Dual Passage Drill

Answers can be found in Part IV.

Questions 38–47 are based on the following passages.

The following are modified passages that explore the design and construction of drug delivery vehicles for biomedical applications.

Passage 1

The technology of drug delivery is one of the most important in the field of medicine and biomedical engineering. The more site-specific a delivery system is, the more effective the drug it is delivering will be; the more conservative a delivered drug dosage is, the less severe the side effects will be. This is especially true of different drugs used to predominantly treat infections and cancers. A new technology called electrostatic processing, or electrospinning, accomplishes both of these goals.

Electrospinning creates biodegradable scaffolds composed of fibers ranging from nanometers to micrometers in diameter, an attribute that is intrinsically difficult to obtain from other fiber-fabrication processes. The electrospinning process begins with a polymer solution at a prescribed charge and viscosity that is pumped through a spinneret. An electric field, powered by a high voltage power supply, is applied to this spinneret so that a droplet is formed at the tip of the spinneret. This droplet morphs into the shape of a cone, in which the surface tension of the droplet is counterbalanced by the applied external electrostatic forces. Once the applied voltage is strong enough to overcome the droplet's surface tension, a fibrous jet is emitted from the cone and captured on a grounded collecting plate. The distance between the spinneret and the collecting plate is where any residual solvent in the ejected jet stream evaporates, resulting in a collection of non-woven submicron-sized fibers that, ultimately, form a highly porous scaffold. Drug delivery via these electrospun scaffolds affords ample flexibility in creating an optimal delivery vehicle for therapeutic treatment.

The chemical properties of the materials utilized as base polymers determine how stable the electrospun scaffolds are and how well they function. Both synthetic and natural materials can be used as base polymers. Between the two, natural polymers typically possess lower levels of toxicity, immunogenicity, and improved biocompatibility. In other words, natural polymers have a greater ability to perform more effectively than synthetic polymers do in the treatment of human disease. Examples of a natural base commonly used as a base for electrospun fibers include collagen and elastin. Collagen is the most prevalent protein in the extracellular matrix (ECM) of soft and hard tissues, and collagen types I, II, and III have all been utilized as the main component of electrospun scaffolds. Elastin has also been substantially utilized as a polymer in electrospinning, especially for vascular tissue engineering. Beyond the inherent advantages that natural polymers possess, the combination of natural polymers can sometimes provide a greater benefit toward constructing an ideal electrospun scaffold. For example, the combination of collagen and elastin in certain ratios has been demonstrated to produce ideally-sized fiber diameters. Thus, the potential to combine—or include—other natural polymers is tremendous in attempting to engineer a drug delivery vehicle with optimal biodegradable properties.

Passage 2

Although it has historically been the case that natural polymers were favored in the construction of electrospun fibers for drug delivery systems, there is a growing trend towards employing synthetic polymers. Synthetic polymers are used to enhance various characteristics of the drug delivery system goals. These characteristics include degradation time, mechanical properties, and cell attachment affinities. Synthetic polymers are able to improve these characteristics as they are more easily tailored to a wider range of properties such as hydrophilicity and hydrophobicity—in other words, the desired solubility of an electrospun scaffold. Because synthetic polymers can be created in laboratories, a nearly innumerable number of possible products that are made from synthetic polymers can be engineered to address any particular clinical need. The most popular of these are the most hydrophobic and biodegradable polymers such as poly(glycolide) (PGA) and poly(lactide).

Despite the clear benefits of synthetic polymers when compared with natural polymers, it is of the utmost importance to not limit scientific or medical pursuit by a purist approach. The ability to blend the variety of synthetic polymers with the strong biocompatible properties of natural polymers may allow biomedical engineers to more precisely fine-tune the properties of electrospun scaffolds. It is this wide-ranging flexibility of polymer compositions that gives electrospun scaffolds such huge promise in medical applications, causing the huge spike of research done in this space in the last several decades. With even more to discover, it is both likely and lucky that this interest will continue for some time.

38

The author mentions infections and cancers (lines 8–9) in order to

A) provide an example of the types of diseases that electrospun scaffolds have cured.

B) point out illnesses that still do not have effective treatments.

C) illustrate types of medical conditions that are more effectively treated by precisely controlled internal drug delivery.

D) demonstrate the kind of vaccines electrospinning technology will help to develop.

39

In Passage 1, the reference to "nanometers to micrometers" (lines 13–14) serves to

A) give a precise measurement of fibers used in electrospinning.

B) further elaborate on the minuteness of electrospun fibers.

C) relate the size of the fibers in electrospun scaffolds to that of the cells of the human body.

D) inform the reader of one of the qualities of electrospun fibers absent in other similar technological approaches.

40

As used in line 30, "residual" most nearly means

A) durable.

B) remaining.

C) steadfast.

D) inhabiting.

41

In discussing the nature of natural polymers, the author of Passage 1 suggests that

A) they are more effective as an electrospun scaffold base as they may be less harmful to people than synthetic polymers.

B) they are not as effective as when blended with synthetic polymers such as poly(glycolide) and poly(lactide).

C) because they are natural materials that exist in the human body, the body is unable to reject them.

D) collagen and elastin are effective polymer bases only when blended together.