup is known as it's **genotype**; PP or Pp
- a Punnett square is used to predict the genotypes of monohybrid or dihybrid crosses
- **autosomal** inheritance occurs equally in both males and females and is passed on chromosomes 1-22 (autosomes)
- **sex linked** inheritance occurs more frequently in males and is passed on sex chromosomes (X-linked or Y-linked)

		Mom	
		b	b
Dad	B	Bb	Bb
	b	bb	bb

50% have brown eyes

		Mom	
		B	b
Dad	B	BB	Bb
	b	Bb	bb

75% have brown eyes

		Mom	
		b	b
Dad	B	Bb	Bb
	B	Bb	Bb

100% have brown eyes

Example 1

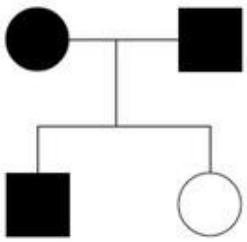
Parents: $X^cX^c \times X^cY$
Normal female x Colorblind male

	X^c	X^c
X^c	X^cX^c	X^cX^c
Y	X^cY	X^cY

Offspring: 100% normal carrier females, 100% normal males

9 Pedigrees

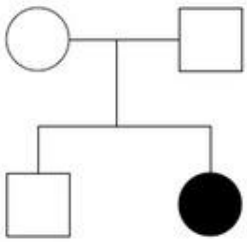
- charts used to determine pattern of inheritance
- be able to identify males as squares and females as circles, affected individual as shaded and unaffected individuals as unshaded
- be able to determine the genotype and phenotype of each individual
- be able to determine whether inheritance is autosomal or sex-linked, and dominant or recessive



Autosomal Dominant

Cannot be recessive as affected parents could not have an unaffected offspring

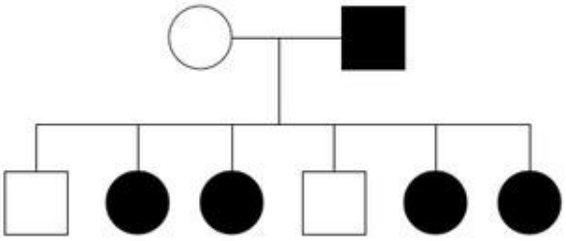
Parents MUST be heterozygous



Autosomal Recessive

Cannot be dominant as unaffected parents could not have an affected offspring

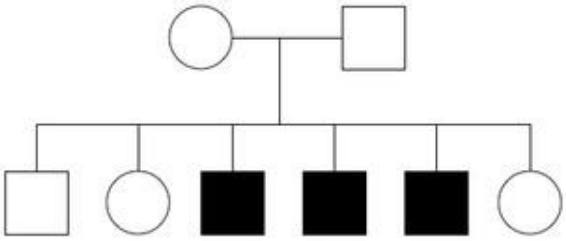
Parents MUST be heterozygous



X-Linked Dominant

Mode of inheritance cannot be confirmed

However, 100% incidence of affected daughters from an affected father suggests X-linked dominant inheritance



X-Linked Recessive

Sex linkage cannot be confirmed

However, high incidence of affected sons suggests X-linked recessive inheritance

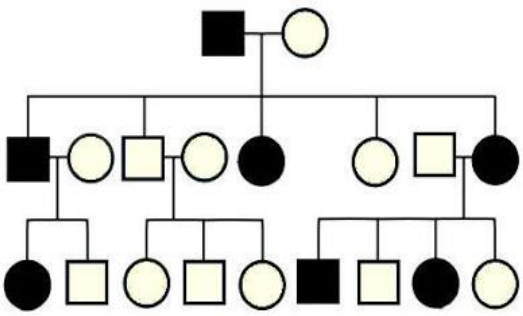
Practice Questions

Identify if the following pedigrees illustrates:

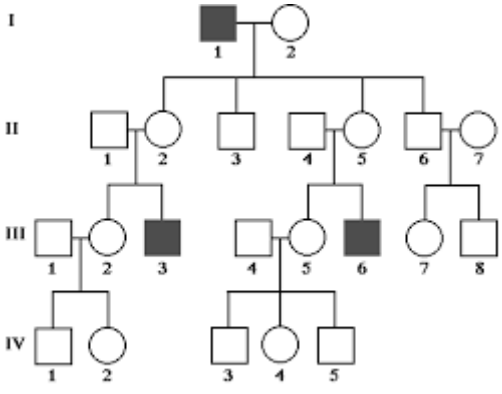
(a) dominant or recessive inheritance?

