Themes in Biology

Directions: Read the real-life scenarios in our world. For each of the following, briefly describe how at least THREE of the Themes of Biology relate to the statements above.

1. XDR-TB is the abbreviation for extensively drug-resistant tuberculosis (TB). One in three people in the world is infected with dormant TB germs (i.e. TB bacteria). Only when the bacteria become active do people become ill with TB. Bacteria become active as a result of anything that can reduce the person’s immunity, such as HIV, advancing age, or some medical conditions. TB can usually be treated with a course of four standard, or first-line, anti-TB drugs. If these drugs are misused or mismanaged, multidrug-resistant TB (MDR-TB) can develop. MDR-TB takes longer to treat with second-line drugs, which are more expensive and have more side-effects. XDR-TB can develop when these second-line drugs are also misused or mismanaged and therefore also become ineffective. (World Health Organization)

2. A molecule called telomerase, best known for enabling unlimited cell division of stem cells and cancer cells, has a surprising additional role in the expression of genes in an important stem cell regulatory pathway, say researchers at the Stanford University School of Medicine. The unexpected finding may lead to new anticancer therapies and a greater understanding of how adult and embryonic stem cells divide and specialize.

In many ways, telomerase is the quintessential molecule of mystery — hugely important and yet difficult to pin down. Telomerase was known to stabilize telomeres, special caps that protect the ends of chromosomes. It stitches short pieces of DNA on these chromosome ends in stem cells and some immune cells, conferring a capacity for unlimited cell division denied to most of the body’s other cells. Its importance is highlighted by the fact that it is inappropriately activated in more than 90 percent of cancer cells, suggesting that drugs or treatments that block telomerase activity may be effective anticancer therapies. However, its vast size, many components and relative rarity — it is not expressed in most of the body's cells — hinder attempts to learn more about it.

3. You may recall the cartoon character the Tasmanian Devil of Looney Tunes fame from your childhood memories. It may surprise you to learn that this character is based on a real animal that lives in Tasmania, a large island-state off the southeast coast of Australia. The devils used to be found in Australia, but they were extirpated some 3,000 years ago (Brown, 2006). They now only exist in Tasmania. The Tasmanian devil (Sarcophilus harrisii) is the world’s largest carnivorous marsupial. It feeds on small prey, such as birds, snakes, and even insects. They are also scavengers, feasting on carrion. As marsupials, the young develop in a protective pouch like the kangaroo (Guiler, 1970). The devil looks like a cross between a rat and a dog, and it weighs between 10–20 pounds. The animal gets its name for the ferocious cries and growls it emits and the threat displays it produces when faced with a predator, fighting for mate, or defending a meal (Pemberton & Renouf, 1993). Tasmanian devils often bite one another while fighting, particularly on the face and neck.
In 1996, conservation authorities in Tasmania noticed that some animals had peculiar ulcers on the face. Further investigation determined that the ulcers were cancerous in nature. The tumors grew relatively rapidly, became friable, and eventually prevented the animal from eating, causing death. This disease was called Tasmanian Devil Facial Tumor Disease (DFTD). Alarmingly, many animals were affected; it is estimated that the population has been halved as animals die from this disease and that the species could go extinct within the next 25–30 years (Quammen, 2008).

4. The GloFish is a patented brand of genetically modified (GM) fluorescent zebrafish with bright red, green, and orange fluorescent color. The original zebrafish from which the GloFish was developed measures three centimeters long and has gold and dark blue stripes. In 1999, Dr. Zhiyuan Gong and his colleagues at the National University of Singapore were working with a gene called green fluorescent protein (GFP), originally extracted from a jellyfish, that naturally produced bright green bioluminescence. They inserted the gene into a zebrafish embryo, allowing it to integrate into the zebrafish’s genome, which caused the fish to be brightly fluorescent under both natural white light and ultraviolet light. Their goal was to develop a fish that could detect pollution by selectively fluorescing in the presence of environmental toxins. It is the first genetically modified animal to become publicly available as a pet.

5. Dissecting animals for science has sparked controversies worldwide, even prompting some companies to create computer simulations as cruelty-free alternatives. For high school students everywhere, this revealing amphibian may be a cut above regular frogs. That’s because the see-through frog does not require dissection to see its organs, blood vessels, and eggs. You can see through the skin how organs grow, how cancer starts and develops. It’s a miracle of genetic engineering and surely a cool mutant gift to students.