

## Experiment



# Q2-1

English (Official)

## P2. Atlas of Enzymes

### Equipment

| Item                         | Quantity | Label |
|------------------------------|----------|-------|
| Eppendorf tubes rack         | 2        |       |
| Micropipette, 10-100 $\mu$ L | 1        |       |
| Micropipette tips            | 40       |       |
| Tips box                     | 1        |       |
| 96-well plate                | 2        |       |

## Experiment



# Q2-2

English (Official)

## Chemicals

| Name                               | State | Concentration | Quantity | Placed in              | Label         |
|------------------------------------|-------|---------------|----------|------------------------|---------------|
| <b>Part A</b>                      |       |               |          |                        |               |
| Mixture <b>E1</b>                  | aq    | -             | 4 mL     | Eppendorf tube, 5 mL   | <b>E1</b>     |
| Mixture <b>E2a</b>                 | aq    | -             | 4 mL     | Eppendorf tube, 5 mL   | <b>E2a</b>    |
| Mixture <b>E2b</b>                 | aq    | -             | 4 mL     | Eppendorf tube, 5 mL   | <b>E2b</b>    |
| Mixture <b>E3</b>                  | aq    | -             | 4 mL     | Eppendorf tube, 5 mL   | <b>E3</b>     |
| Mixture <b>E4</b>                  | aq    | -             | 4 mL     | Eppendorf tube, 5 mL   | <b>E4</b>     |
| Mixture <b>E5</b>                  | aq    | -             | 4 mL     | Eppendorf tube, 5 mL   | <b>E5</b>     |
| Substrates solutions <b>S1–S10</b> | aq    | -             | 0.5 mL   | Eppendorf tube, 0.5 mL | <b>S1–S10</b> |
| <b>Part B</b>                      |       |               |          |                        |               |
| Substrates solutions <b>M1–M3</b>  | aq    | -             | 0.5 mL   | Eppendorf tube, 0.5 mL | <b>M1–M3</b>  |
| <b>Part C</b>                      |       |               |          |                        |               |
| Substrates solutions <b>W1–W7</b>  | aq    | -             | 0.5 mL   | Eppendorf tube, 0.5 mL | <b>W1–W7</b>  |

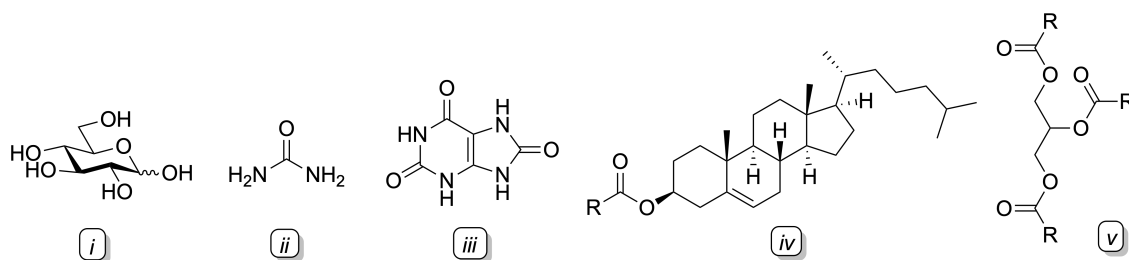
## Experiment

| 11 % of total |     |     |     |     |     |     |     |     |       |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| Question      | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | Total |
| Points        | 50  | 2   | 4   | 1   | 5   | 9   | 35  | 2   | 108   |



*Atlas is a smooth single-faced fabric woven from natural silk. Atlas is not just a simple fabric—it is a woven chronicle of the unique Uzbek culture and identity.*

Enzyme mixtures are used for qualitative and quantitative analysis of organic substances in biological fluids (plasma, urine, etc.). **E1–E5** can contain one or several enzymes. These also contain all the necessary reagents (buffer and other components). **E1–E5** are designed for the selective determination of *i) glucose, ii) urea, iii) uric acid, iv) cholesteryl ester, and v) triglyceride*.



All reaction mixtures in this problem are prepared in a 96-well plate using a micropipette.

The instructions below apply when performing the reaction between any substrate solution with any enzyme mixture **E1–E5**:

- For all reaction tests except those with **E2**, **add** 20  $\mu\text{L}$  of the substrate solution to 100  $\mu\text{L}$  of the enzyme solution and **incubate** for approximately 5 min at room temperature.
- For mixture **E2** (composed of separate solutions **E2a** and **E2b**), **add** 20  $\mu\text{L}$  of substrate solution to 100  $\mu\text{L}$  of **E2a** solution. **Incubate** for approximately 5 min at room temperature. **Add** 100  $\mu\text{L}$  of the **E2b** solution to this mixture and **continue** to incubate for approximately another 5 min at room temperature.
- If the tested solution contains the specific substrate, the mixture shows a colour distinct from the other solutions without the specific substrate.

