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Level 3 Cambridge Technical in Applied Science

05874 Unit 23: Scientific research techniques

Pre-release material

To prepare candidates for the examination taken on Wednesday 19 January 2022 – Afternoon

Please write clearly in black ink.

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

Date of birth | D | D | M | M | Y | Y | Y | Y |

INSTRUCTIONS

- **Seven** days before the exam, hand in this booklet to your teacher. This booklet will be given back to you at the start of the exam.
- Do **not** take any notes into the exam.
- At the end of the exam, hand in this booklet with your exam paper.

INFORMATION

- This document has **8** pages.

Case study: The impact of high-intensity interval training

Source A – extract adapted from www.sciencedaily.com/releases/2017/05/170502142024.htm

'Exercise-in-a-pill' boosts athletic endurance by 70 percent

Researchers at the Salk Institute have discovered that a gene pathway triggered by running may also be fully activated by a chemical compound. The study (see reference 1) offers people with heart conditions, pulmonary disease, type 2 diabetes and other health conditions, the hope of achieving the benefits of exercise pharmacologically.

"It's well known that people can improve their aerobic endurance through training" says senior author Ronald Evans, "the question for us was: how does endurance work? And, if we really understand the science, can we replace training with a drug?"

Endurance is the ability to sustain aerobic activity for long periods of time. As endurance improves, muscles exhibit physiological changes that increase the body's ability to burn fat rather than glucose. Researchers therefore assumed that endurance was a consequence of the body's ability to burn fat.

In previous research into a gene called PPAR delta (PPARD), mice genetically engineered to have permanently activated PPARD showed high levels of endurance, were highly responsive to insulin and resisted weight gain. The research team found that a chemical compound called GW1516 also activates PPARD.

Mice given GW1516 typically ran for 270 minutes on a treadmill before exhaustion. Mice in the control group ran for 160 minutes before exhaustion. For both groups, exhaustion occurred when blood glucose decreased to around 70 mg/dL. This indicates that low glucose levels are the cause of fatigue.

The researchers found that GW1516 changes the expression of 975 genes in a major muscle of mice. Genes with increased expression regulate the breakdown of fat. Genes with decreased expression regulate the breakdown of glucose. This means that the PPARD gene pathway prevents glucose being an energy source in muscle during exercise.

"PPARD is suppressing all the points that are involved in sugar metabolism in the muscle" says Michael Downes, co-senior author of the paper. "This suggests that burning fat is less a driver of endurance than a compensatory mechanism to conserve glucose."

Muscles can burn either glucose or fat, but the brain prefers glucose. During periods of high energy expenditure it is important to maintain brain function. According to the researchers, this explains why runners who "hit the wall" during intense exercise experience both physical and mental fatigue when they use up their supply of glucose.

(1) Cell Metabolism https://www.cell.com/cell-metabolism/pdfExtended/S1550-4131(17)30211-5

Further Information

PPARD - https://en.wikipedia.org/wiki/Peroxisome_proliferator-activated_receptor_delta

GW1516 - https://en.wikipedia.org/wiki/GW501516

Source B – extract adapted from www.theguardian.com/science/2017/may/02/exercise-pill-could-deliver-benefits-of-fitness-in-tablet-form

'Exercise pill' could deliver benefits of fitness in tablet form

According to researchers at the Salk Institute, the benefits of fitness training could be delivered in a tablet transforming the lives of people who are unable to exercise because of obesity or serious physical disabilities.

The researchers found that an experimental drug allowed mice to run for 270 minutes on a treadmill before exhaustion compared with 160 minutes for mice who ran without the drug. Mice which had been given the drug also showed improved control of blood sugar levels and lower weight gain.

In previous studies the drug known as GW1516 led to improved endurance and increased fat burning. In the current study the researchers set out to discover what endurance means at a molecular level. They found that GW1516 changes the activity of nearly 1000 genes. Many that become more active are involved in fat burning while many genes that are suppressed by the drug are involved in the conversion of glucose into energy.

Writing in the journal Cell Metabolism (see reference 1) the researchers explain that the drug makes the body burn fat faster, but also burn glucose more slowly. Endurance athletes such as runners and cyclists "hit the wall" when they push themselves too hard due to the drop in glucose. When using the drug, the feeling of hitting the wall happens much later than normal.

Exercise activates a group of muscle proteins called PPARD. The drug, which also activates PPARD is "sufficient to dramatically improve endurance capacity," says Weiwei Fan, the paper's first author. "We're showing that you can improve endurance to the equivalent level as someone in training, without all the physical effort."

The drug was originally developed in the 1990s as a potential treatment for metabolic and cardiovascular disease. It was abandoned after a number of studies found that high doses might cause cancer. In 2009 it was banned by the World Anti-Doping Agency (WADA) following abuse by some athletes in the 2008 Beijing Olympics. WADA has issued additional warnings to athletes that GW1516 is not safe. Louise MacKenzie, a pharmacologist at the University of Hertfordshire who has studied GW1516, says that while the drug appears to have benefits at low doses, it can have bad side effects at high doses. "It goes from being remarkably healthy to being the complete opposite, there's no in-between."

Ali Tavassoli, professor of chemical biology at Southampton University, who was not involved in the study, says "there are groups of people who, for one reason or other, cannot exercise and you could potentially have a pill that gives them some of the benefits of exercise." However he is not convinced that such a pill would get regulatory approval: "Someone with obesity or diabetes might be taking a pill for 40 or 50 years. What happens when you take a drug like this for that long? What happens to you? These are big unanswered questions." Nor is he convinced that such a pill would even be possible: "There's a big difference between showing in an organism that you can mimic exercise over the short term, and demonstrating the long term effects of doing this."

(1) Cell Metabolism https://www.cell.com/cell-metabolism/pdfExtended/S1550-4131(17)30211-5

Further Information

WADA - https://en.wikipedia.org/wiki/World_Anti-Doping_Agency

Research notes: