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Module: Introduction to physiology

Case study 1: Understanding Type 2 Diabetes Mellitus and Its Management.

Type 2 diabetes mellitus (T2DM) is a chronic long-term condition that affects the way the body regulates blood glucose levels. It develops when the body cells become less responsive to insulin or when the pancreas cannot produce enough insulin to maintain normal blood glucose levels. Insulin is a hormone produced by beta cells in the islets of Langerhans within the pancreas. Its main function is to help glucose move from the bloodstream into cells. Where it is used to provide energy. Insulin also helps the liver store glucose and reduce the amount of glucose it releases into the blood. When insulin does not work effectively, glucose build up in the bloodstream, leading to high blood glucose levels (NHS, 2025). Understanding the physiology of T2DM is important for health professional because prolonged high blood glucose levels can affect distinct parts of the body. Over time, the condition may increase the risk of complications such as cardiovascular disease, kidney damage, nerve damage, and problems with vision. This complication can affect a person's health and quality of life if the condition is not managed effectively. This assignment will discuss how the body regulates blood glucose, how T2DM affects cellular metabolism, and the importance of monitoring blood glucose levels. It will also consider how lifestyle changes and appropriate treatment can help manage the condition and reduce the risk of complication.

The physiology of Glucose Regulation is an important source of energy for the body, particularly for the brain and muscles. The body maintains blood glucose levels through the combined action of the pancreas, liver, muscles, and adipose tissue (body fat). Two hormones, insulin and glucagon, play a key role in this process. After eating carbohydrates, the digestive system breaks them down into glucose, which is absorbed through the small intestine into bloodstream. As blood glucose levels rise, beta cells in the pancreas release insulin to help regulate the amount of glucose in the blood. (Diabetes UK, 2023).

Insulin works by binding to receptors on the surface of cells, triggering processes that allow glucose to enter certain tissues. In skeletal muscles and adipose tissue, insulin helps move glucose transporter type 4 (GLUT4) to the cell membrane, allowing glucose to enter the cells. The glucose can then be used to produce energy or stored for future use. Glucagon is another hormone involved in blood glucose regulation. It is produced by alpha cells in the pancreas and works mainly when blood glucose levels fall. Glucagon signals the liver to break down stored glycogen and produce glucose, which is released into the bloodstream. The actions of insulin and glucagon help maintain a stable supply of glucose during periods of eating and fasting.

In people with type 2 diabetes mellitus (T2DM), this process does not work effectively. The body's cells become less responsive to insulin resistance. As a result, muscles accept less glucose levels are already high. Initially, the pancreas may produce additional insulin to

compensate. However, over time, the beta cells may become less effective at producing sufficient insulin, causing blood glucose levels to remain elevated (Waugh and Grant, 2018).

Several factors can contribute to insulin resistance, including genetic factors, excess body fat, physical inactivity, and ageing. Excess fat around the internal organs, known as visceral fat, can affect the release of substances involved in inflammation and insulin sensitivity. These changes can make it more difficult for insulin to regulate blood glucose effectively.

Understanding glucose regulation is important in nursing practice because it explains how T2DM develops and why appropriate management is necessary. Knowledge of these processes helps nurses educate patients about healthy eating, regular physical activity, weight management, and prescribed medication. It also supports individualised care, as each person's risk factors and response to treatment may differ.

Cellular metabolism refers to the chemical processes that occur within cells to provide energy and maintain normal body functions. Glucose is an important energy source and is broken down through cellular respiration. During glycolysis, glucose is converted into pyruvate in the cytoplasm, producing a small amount of adenosine triphosphate (ATP). When oxygen is available, further reactions occur in the mitochondria, including the citric acid cycle and oxidative phosphorylation, which produce most of the ATP required for cellular activities (Scanlon and Sanders, 2019)

In people with type 2 diabetes mellitus (T2DM), insulin resistance affects how the body uses and stores glucose. Muscle cells become less responsive to insulin, reducing glucose uptake, while the liver may continue releasing glucose into the bloodstream. This differs from normal glucose regulation, where insulin help control blood glucose levels after meals. Although the pancreas may initially produce more insulin to compensate, beta-cell function can gradually decline, making it difficult to maintain normal blood glucose levels (Waugh and Grant, 2018; World Health Organization (WHO), 2024).

