2.1 Principles of organisation and digestion

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS enzyme • tissue • organ • organ systems • Bile

Objective

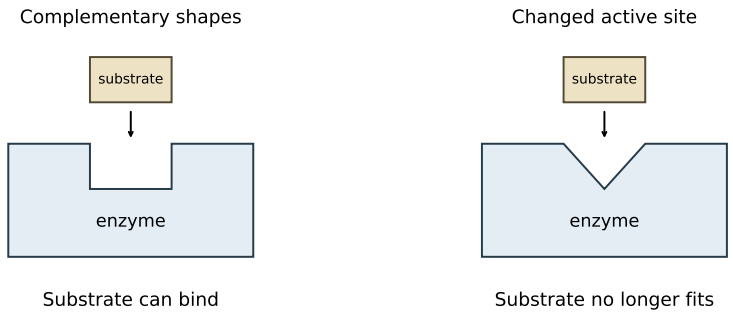
Order cells → tissues → organs → systems; recall the enzymes table with sites and products; explain lock and key, denaturing and bile. Original questions for spec statements 4.2.1–4.2.2.1 and RP4/RP5.

1 Key knowledge and worked examples

Cells → tissues → organs → organ systems → organism. A **tissue** contains cells with similar structure and function. An **organ** contains different tissues working together. **Organ systems** contain organs working together.

Digestive example: a muscle cell belongs to muscular tissue; the stomach also contains glandular tissue (secretes digestive juice) and epithelial tissue (covers surfaces). These tissues together form the stomach. The stomach, intestines and other digestive organs work together in the digestive system. Calling the stomach a tissue misses its several tissue types.

Enzymes are protein biological catalysts: they speed reactions without being used up. In the simplified **lock-and-key model**, a substrate fits a complementary **active site**. Products leave and the enzyme can act again. This is a shape model, not a drawing of real molecules.



Cold versus denatured: at low temperature, particles move more slowly, so there are fewer successful enzyme–substrate collisions; warming can increase the rate again. High temperature can change the enzyme's shape permanently (**denaturation**), so the substrate no longer fits. pH changes can reduce activity by affecting the active site; do not claim every small move away from optimum causes permanent denaturation.

Enzyme	Production sites	Substrate → products
Amylase	Salivary glands; pancreas; small intestine	Starch → simple sugars
Protease	Stomach; pancreas; small intestine	Protein → amino acids
Lipase	Pancreas; small intestine	Lipids → glycerol + fatty acids

Small soluble digestion products are absorbed across the small-intestine wall into blood. Amylase makes simple sugars, not glucose directly.

Bile is made in the **liver** and stored in the **gall bladder**. It is alkaline: neutralising stomach acid provides suitable conditions for lipase in the small intestine. It also **emulsifies** large fat globules into smaller droplets, increasing surface area for lipase. Bile is not an enzyme; emulsification does not itself make glycerol and fatty acids.

RP4: use separate portions of a prepared food sample for each test. Record reagent, treatment and observed colour; use known positive and negative controls to check the procedure.

Substance	Reagent / treatment	Positive result
Reducing sugar	Benedict's; hot water bath	Green/yellow/orange/brick-red
Starch	Iodine solution	Blue-black
Protein	Biuret reagent	Purple/lilac
Lipid	Sudan III; mix, allow to separate	Red-stained oil layer

Benedict's starts blue; iodine starts yellow-brown; Biuret starts blue. A negative result means **not detected by this test**, not proof that none is present. Benedict's does not test for every kind of sugar. Heating supplies energy for the Benedict's reaction; brick-red is not the only positive colour. Wear eye protection; use a water bath, not a flame under the food-test tube. Follow school handling instructions for reagents.

RP5: pH and amylase rate. Change pH with buffers; measure time for the starch endpoint, then compare relative rates. Use a water bath to control temperature and sample onto iodine **every 30 s**, as specified by AQA.

Reproducible sequence: place separate drops of iodine in a spotting tile. Equilibrate measured starch, amylase and buffer in the same water bath. Mix at the chosen

pH and start the timer immediately. Every 30 s, transfer a fresh small sample of reaction mixture to a new iodine drop, using clean equipment so iodine is not carried into the reaction tube. Record the first sample that stays yellow-brown. Repeat the sequence with fresh reactants at each pH.

Keep temperature, enzyme/starch concentrations and volumes, buffer volume, total volume and sampling interval constant. Repeat each pH at least three times and calculate a mean. Choose pH values that span the possible peak; investigate smaller pH steps around the fastest tested condition. Shortest time identifies the fastest **tested** pH, not an exact universal optimum.

Teacher example (invented data, not a past-paper table): mean endpoint times at pH 5, 6, 7 and 8 are 180, 90, 60 and 120 s. The same initial starch quantity and endpoint make reciprocal time a useful relative-rate measure.

$$r = \frac{1}{t}$$

$$r = \frac{1}{60\ \text{s}} = 0.0167\ \text{s}^{-1}$$

At pH 6, r = 1/(90 s) = 0.0111 s^{-1}. The pH 7 reaction is 1.5 times as fast by this measure. Plot pH horizontally and relative rate (s^{-1}) vertically; a time graph instead has its **minimum** at the fastest tested pH. If starch still remains when observation ends, report "endpoint not reached"; do not invent an endpoint or use zero time. The 30 s sampling interval limits time resolution.

2 Practice

2.1 Define a tissue and give one example from the digestive system. [2]

2.2 Name the enzyme that digests starch, its two production sites and its product. [4]

2.3 State the two functions of bile and the reason each works. [4]

3 Exam-style questions

3.1 Explain why amylase stops working at 80 °C but works again if cooled when at 5 °C it is only slow. [4]

3.2 A student tests a mystery food: Benedict's stays blue; iodine goes blue-black; Biuret stays blue.

(a) What does the food contain? [2]

(b) Why must the Benedict's tube be heated? [1]

3.3 Describe a method for investigating the effect of pH on the rate of amylase (RP5). Include how the rate is judged and two control variables. [6]

Solutions

2.1 A group of cells with a similar structure and function; e.g. glandular/muscular/epithelial tissue.

2.2 Amylase; salivary glands and pancreas / small intestine; simple sugars.

2.3 Alkaline – neutralises hydrochloric acid from the stomach so lipase works; emulsifies fat into small droplets – a larger surface area for lipase to work on, so a faster rate.

3.1 At 80 °C the enzyme has denatured – the active site's shape changed permanently, so starch no longer fits; this is irreversible, so it stays inactive on cooling. At 5 °C the enzyme is undamaged, just low kinetic energy – fewer successful collisions, so the reaction is slow but restarts when warmed.

3.2 (a) Starch (iodine blue-black, B1) with reducing sugar and protein not detected. (b) Heating supplies the energy needed for the Benedict's reaction with reducing sugar; a positive result may be green, yellow, orange or brick-red.

3.3 Indicative content: set up water bath at constant temperature; mix amylase, starch and buffer at each pH value; start timing; sample every 30 s onto fresh iodine drops in a spotting tile (continuous sampling); record when iodine stays orange-brown (all starch digested); shortest time = fastest tested rate, or relative rate = 1/time; repeat at each pH and use means; controls – temperature, volumes of enzyme and starch, same concentration. Level 3 (5–6): all key steps, sampling method, controls and repeats. Level 2 (3–4): most steps with a gap. Level 1 (1–2): isolated relevant steps. These are teacher-authored marking bands, not an official AQA scheme.