BIOMEDICAL SCIENCE JOURNAL FOR TEENS

Can we write biological "software updates" to cure disease?

TEACHER'S KEY

Check your understanding

1 Why does cancer make people sick?

Answer

Normal cells are carefully regulated and all work together. When old cells get damaged they die and a new cell takes its place. This allows all cells in the body to get the nutrients and oxygen they need to perform their specialized functions. Cancer cells grow unchecked regardless of if their genes are mutated, and continue to grow whether or not the tissue can support its growth. They can change the circulation through the tissue to take more nutrients than the surrounding cells can afford to give away. The larger the cancer gets, the more it interferes with the tissue's ability to function, and once it metastasizes it can grow and interfere interfere with other key tissues and organs.

2 Why did we used plasmids instead of adding our proteins directly?

Answer

- Because the cells do the work of making the proteins, so it's a lot less work for us! The cells will then continue to make the protein long after we transfect them. Plus, we have an easier time getting plasmids into cells than we do proteins.
- More detailed explanation: proteins get degraded over time (especially in our case - they're self-regulated proteases that permanently shut each other off). By giving cells the information to continue making new proteins it replaces the ones that get broken down.

3 Why was the threshold filter so important?

Answer

Cancer cells overuse normal cellular programs. This filter allows us to kill cells that overuse the signaling pathway (cancer) but leave the cells that use the pathway at a normal level to stay alive.

4 Can you think of any other diseases where an engineered protein circuit could provide a cure?

Answer

- Any genetic disease where the cells still exist: diabetes (add proteins that make insulin when it senses glucose), HIV (add a "detect-and-kill" circuit to selectively kill infected cells only).
- Other diseases where gene therapies could provide a cure through replacing a bad gene: cystic fibrosis, sickle cell disease, hemophilia.
- Once the cells are dead or too damaged to be saved, gene therapy is not likely to help. Advanced Alzheimer's, advanced kidney/liver/heart failure. (In the far future, gene therapy may be able to save organs that still have some healthy tissue left. Early stage studies are already happening.)