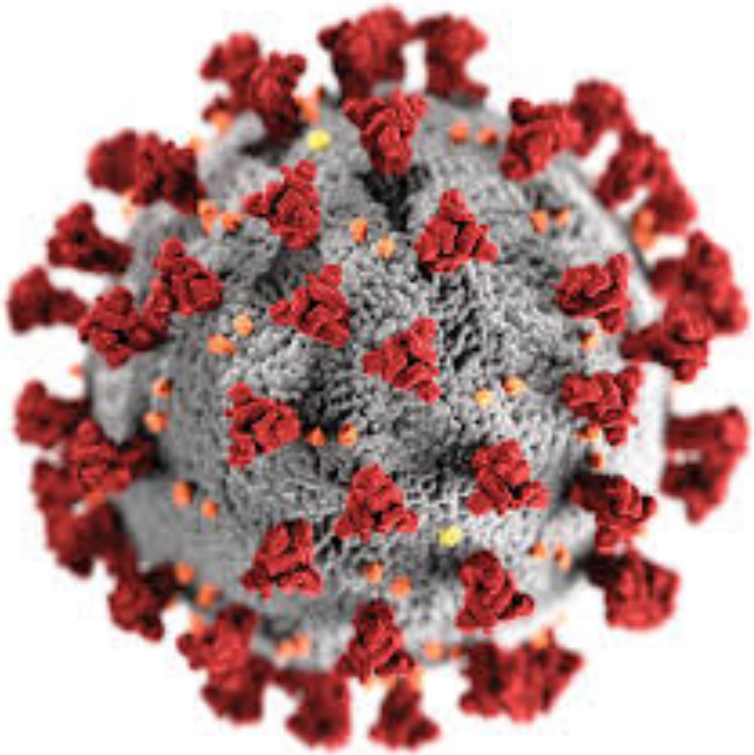
QUIZ SESSION 1

Introductory arguments

Cell division



Quiz #1 – Intermolecular forces

The schematic shows the binding of Penicillin G to a bacterial protein. For simplicity only the side chains of the amino acids involved in drug binding are shown (the structure of Penicillin G alone is also shown on the right)

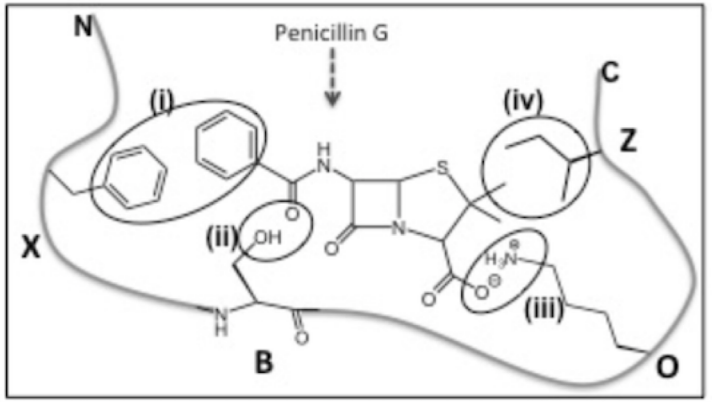
Identify the type of noncovalent interactions of Penicillin G with the protein at:

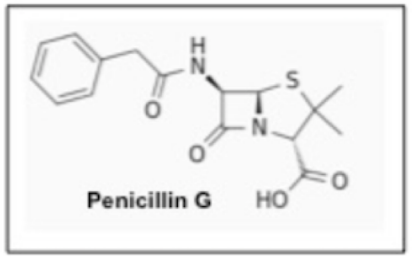
Q1. Region (i)
A1. **Hydrophobic interaction**

Q2. Region (ii)
A2. **Hydrogen bond**

Q3. Region (iii)
A3. **Ionic bond (or salt bridge)**

Q4. Region (iv)
A4. **Hydrophobic interaction**





Drug design
Drug resistance

Quiz #2 – Nucleotides (Lessons 1, 2 and 9)