Persistent hyperglycaemia can contribute to oxidative stress and the formation of advanced glycation and products (AGEs). These substances develop when sugars react with proteins or lipids and may affect the structure and function of tissues. Over time, these processes can contribute to damage to blood vessels, Nerves, kidneys, and eyes. A disadvantage of prolonged hyperglycaemia is that complications may develop gradually and remain unnoticed in the initial stages (Peate and Nair, 2011; WHO, 2024).

The kidneys also play a key role in glucose regulation by filtering glucose from the blood and normally reabsorbing it. When blood glucose levels become sufficiently high, glucose may pass into the urine, drawing water with it. This process, known as osmotic diuresis, can lead to frequent urination, dehydration, and increased thirst. Persistent hyperglycaemia can also

damage peripheral nerves, reducing sensation in the feet and increasing the risk of unnoticed injuries (Tucker and Foulston, 2015).

These effects demonstrate that T2DM affects more than blood glucose levels alone. Understanding cellular metabolism helps nurses explain why glucose monitoring, prescribed treatment and lifestyle changes are important. A comprehensive approach should also consider cardiovascular health, kidney function, eye health, and foot care to reduce the risk of long-term complications (Ody and Dufresne, 2018; NICE, 2026).

Regular monitoring is important in T2DM because it helps healthcare professionals assess glucose control, evaluate treatment effectiveness, and identify complications. One commonly used test is glycated haemoglobin (HbA1c), which measures the proportion of haemoglobin with glucose attached to it. As red blood cells remain in circulation for approximately three months, HbA1c provides an indication of average blood glucose levels over the preceding two to three months. Unlike a single blood glucose reading, HbA1c gives a broader picture of longer-term glucose control (Wagh and Grant, 2018; NICE, 2026).

NICE recommends measuring HbA1c every three to six months until blood glucose levels and treatment are stable, followed by six-monthly monitoring once stable. For many adults, an HbA1c target of forty-eight mmol/mol (6.5%) may be appropriate when managing diabetes through lifestyle changes or medicines that do not usually cause hypoglycaemia. However, targets should be individualised according to the person's treatment, risk of low blood glucose and other health conditions. Although HbA1c is useful for assessing longer-term control, it may be less dependable in certain conditions that affect red blood cells (NICE, 2026).

Capillary blood glucose testing provides immediate information about glucose levels and may help individuals understand how meals, physical activity and medication affect their blood glucose. However, a single reading cannot show the overall pattern across several months. Frequent finger-prick testing is not necessary for everyone with T2DM, so its use should depend on the person's treatment and clinical circumstances. Continuous glucose monitoring may also be suitable for some individuals (NICE, 2026; American Diabetes Association Professional Practice Committee, 2026).

Monitoring should also include blood pressure, cholesterol, kidney function, urinary albumin, retinal screening and foot assessments; these checks are important because diabetes can damage blood vessels, kidneys, eyes, and nerves. For example, estimated glomerular filtration rate (eGFR) and urine albumin-to-creatinine ratio can help identify kidney impairment, while foot assessment can detect reduced sensation and circulation. The benefit of this wider assessment is that complications may be identified earlier, although attending multiple appointments can be difficult for many patients (Peate and Nair, 2011; NHS, 2025).

Nurses support monitoring by explaining results, encouraging attendance at reviews, and helping patients understand when to seek medical advice. No single test provides a complete assessment of diabetes, so combining appropriate investigation with person-centred care support safer treatment decisions and better health outcomes (Tucker and Foulston, 2015; NICE, 2026).

Lifestyle management is an important part of T2DM care because diet, physical activity, weight management and other health behaviours can influence insulin sensitivity and blood glucose regulation. However, lifestyle advice should be individualised according to the person's health, preferences, culture, and circumstances. Nurses should encourage realistic changes that patients can maintain over time (Peate and Nair, 2011; Diabetes UK, 2023).