(b) autosomal or sex-linked inheritance?

#1



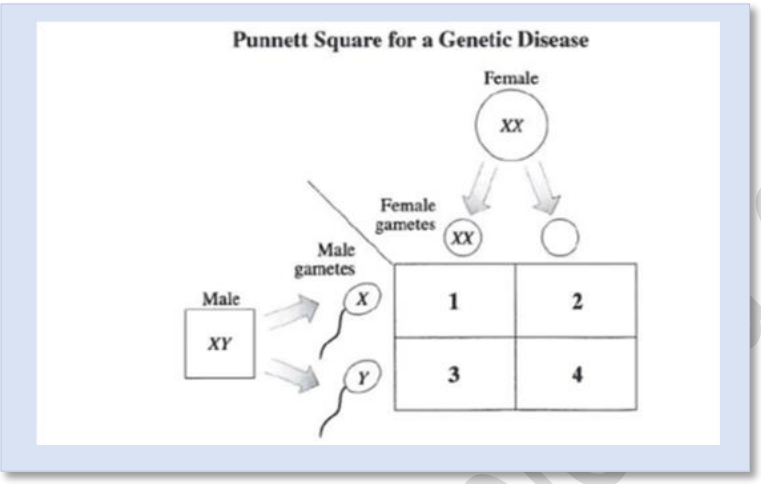
#2



25) Cystic fibrosis is a disease caused by a recessive allele. If both parents are carriers, the probability of their offspring having the disease is _____%

(Record your answer in the numerical-response answer sheet)

Use the following information to answer the next question:



26) Match each of the numbered spaces in the Punnett square above to the genotype to which it corresponds, as given below.

X _____ (Record in the **first** column)

XXX _____ (Record in the **second** column)

XXY _____ (Record in the **third** column)

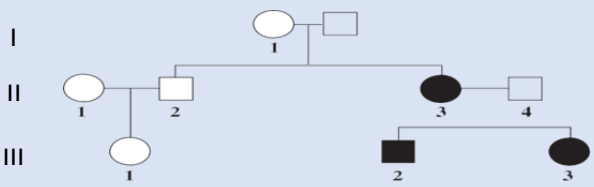
Y _____ (Record in the **fourth** column)

*(Record all **four digits** of your answer in the numerical-response box.)*

Use the following information to answer the next question:

Phenylketonuria (PKU) is an autosomal recessive disorder.

Pedigree Chart Illustrating PKU Inheritance



P = unaffected
p = affected

27) The genotype of individual **II-4** is:

A. PP

B. Pp

C. Pp or PP

D. PP or pp

28) Which of the following people represented on the pedigree chart has a homozygous genotype?

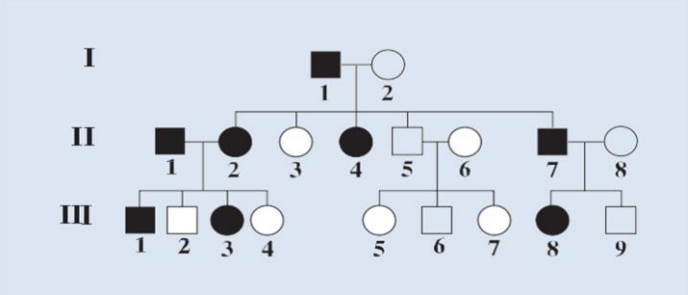
A. I-1 **C.** II-3

B. I-2 **D.** II-4

Use the following information to answer the next question:

A widow's peak is a type of hairline where a peak forms near the centre of a person's forehead, as shown below.