## Experiment

### Part A

You are given the following substances in the 10 solutions **S1–S10**. Each solution **S1–S10** contains only two substances out of the five substances *i–v*. **S1–S10** contain different combinations of substances *i–v*. The composition of **S1–S5** is:

- **S1:** *i + ii*
- **S2:** *i + iv*
- **S3:** *ii + iii*
- **S4:** *iii + v*
- **S5:** *iv + v*

**Perform** the tests of each solution **S1–S10** with each enzyme mixture **E1–E5**. The tubes in your rack might not necessarily be arranged in numerical order. Some substrates could appear as cloudy solutions or suspensions.

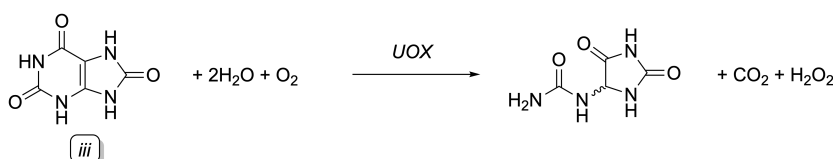
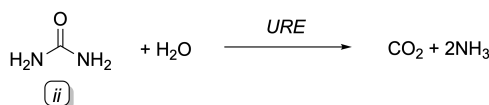
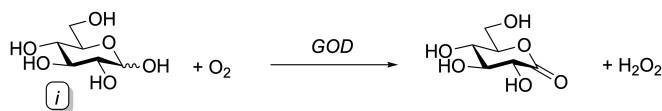
**Q2.1** Tick the box with the corresponding colour change for each of the enzyme mixtures **E1–E5** with substrates **S1–S10**, relative to the initial colour of **E1**, **E2a**, **E3**, **E4**, and **E5**. The colour codes are given below: 50 pt

**N** - no colour change  
**Y** - change to yellow  
**G** - change to green  
**B** - change to black  
**PR** - change to pink/red

**Q2.2** Tick the box for the enzyme–substrate pair(s) that gave a positive result. 2 pt

**Q2.3** Tick the boxes for the correct substrates present in **S6–S10**. 4 pt

The reaction scheme of enzymes, substrates *i–v*, and additional components of mixtures **E1–E5** are given below:



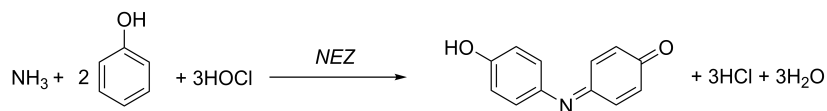
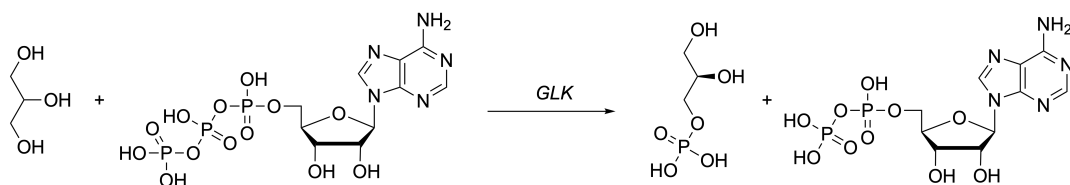
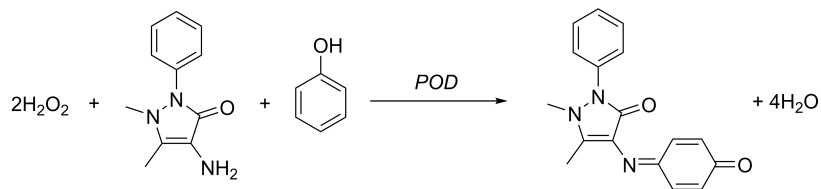
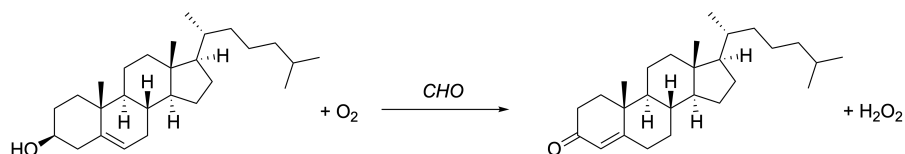
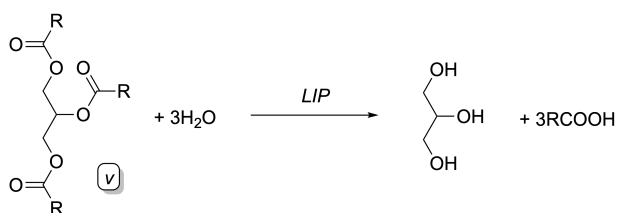
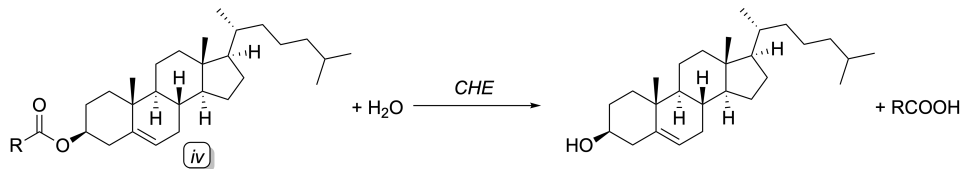
# Experiment



58th International  
Chemistry Olympiad  
Uzbekistan 2026

# Q2-5

English (Official)



## Experiment



# Q2-6

English (Official)

All of the reactions above are balanced. Abbreviations:

- Glucose oxidase – *GOD*
- Urease – *URE*
- Uricase – *UOX*
- Cholesterol esterase – *CHE*
- Lipases – *LIP*
- Cholesterol oxidase – *CHO*
- Peroxidase – *POD*
- Glycerol-3-phosphate oxidase – *GPO*
- Glycerol kinase – *GLK*
- Non-enzymatic reaction – *NEZ*

**Q2.4** Intensely coloured products are formed only in two reactions from the list above. 1 pt  
**Tick** the boxes for the reactions that give coloured products.

**Q2.5** **Tick** the components that are present in reaction mixtures **E1–E5**. 5 pt

### Part B

Enzymes **E2**, **E4**, and **E5** give positive tests with substrates **F**, **G**, and **H**, respectively. Solutions **M1**, **M2**, and **M3** contain all of the substrates **F**, **G**, and **H** in different concentrations. For solutions **M1–M3**, after approximately 5 min of enzymatic reaction, the colour intensity of the reaction mixture is linearly dependent on the initial concentration of the substrate. Assume that approximately 5 min is enough to achieve complete substrate conversion.

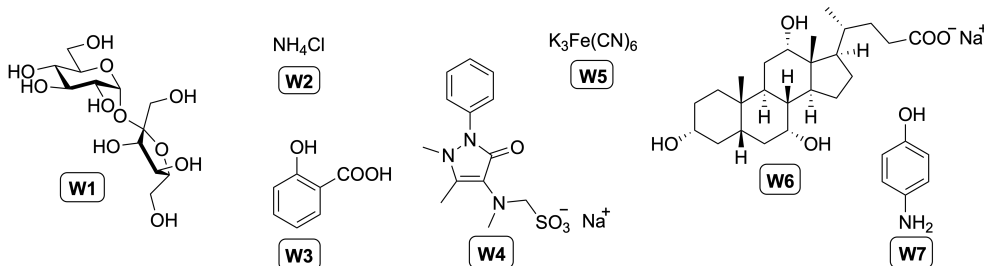
**Perform** the tests of each solution **M1–M3** with each enzyme mixture **E2**, **E4**, and **E5**. Some substrates could appear as cloudy solutions or suspensions.

**Q2.6** **Arrange M1–M3** in increasing order of concentrations for each of **F**, **G**, and **H** substrates based on the performed reactions. 9 pt

## Experiment

### Part C

Some or all of the substances **W1–W7** can react with components of mixtures **E1–E5** and interfere with the accurate determination of their native substrates. Substances **W1–W7** are given below:



**Perform** the tests of each substance **W1–W7** with each enzyme mixture **E1–E5**. Some substrates could appear as cloudy solutions or suspensions.

**Q2.7** **Tick** the box with the corresponding colour change for each of the enzyme mixtures **E1–E5** with substances **W1–W7**. Use the same colour codes as in **Q2.1**. Compare the colour of the reaction mixtures to the initial colour of **E1**, **E2a**, **E3**, **E4**, and **E5**. 35 pt

**Q2.8** **Write down** the balanced reaction equation(s) that describe(s) the positive test(s) in **Q2.7**. 2 pt