A balanced diet containing vegetables, fruit, wholegrain foods, pulses, and other fibre-rich foods can support blood glucose management and general health. Fibre may slow carbohydrate absorption and help individuals feel fuller for longer. Reducing sugar drinks and limiting foods high in added sugar can also help manage energy intake. Unsaturated fats, such as those found in nuts, seeds and olive oil, can be chosen instead of foods high in saturated fat where appropriate. The advantage of a balanced dietary approach is that it supports glucose management and cardiovascular health. However, restrictive diets may be difficult to maintain and may not suit everyone's nutritional needs. Nurses should therefore encourage sustainable dietary changes and consider referral to a registered dietitian where appropriate (Tucker and Foulston, 2015; NHS, 2025).

Regular physical activity can improve insulin sensitivity because working muscles accept glucose for energy. Activities such as walking, cycling, and swimming can also support cardiovascular fitness and weight management. Adults should aim for at least 150 minutes of moderate-intensity activity each week, according to their abilities and clinical circumstances. A benefit of exercise is that it can improve metabolic health alongside other treatment. However, mobility difficulties, pain or lack of time may prevent most individuals from exercising regularly. People taking medicines that can cause hypoglycaemia may also need advice about managing glucose levels around exercise. Gradually increasing activity can make exercise more achievable (Scanlon and Sanders, 2019; WHO, 2024).

For people living with overweight or obesity, sustainable weight loss may improve insulin sensitivity and blood glucose control. In individuals, substantial weight loss can contribute to diabetes remission, although remission does not mean that diabetes has been permanently cured, an advantage of weight management is that it may improve aspects of health at the same time. However, losing weight can be challenging, and focusing only on body weight may cause distress or overlook other factors affecting health. Nurses should use respectful, non-judgemental communication and agree on realistic goals with everyone (Vaughan and Grant, 2018; Diabetes UK, 2023).

Lifestyle changes may improve diabetes control, but they do not automatically replace prescribed medication. Treatment should consider the person's glucose levels, cardiovascular and renal health, other considerations and preferences. NICE recommends selecting treatment according to individual clinical needs, including the potential benefits of protecting the heart and kidneys. Nurses can explain the purpose of medicines, discuss possible adverse effects, and encourage patient to seek professional advice before changing their treatment. Structured diabetes education can also improve understanding of glucose monitoring, diet, physical activity, and prevention of complications (NICE, 2026; American Diabetes Association Professional Practice Committee, 2026).

Smoking cessation is important because smoking and diabetes both can increase cardiovascular risk. Alcohol advice should consider its effects on blood glucose, particularly for people taking medicines associated with hypoglycaemia (introduction to Anatomy and Physiology for Healthcare students, 2018). Emotional wellbeing is also relevant because stress, anxiety and low mood can make diabetes self-management more difficult. Nurses should assess individual needs and help patients access suitable support. This demonstrates the importance of addressing physical and psychological wellbeing together when managing a long-term condition (NHS, 2025; WHO, 2024).

Overall, lifestyle management offers important benefits but can also present challenges, including maintaining changes over time and overcoming personal or social barriers. A person-centred nursing approach that combines education, encouragement, appropriate treatment, and regular review can help individual make sustainable changes and improve their quality of life (Ody and Dufresne, 2018; NICE, 2026).

Type 2 diabetes mellitus is a complex metabolic condition involving insulin resistance, progressive pancreatic beta-cell dysfunction, and impaired regulation of blood glucose. These abnormalities affect glucose uptake, hepatic glucose production and cellular metabolism. Persistent hyperglycaemia can contribute to oxidative stress, vascular damage and complications involving the kidneys, eyes, nerves, and cardiovascular system.

An understanding of this physiological mechanism provides a foundation for effective nursing assessment and patient education. HbA1c testing, blood glucose assessment where indicated, renal monitoring, retinal screening and foot assessments support early identification of problem and evaluation of treatment. Lifestyle interventions, including balanced nutrition, physical activity and appropriate weight management, can improve metabolic health, but should be combined with individualised clinical treatment when required.

Good diabetes care requires more than achieving a numerical glucose target. Nurses should collaborate with individuals, supporting informed decision, sustainable self-management, and prevention of complications. Integrating physiological knowledge with evidence-based and person-centred care can help improve health outcome and quality of life for people living with T2DM.

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