A Pedigree Chart Illustrating the Incidence of Widow's Peak in a Family



29) Based on the pedigree chart above, the mode of inheritance for widow's peak is **most likely**:

A. autosomal recessive **C.** X-linked recessive

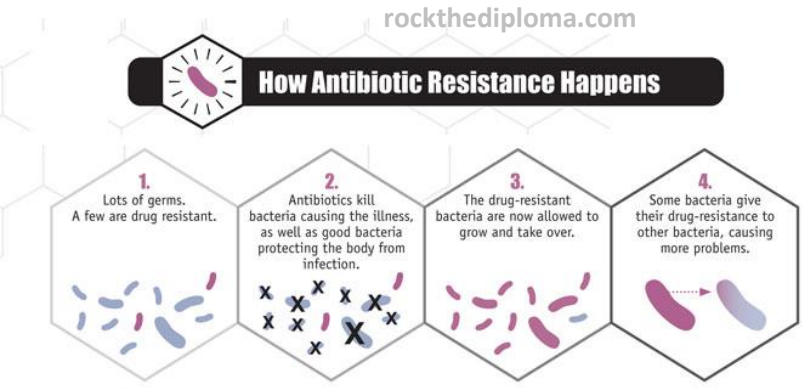
B. autosomal dominant **D.** X-linked dominant

10 DNA Technology

- **genetic engineering** occurs when DNA is directly manipulated using molecular biology techniques. This results in recombinant DNA and is used for **gene therapy** and the development of **genetically modified organisms**

11 Resistance in bacteria and viruses

- antibiotic resistance can develop in bacteria due to **mutation**. This resistance can be shared with other bacteria via **plasmid transfer** and **transformation** where genetic information from drug resistant bacteria is shared with non-resistant bacteria.
- natural selection will favour antibiotic resistant bacteria when antibiotics are overprescribed.



https://www.cdc.gov/antibiotic-use/community/about/antibiotic-resistance-faqs.html

Use the following information to answer the next question:

Some scientists are researching the possibility of using viruses to treat genetic disorders caused by a mutated gene. This treatment uses modified viruses to deliver DNA containing the non-mutated gene to the affected person's cells.

30) The type of treatment described above is called:

A. gene therapy
B. plasmid transfer
C. genetic screening
D. genome sequencing

Use the following information to answer the next question:

Adenosine deaminase (ADA) deficiency is a genetic disorder that prevents DNA replication in the stem cells that produce T cells and B cells. Some people with ADA deficiency have DNA from their T cells removed. This DNA is modified with a functioning ADA gene and then inserted into a virus. The virus is then delivered back into the person with ADA deficiency, who is then able to produce normal levels of T cells and B cells.

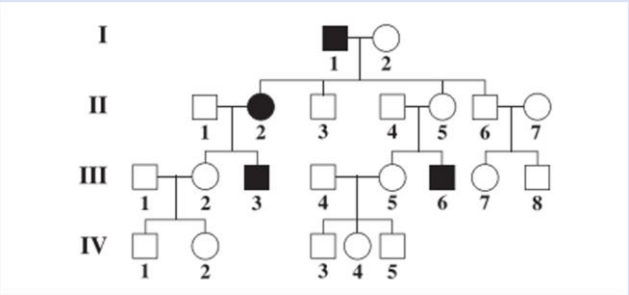
31) The treatment described above is an example of:

A. DNA fingerprinting
B. genetic screening
C. transformation
D. gene therapy

Use the following information to answer the next question:

Changes to the *Gla* gene cause Fabry disease, an X-linked recessive disorder that results in a build-up of fat in many body cells. As the disease progresses, fat builds up in the large blood vessels that move blood away from the heart, increasing the risk of kidney damage, heart attack, and stroke.

Pedigree Chart Representing a Family with Fabry Disease



32) The blood vessels expected to be **most affected** by Fabry disease are:

A. capillaries
B. venules
C. arteries
D. veins

33) Which of the following rows represents the genotype and phenotype of individual **II-4** shown in the pedigree chart above?

Row	Genotype of II-4	Phenotype of II-4
A.	Affected male	X^FY
B.	Unaffected male	X^FX^f
C.	X^FY	Unaffected male
D.	X^FX^f	Affected male

34) Which of the following processes could cause Fabry disease?

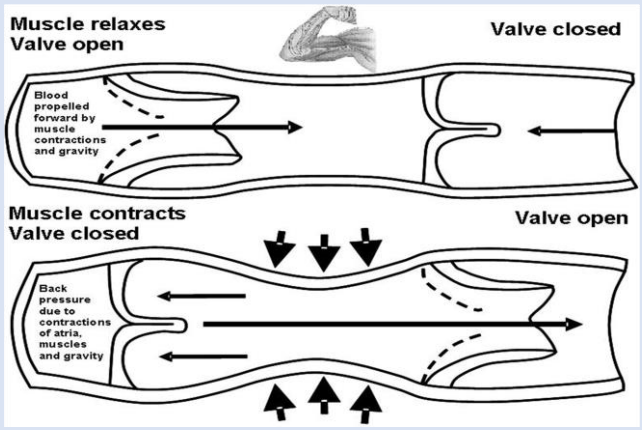
A. A base pair mutation
B. Meiosis in fat cells
C. Mitosis in fat cells
D. A viral infection

35) The type of blood vessels that releases nutrients and oxygen to the tissues is called:

A. a vein
B. a venule
C. a capillary
D. an artery

Use the following diagram to answer the next question:

Section of a Blood Vessel



36) The type of blood vessel depicted in the diagram above is:

A.	an artery	**C.**	a capillary
B.	a vein	**D.**	an arteriole

37) A blood vessel is classified as an artery if it carries:

A.	blood away from the heart	**C.**	oxygenated blood
B.	blood toward the heart	**D.**	deoxygenated blood

38) A diode is a device in an electric circuit. It permits electrons to travel in only one direction. A structure in the circulatory system that has a similar function to that of a diode in an electronic circuit is a:

A.	valve	**C.**	ventricle
B.	capillary	**D.**	venule

Use the following information to answer the next question:

A researcher makes the following hypothesis:

Athletes who have trained at a high altitude before competing at a low altitude will have greater endurance because they are able to use oxygen more effectively.

The researcher does a search of several studies related to his hypothesis.

Experimental Designs of Some Circulatory System Studies

I The average red blood cell count of a group of people living at a high altitude was compared with the average red blood cell count of a similar group of people living at a low altitude.

II The average white blood cell count of runners before a high-altitude marathon race was compared with the average white blood cell count of the runners after the race.

III The quantity of hemoglobin per millilitre of blood was measured in people who trained at a low altitude and then measured again after these people spent one month training at a high altitude.

IV The average platelet count of a group of people living at a high altitude was compared with the average platelet count of a similar group of people living at a low altitude.

V The concentration of antibodies in a group of people living at a high altitude was compared with the concentration of antibodies in a similar group of people living at a low altitude.

39) Two studies described above that would best test the researcher's hypothesis are:

A.	I and III	**C.**	II and V
B.	I and IV	**D.**	III and IV

40) Two of the studies described above helped to establish that altitude has an effect on immunity. The studies that this evidence most likely came from are:

A.	I and II	**C.**	II and V
B.	I and IV	**D.**	III and V

Use the following information to answer the next question:

Variables in One of the Circulatory System Studies

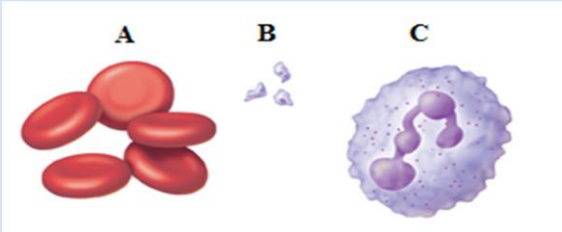
Manipulated variable	– Altitude
Responding variable	– Ability to clot blood
Controlled variable	– Age of participants

41) The variables listed above most likely came from Study:

A.	II	**C.**	IV
B.	III	**D.**	V

Use the following information for the next question:

Blood Components



42) Cell types A, B and C shown above represent, respectively:

A. white blood cells, platelets, and a red blood cell
B. platelets, red blood cells, and a white blood cell
C. red blood cells, white blood cells, and a platelet
D. red blood cells, platelets, and a white blood cell

43) Treatment in a low-air-pressure chamber causes a person's body to produce more oxygen-carrying blood cells, which are called:

A.	helper T cells	**C.**	white blood cells
B.	platelets	**D.**	red blood cells

44) Blood clotting factors are routinely tested. Clotting is initiated by

A.	helper T cells	**C.**	white blood cells
B.	platelets	**D.**	red blood cells

Use the following information to answer the next question

Four Substances Transported by Blood

1 Glucose
2 Oxygen
3 Carbon dioxide
4 Dissolved waste

45) Match the substances transported by blood, as numbered above, with the appropriate descriptions given below. Use each number only once.

Is an organic nutrient _____ (Record in the **first** column)

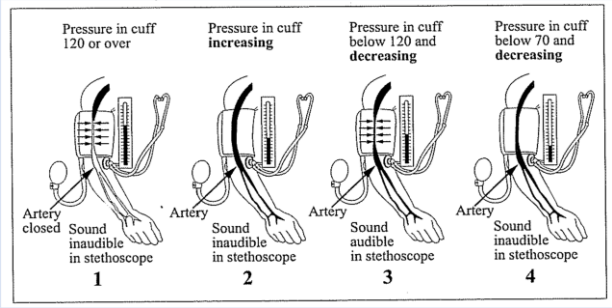
Is removed in lungs _____ (Record in the **second** column)

Is removed in kidneys _____ (Record in the **third** column)

Is transported from lungs to tissues _____ (Record in the third column)

*(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)*

Use the following information to answer the next question.



46) Blood pressure is an indicator of a person's susceptibility to heart disease. The correct sequence of steps in measuring blood pressure with a blood pressure cuff (sphygmomanometer) is _____, _____, _____, and _____.

*(Record your **four digits** answer in the numerical-response box.)*

47) A pathogen is more likely to infect a person who has:

A.	badly damaged skin	**C.**	excessive sweat secretions
B.	high red blood cell levels	**D.**	stomach acid with a low pH

Use the following information to answer the next question:

Type of White Blood Cell	One Function	Another Function
1 Helper T cells	**4** Recognize antigens and send chemical message	**7** Expose foreign antigens
2 Macrophages	**5** Produce proteins which bind to specific antigens of the invaders	**8** Become memory cells
3 B cells	**6** Surround invading pathogens	**9** Signal production of killer T cells

48) Using the numbers above, choose **one type of white blood cell** and match it with two functions of that type of white blood cell. (There is more than one correct answer.)

Type of white blood cell _____ (Record in the **first** column)

One function _____ (Record in the **second** column)

Another function _____ (Record in the **third** column)

(Record your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question:

Erwin Chargaff was a scientist whose work led to the discovery of which nitrogen bases in a DNA molecule pair together. He determined the relative portions of each of the four nitrogen bases in a particular DNA molecule.

Some Results from Chargaff's Experiment

Nitrogen Base	Relative Portion of a Particular DNA Molecule
Adenine	30%
Guanine	20%

49) Based on the results of Chargaff's experiment, which of the following rows identifies the relative portion of cytosine in the DNA molecule and the relative portion of thymine in the DNA molecule?

Row	Relative Portion of Cytosine in the DNA Molecule	Relative Portion of Thymine in the DNA Molecule
A.	20%	30%
B.	30%	20%
C.	70%	80%
D.	80%	70%

50) If a nitrogen base sequence on a particular strand of DNA is AAG, then the sequence on the complementary strand of DNA is:

A.	GGC	**C.**	TTC
B.	CCT	**D.**	TTA

Use the following information to answer the next question.

Steps in Preparing Bacteria to Produce Insulin

1. Bacteria containing the recombinant DNA is cultured and grown.
2. The insulin-producing gene is obtained from pigs.
3. DNA from bacteria is cut.
4. The insulin-producing gene is inserted into the bacterial DNA.

51) The order in which the steps listed above should be performed in order for bacteria to produce insulin is _____, _____, _____, and _____.