Q1. Which nucleotide is this?
A1. **Adenine**

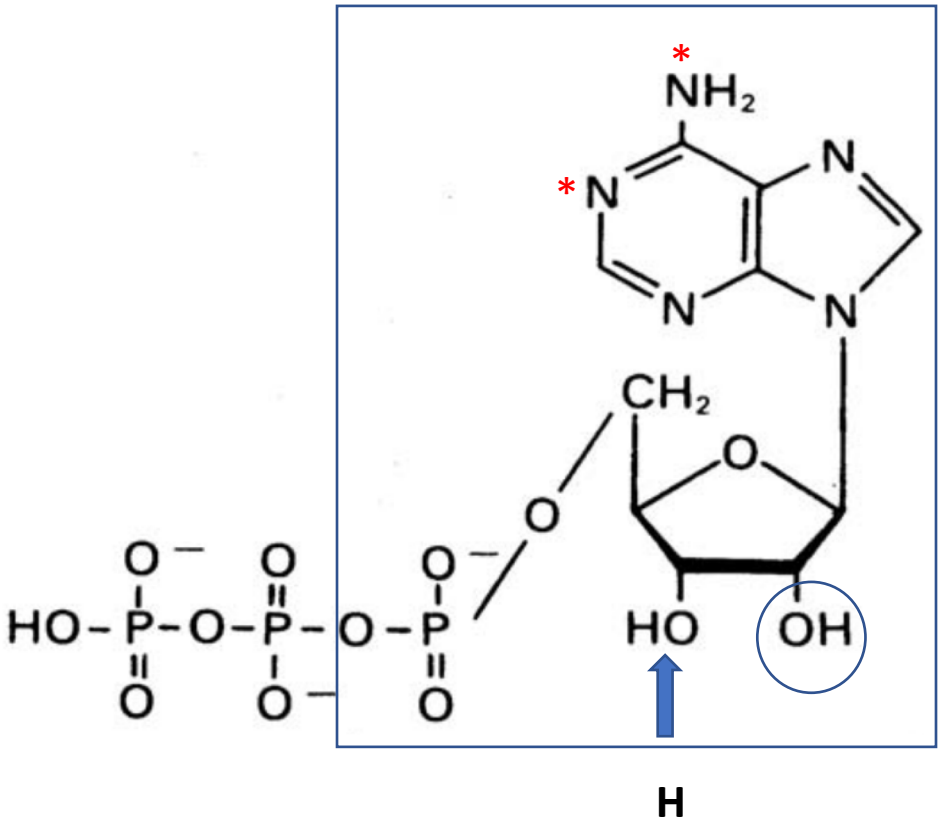
Q2. Box the part that is added to a growing chain of nucleic acid
A2. **The base, the sugar and 1 phosphate group**

Q3. Mark with a star the atom(s) that can form a hydrogen bond with the complementary nitrogenous base
A3. **The primary nitrogen (NH_2) and the adjacent pyrimidine N**

Q4. Which is its complementary base?
A4. **Uracil**

Q5. Circle the part of the molecule that decreases the stability of RNA as compared to DNA
A5. **The OH group in 2'**

Q6. Draw an arrow to the part of this molecule that you would modify to prevent further elongation. Indicate what change you would make next to the arrow drawn
A6. **The 3'OH; substitute with an H**



H

Quiz #3 – Protein structures (Lesson 3)

You have discovered a new enzyme, enzyme E, which breaks down proteins by cleaving peptide bonds after tyrosine or phenylalanine.

Q1. Enzyme E is the product of gene G that encodes a protein with the molecular weight of 50 kilodaltons (50 kD). When you purify enzyme E, you obtain a single type of polypeptide of 50 kD. However, active enzyme E has a molecular weight of 250 kilodaltons (250 kD), not 50 kD. Why might active purified enzyme E be larger than the product encoded by gene G?
A1. **The active enzyme must have multiple subunits. Likely it is a pentamer of the 50 kD polypeptide encoded by gene G.**

Q2. Briefly define the primary, secondary, tertiary, and quaternary structure of proteins
A2. **The primary structure is the linear sequence of amino acids. The secondary structure is localized regions of alpha helix and beta sheet. The tertiary structure is the 3 dimensional shape. The quaternary structure is the association of distinct polypeptide chains with each other**

Q3. Is the primary structure of the 50 kD protein the same or different than the primary structure of the 250 kD protein? Explain briefly
A3. **Because each subunit is encoded by the G gene, the linear sequence of amino acids is the same. Thus the primary structure is the same**

Q4. Is the tertiary structure of the 50 kD protein the same or different than the tertiary structure of the 250 kD protein? Explain briefly
A4. **It is likely that the tertiary structure is the same. Each polypeptide folds to form the same 3 dimensional shape. However, if the association between the subunits influences the shape of each, the tertiary structure could be different**

Q5. Is the quaternary structure of the 50 kD protein the same or different than the quaternary structure of the 250 kD protein? Explain briefly
A5. **The 50 kD protein, as a single polypeptide does not have quaternary structure, the quaternary structure of the 250 kD protein is the five subunit nature of this protein**

Quiz #4 – Free energy and enzymes (Lesson 5)

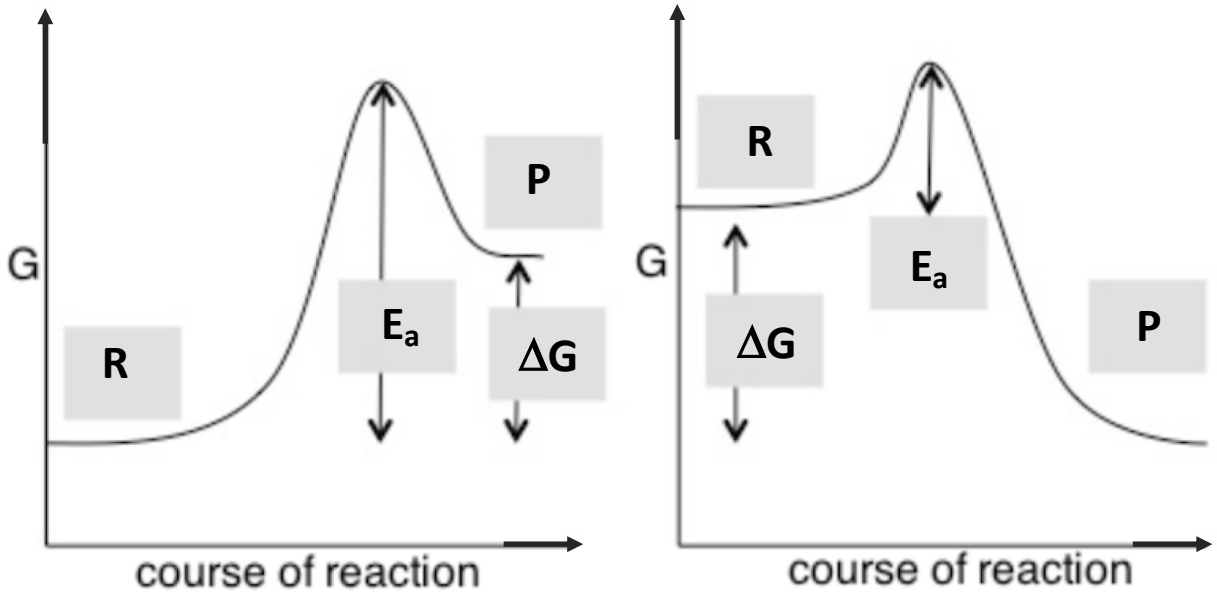
Q1. Reactions which require energy are called?
A1. **Endergonic**

Q2. Endergonic reactions are usually needed by the cell for?
A2. **Products synthesis (anabolic reactions)**

Q3. Reactions which release energy are called?
A3. **Exergonic**

Q4. Exergonic reactions are usually needed by the cell for?
A4. **Products degradation and to obtain "usable" energy (catabolic reactions)**

