

## Pharmaceutical Research Worksheet **Answer Key**

### ~ Research new drug delivery methods ~

### **Example answers**

What are they?

Some biologic drugs, like insulin, antibodies and vaccines, are not effective when taken orally and must be delivered via injection. However, this is about to change. A new drug delivery system has been tested in pigs that delivers medication directly to gastrointestinal tissues via an oral capsule using microneedles. Nanosponges are comprised of a scaffold of tiny, specialized polyester particles coated with disease-targeting compounds and filled with an anticancer drug.

How do they work?

The capsule is designed to protect the medication inside until it reaches the gastrointestinal (GI) tract. Once the capsule reaches its target destination, it dissolves and exposes the drug reservoir that is covered with five-millimeter-long needles. The needles pierce the intestines when the tissue contracts, delivering the drug directly.

The nanosponges hone in on tumors after being injected into the body. Once at their intended sites, they safely and slowly degrade, releasing medication at the tumor site at a steady, controlled rate. Early studies have also shown that the nanosponges can be used to treat glaucoma, the fourth leading cause of blindness.

How will considerations differ if a drug is taken orally vs. delivered another way?

If a drug is taken orally, it must be designed to survive the gastrointestinal juices, have a high enough adsorption through the lining of the digestive tract, and the solubility of the drug must be sufficient in multiple environments. The length of time before the drug takes effect must also be accounted for.

What issues are specific to different delivery methods?

*Intravenous:* Toxic concentrations could be close to effective ones and more labor intensive.

*Intramuscular and subcutaneous:* Absorption unpredictable and difficult for needle-phobics.

*Topical:* High molecular weight molecules have difficulty passing through membranes and unpredictable adsorption.

*Inhalation:* Bioavailability depends on size of drug; proper technique is required for correct dosage.

*Suppository:* Cannot be used after certain surgeries.

Pick a target organ and identify two possible drug delivery method(s) to it.

To the kidney:

*Orally* goes to the bloodstream via the digestive tract and is removed from the body through the kidneys

*Injection* gets into the bloodstream and then to the kidneys

### ~ Future drug delivery methods ~

Can you think of a novel approach? Describe it.

I think diabetes is manageable, but it requires the afflicted to check and monitor their blood sugar levels constantly depending on the food ingested. If I were designing a drug delivery method, I would create a device to be implanted that would last at least a year, continuously monitoring blood sugar levels and adjusting the insulin on its own. Then the diabetic would not have to worry except once a year when the device is replaced.

How might nanotechnology improve the drug delivery process?

Nanotechnology is important because our membranes are small, which requires the drugs to be small as well. Improvements in nanotechnology result in strides in how drugs are delivered. Nanorobots could be used to deliver cancer treatments to tumors in the body.

*Helpful hint when searching:* A professor at MIT is one of the greatest innovators in drug delivery and tissue engineering. He was the second person to win the *Queen Elizabeth Prize for Engineering*.