*(Record all **four digits** of your answer in the numerical-response section on the answer sheet.)*

Use the following information to answer the next question:

People with hemophilia A, a recessive sex-linked disorder, lack a blood protein known as clotting factor VIII. A woman with hemophilia (X^hX^h) and a man without hemophilia (X^HY) have a child.

52) The percent probability the child described above will have hemophilia is _____%.

(Record your answer in the numerical-response section on the answer sheet.)

Chapter B1: Acids and Bases

Property	Acid	Neutral (ionic or molecular)	Base
Taste	▪ Sour	▪ Varies: e.g. salty or sweet	▪ Bitter
Feel	▪ Corrosive		• Corrosive • Slippery
Indicator tests	▪ Litmus turns red ▪ Phenolphthalein is colourless ▪ Bromothymol Blue turns yellow	▪ Red litmus stays red ▪ Blue litmus stays blue ▪ Phenolphthalein is colourless ▪ Bromothymol blue turns green	▪ Litmus turns blue ▪ Phenolphthalein turns pink ▪ Bromothymol blue stays blue
pH	< 7	= 7	>7
Conductivity	Yes	Ionic – Yes Molecular - NO	Yes
Chemical properties	▪ Acids corrode metals releasing hydrogen gas ▪ Reacts with base in a neutralization		▪ Reacts with acid in a neutralization
Examples (pH)	▪ apple(3.0) ▪ milk(6.6) ▪ normal rain (5.6) ▪ lemon juice(2.0) ▪ black coffee(5.0)	▪ Ionic: salt solution (7.0) ▪ Molecular: sugar solution (7.0) ▪ Distilled water (7.0)	▪ blood(7.4) ▪ baking soda(8.2) ▪ ammonia ▪ cleaner(11.1), ▪ bleach(12.4)

Practice Questions

Use the following information to answer the next question.

A lab technician performed the following tests on four solutions and recorded the results in the table below.

Tests Performed on Unlabelled Solutions ➢

Test	Solution			
	1	2	3	4
Dissolves in $H_2O(l)$	✓	✓	✓	✓
Conducts electricity	✓	✗	✓	✓
Blue litmus	no change	no change	red	no change
Red litmus	no change	no change	no change	blue

1) Match each of the solutions numbered above with the name of a chemical that it could be, as given below:

Sodium hydroxide, NaOH(aq) _____ (Record in the **first** column)
Sodium chloride, NaCl(aq) _____ (Record in the **second** column)
Glucose, $C_6H_{12}O_6$ (aq) _____ (Record in the **third** column)

Hydrochloric acid, HCl(aq) _____ (Record in the **fourth** column)

2) If a substance has a basic pH, then the pH for that substance is

A. less than 7 and will turn red litmus blue
B. less than 7 and will turn blue litmus red
C. greater than 7 and will turn red litmus blue
D. greater than 7 and will turn blue litmus red

Bronsted-Lowry definitions of acids and bases:

- An **acid** is a proton (H^+) donor
  - Ex. When hydrogen chloride is dissolved in water, it undergoes an **ionization reaction** where it reacts with water to form a hydronium ion which is able to act as a proton donor:

An **acid** loses a hydrogen ion to form the **conjugate base**

$$HCl_{(g)} + H_2O_{(l)} \rightarrow \mathbf{H_3O^+_{(aq)}} + Cl^-_{(aq)}$$

A **base** gains a hydrogen ion to form the **conjugate acid**

**NOTE: the transfer of a H^+ ion from the acid molecule to the water molecule forms the hydronium ion.*

- A **base** is a proton (H^+) acceptor
  - Ex 1. When sodium hydroxide is dissolved in water, it undergoes a **dissociation** where the positive and negative ions separate in solution forming a **hydroxide ion** which acts as a proton acceptor:

$$NaOH_{(s)} \rightarrow Na^+_{(aq)} + \mathbf{OH^-_{(aq)}}$$

  - Ex 2. When ammonia dissolves in water, it undergoes an **ionization reaction** where it reacts with water to form a hydroxide ion which acts as a proton acceptor:

An acid loses a hydrogen ion to form the conjugate base

$$NH_{3\,(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + \mathbf{OH^-_{(aq)}}$$

A base gains a hydrogen ion to form conjugate acid

**NOTE: Ionization involves the formation of ions from molecular compounds where no ions previously existed. Dissociation involves the separation of an ionic compound into positive and negative ions.*

Practice Questions

Use the following information to answer the next question.