Q5. Which of the graphs refers to anabolic reactions and which to catabolic reactions? Explain then fill in the boxes with the corresponding thermodynamic terms
A5. **Left, anabolic; right, catabolic**

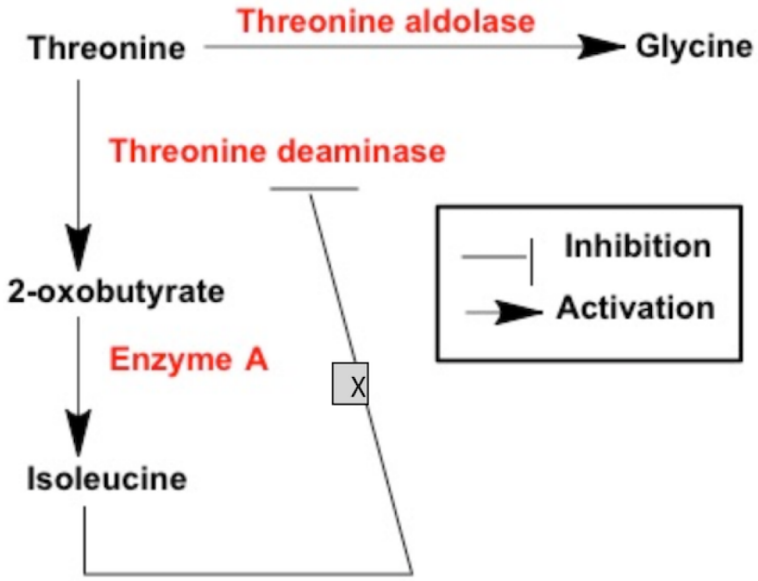


Quiz #5 – Paths and Feedback (Lesson 6)

The following pathway shows the conversion of the amino acid Threonine (T) into Glycine (G) or Isoleucine (I).

The direct conversion of T into G is catalyzed by the enzyme Threonine aldolase.

Threonine is also the starting molecule to obtain another amino acid, Isoleucine (I), via the intermediate product 2-oxobutyrate (2-OB). This pathway is controlled by two enzymes:
Threonine deaminase, which catalyzes the conversion T→2-OB
Enzyme A, which catalyzes the conversion 2-OB→I



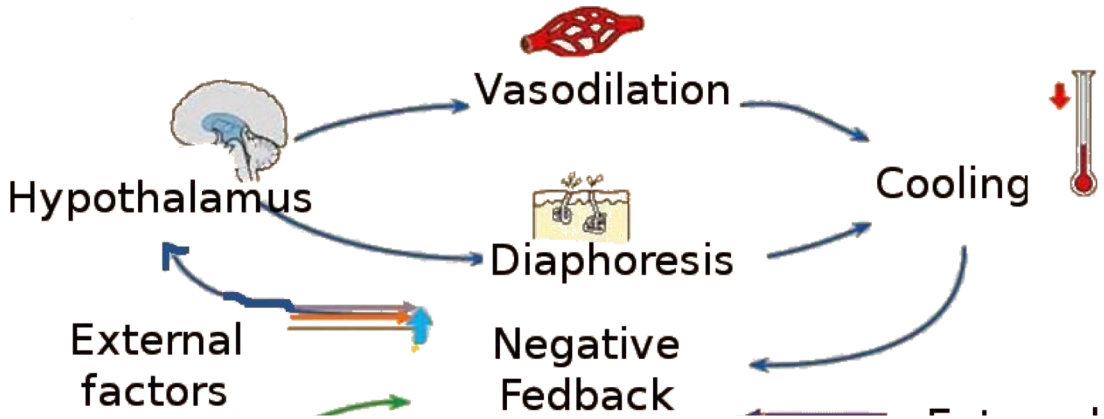
How would an increase in the concentration of Isoleucine affect the amount of Glycine produced?
It would increase the amount of Glycine produced

Body temperature control

Homeostasis is maintained prevalently by negative feedback loops

A prototypical example is **body temperature regulation**

The human body's temperature regulatory center is the **hypothalamus** in the **brain**

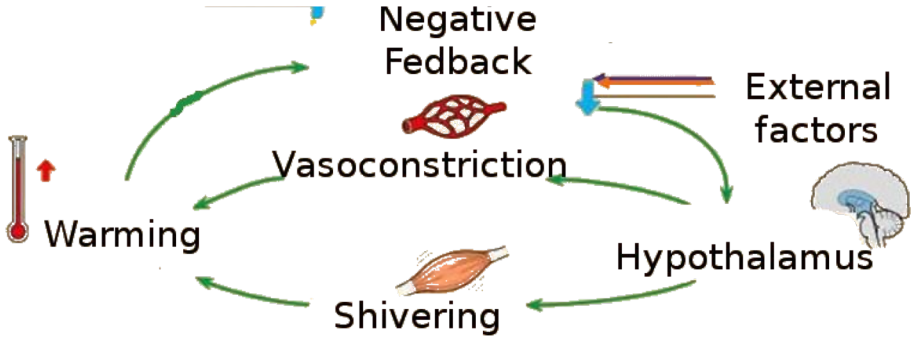


Cooling Down

When the hypothalamus receives data from sensors in the skin and brain that **body temperature is higher than the set point**, it sets into motion the following responses:

- Blood vessels in the skin dilate (vasodilation) to allow more blood from the warm body core to flow close to the surface of the body so heat can be radiated into the environment
- As blood flow to the skin increases, sweat glands in the skin are activated to increase their output of sweat (diaphoresis):
  - When sweat evaporates from the skin surface into the surrounding air, it takes the heat with it
- Breathing becomes deeper, and the person may breathe through the mouth instead of the nasal passages
  - This increases heat loss from the lungs (remember dogs?)

Body temperature control



Heating Up

When hypothalamus get the opposite message
it sets into motion the following responses:

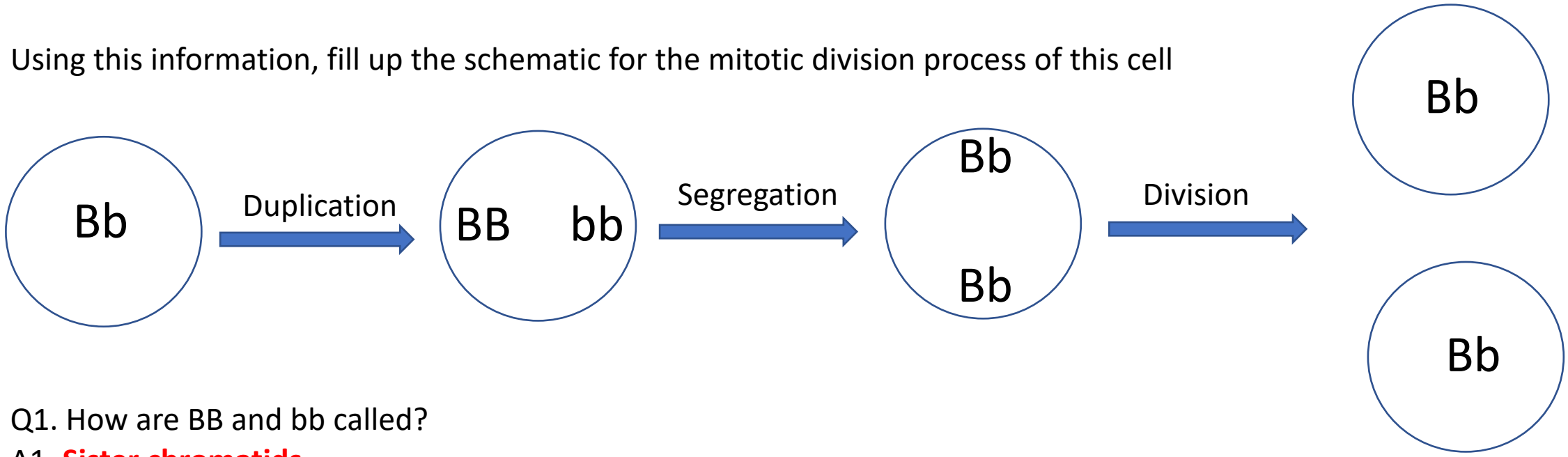
- Blood vessels in the skin contract (vasoconstriction)
  to prevent blood from flowing close to the surface of the body, thereby reducing heat loss from body surface
- Random signals to skeletal muscles are triggered, causing them to contract
  - this causes shivering, which generates a small amount of heat
- The thyroid gland may be stimulated by the brain (via the pituitary gland) to secrete more thyroid hormone
  - this hormone increases metabolic activity and heat production in cells throughout the body
- The adrenal glands may also be stimulated to secrete the hormone adrenaline
  - this hormone causes the hydrolysis of glycogen (the carbohydrate used for energy storage in animals) to glucose, which can be used as an energy source (catabolic process, exergonic or heat producing!)