Ionization of Ethanoic Acid

$$CH_3COOH(aq) + H_2O(l) \rightleftarrows CH_3COO^-(aq) + H_3O^+(aq)$$

3) The proton donors in the equilibrium equation above are

A. $H_2O(l)$ and $CH_3COO^-(aq)$
B. $H_2O(l)$ and $H_3O^+(aq)$
C. $CH_3COOH(aq)$ and $H_3O^+(aq)$
D. $CH_3COOH(aq)$ and $CH_3COO^-(aq)$

Use the following information to answer the next question.

Reaction of $H_2S_{(g)}$ with Water: $H_2S_{(g)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HS^-_{(aq)}$

4) Which substances in the equation above donate a proton?

A. $H_2O_{(l)}$ and $H_2S_{(g)}$
B. $H_2O_{(l)}$ and $HS^-_{(aq)}$
C. $H_2S_{(g)}$and $HS^-_{(aq)}$
D. $H_2S_{(g)}$and $H_3O^+_{(aq)}$

Combustion Reactions and their products

- Burning **fuels** like methane, propane, butane, coal, gasoline, diesel is known as a **combustion**
- The products of this combustion are usually carbon dioxide (CO_2) and water (H_2O) but may contain other products depending on the atoms present in the fuel. These products are known as **emissions.**

Emission	Source of emission	Effect of emission
carbon dioxide, CO_2	burning of fossil fuels cellular respiration	global warming
carbon monoxide, CO	incomplete combustion of fossil fuels	binds hemoglobin on RBC lowering the blood's ability to transport oxygen – affects human health
sulfur dioxide, SO_2	generation of electricity from coal, oil or gas that contains sulfur, processing of mineral ores which contain sulfur; fossil fuel combustion	acid deposition
nitrogen oxides, NO_x	transportation, oil and gas industry, generation of electricity	acid deposition formation of smog
particulate matter	transportation, electricity generation, combustion of fossil fuels, industry	affects human health reduces visibility (haze) and contributes to formation of smog

Practice Questions

Use the following information to answer the next question:

Low-grade coal has a high sulfur content. The burning of low-grade coal contributes to harmful emissions that can undergo chemical reactions in the atmosphere.

5) When the sulfur present in low-grade coal is burned, it forms___***i***___, which can react with water in the atmosphere to form___***ii***___.

The statement above is completed by the information in row:

Row	*i*	*ii*
A.	$SO_2(g)$	$H_2SO_4(aq)$
B.	$SO_2(g)$	$S_8(s)$
C.	$H_2S(g)$	$H_2SO_4(aq)$
D.	$H_2S(g)$	$S_8(s)$

6) The pollutants that contribute most to acid deposition are

A. $CO_{(g)}$ and $NO_{x(g)}$

B. $SO_{2(g)}$ and $NO_{x(g)}$

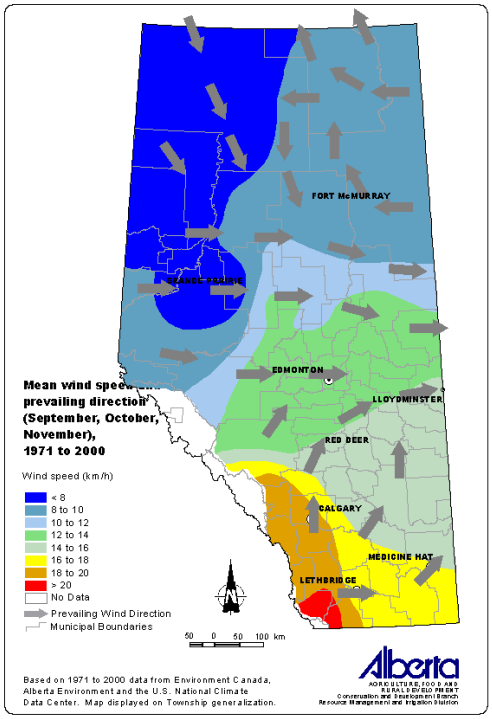
C. $CO_{(g)}$ and $SO_{2(g)}$

D. $NO_{x(g)}$ and $O_{3(g)}$

Prevailing Winds

Patterns of acidic deposition are influenced by prevailing winds.

Wind patterns provide a way to trace the path of acid deposition back to its source.



Measuring the Impact of Acids and Bases on the Environment

- pH of a solution is a measure of the concentration of hydrogen or hydronium ions (H_3O^+)
- $pH = -\log[H_3O^+]$
- Each whole-number division on the pH scale represents a **ten-fold** difference in the concentration of hydronium ions from the value above or below it.
- As pH values increase, hydronium ion concentrations decrease.
- As pH values decrease, hydronium ion concentrations increase.

pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
$[H_3O^+]$	10^{0}	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{-14}

Practice Questions

7) If a sample of hydrochloric acid, HCl(aq), has a hydronium ion concentration, $[H_3O^+(aq)]$, of 5.3×10^{-4} mol/L, then the pH of the sample is:

A. 1.00 **C.** 3.28

B. 2.88 **D.** 4.72

8) If the pH of a solution increases from 5 to 7, the hydronium ion concentration

A. increases by a factor of 10 **C.** increases by a factor of 100

B. decreases by a factor of 10 **D.** decreases by a factor of 100

Indicators

- **Indicators** are weak acids that change colour with a change in pH.
- We can represent an indicator with the formula H*In*.

$$HIn_{(aq)} \rightleftharpoons H^+_{(aq)} + In^-_{(aq)}$$

Acid form (one colour) — Conjugate Base (another colour)

Acid–Base Indicators at 25°C

Indicator	Abbreviation (acid/conjugate base)	pH Range	Colour Change as pH Increases
methyl violet	HMv(aq) / Mv^-(aq)	0.0 – 1.6	yellow to blue
thymol blue	H_2Tb(aq) / HTb^-(aq)	1.2 – 2.8	red to yellow
thymol blue	HTb^-(aq) / Tb^{2-}(aq)	8.0 – 9.6	yellow to blue
orange IV	HOr(aq) / Or^-(aq)	1.4 – 2.8	red to yellow
methyl orange	HMo(aq) / Mo^-(aq)	3.2 – 4.4	red to yellow
bromocresol green	HBg(aq) / Bg^-(aq)	3.8 – 5.4	yellow to blue
litmus	HLt(aq) / Lt^-(aq)	4.5 – 8.3	red to blue
methyl red	HMr(aq) / Mr^-(aq)	4.8 – 6.0	red to yellow
chlorophenol red	HCh(aq) / Ch^-(aq)	5.2 – 6.8	yellow to red
bromothymol blue	HBb(aq) / Bb^-(aq)	6.0 – 7.6	yellow to blue
phenol red	HPr(aq) / Pr^-(aq)	6.6 – 8.0	yellow to red
phenolphthalein	HPh(aq) / Ph^-(aq)	8.2 – 10.0	colourless to pink
thymolphthalein	HTh(aq) / Th^-(aq)	9.4 – 10.6	colourless to blue
alizarin yellow R	HAy(aq) / Ay^-(aq)	10.1 – 12.0	yellow to red
indigo carmine	HIc(aq) / Ic^-(aq)	11.4 – 13.0	blue to yellow
1,3,5–trinitrobenzene	HNb(aq) / Nb^-(aq)	12.0 – 14.0	colourless to orange

- In an acidic solution, when the $[H^+]$ is high, and most of the indicator exists in the "acid form".
- In a basic solution, the $[H^+]$ drops and most of the indicator exists in the "base form".
- Each indicator has a characteristic pH range over which it changes colour from its acid form to its conjugate base form.
- Intermediate colours occur between the acid and base form. For example, bromothymol blue will turn green between pH 6.0 and 7.6.