Q. Can you mention a couple of prototypical macroscopic POSITIVE FEEDBACK LOOPS?
A. **Child birth, blood clotting**

Quiz #6 – Cell division - Mitosis (Lesson 8)

Let us consider a diploid somatic cell with only 1 homolog (1 copy of two homologous chromosomes), and let:
B = the paternal chromosome in the homolog
b = the maternal chromosome in the homolog

Using this information, fill up the schematic for the mitotic division process of this cell



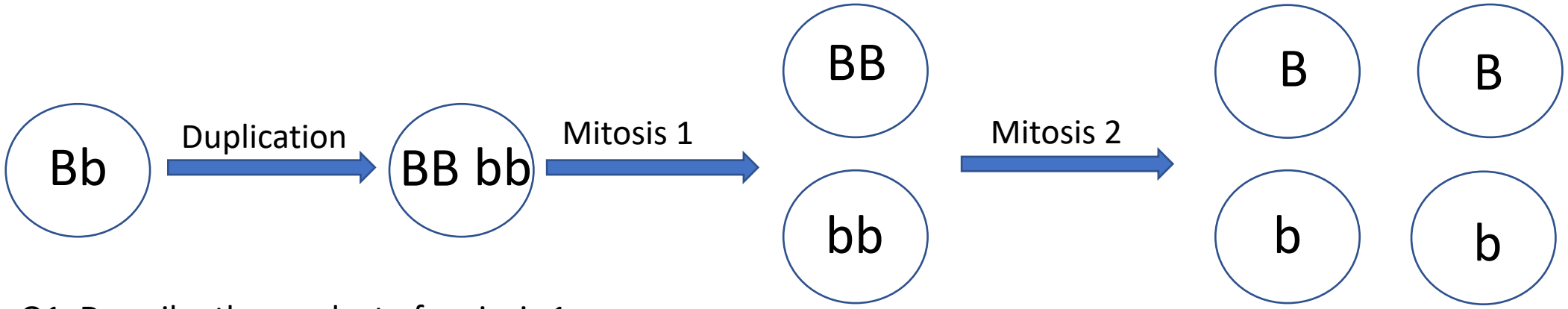
Q1. How are BB and bb called?
A1. **Sister chromatids**

Q2. How are the two daughter cells with respect to the mother cell?
A2. **Identical: diploid somatic with genotype Bb**

Quiz #6 – Cell division - Meiosis (Lesson 8)

Let us consider a diploid somatic cell with only 1 homolog (1 copy of two homologous chromosomes), and let:
B = the paternal chromosome in the homolog
b = the maternal chromosome in the homolog

Using this information, fill up the schematic for the (**simplified**) meiotic division process of this cell



Q1. Describe the product of meiosis 1
A1. **2 diploid daughter cells with genotype different from the mother cell and different from each other (BB and bb)**

Q2. Describe the product of meiosis 2
A2. **4 haploid daughter cells (germ cells), two with haplotype B and two with haplotype b**