Solution manual

Chapter 2

1. The use of glass in micro total- analysis-systems (μTAS) applications is advantageous because of its optical transparency, good fluorescence properties and dielectric properties. In addition, glass has high thermal stability, chemical inertness and established protocols for surface modification and functionalization. The use of glass substrates may also improve the long-term chemical stability of the devices in comparison with silicon-based systems, because of mechanical strength and good mechanical stability of glass.
2. Glass materials based on silica-activated oxide are soda-lime glass, borosilicate glass and pure silica glass (quartz glass).
3. Most of the bioactive glasses are based on the SiO_2-P_2O_5–CaO-Na_2O system. Other glass and glass ceramics include ZnO, Ag_2O and Al_2O_3 as well.
4. Silicon has a good mechanical, electrical, optical and biocompatibility properties and a variety microfabrication and micromachining methods are dedicated for silicon. Silicon is transparent in the near infrared wavelength range, that is, chips can be integrated with silicon photonics elements such as waveguides, couplers, gratings, interferometers, etc. The well established silicon based micro electronics also makes silicon an excellent material for bio chips with electrical controls for electro-osmosis, electro wetting, etc. Silicon has high Young's modulus and thermal conductivity, suitable for applications involving deflection and heat transfer. The disadvantages of using silicon are its high cost, elaborate steps of fabrication (cleaning, resist coating, photolithography etc.), a long fabrication time and the requirement of high-quality clean room facility.
5. Glass transition temperature is the temperature range at which the polymer changes from a rigid glassy material to a soft material and it is dependent on the crystallinity of the polymer.
6. PDMS is easy to prepare, has a good transparency and its Young's modulus can be tuned over two orders of magnitude by controlling the amount of cross linking between polymer chains. Due to its mechanical properties and good gas permeability it is highly suitable for manufacturing devices supporting living cells. The fabrication of PDMS can be achieved in any laboratory by soft lithography, hot embossing, casting, etc. PDMS is easily cast against the master to yield a polymeric replica containing the network of microchannels.
7. Ormocomp is a new, commercial hybrid material, suitable for microfluidic bioanalytical applications. Ormocomp belongs to the family of organically modified ceramics (ORMOCERs), the properties of which can be tailored to different applications, such as

optical devices or antistatic and anti adhesive coatings. These organic-inorganic polymer structures natively resist bio-fouling on microchannel walls so that the Ormocomp microchips can be used in protein analysis without prior surface modification. Ormocomp was shown to be suitable for optical fluorescence detection as well.

8. A biopolymer should have the following material properties: 1) they can be processed using mild conditions to facilitate protein or growth factor incorporation; 2) they naturally promote adhesion and normal function of seeded cells; 3) they contain moieties for potential chemical modification of the surface; 4) they exhibit slow and predictable degradation rates to maximize the duration of functional implanted devices; 5) they have robust, yet flexible mechanical properties; 6) they are relatively inexpensive.
9. Collagen, chitosan, and gelatin are biopolymers.

Chapter 3

1. Amino acids have two characteristic functional groups: the amino (NH_2) and carboxyl (COOH) groups.
2. Venn diagram groups the 20 naturally occurring amino acids according to their physic-chemical properties (size, polarity, hydrophilic/hydrophobic properties).
3. The **primary structure** of peptides and proteins is defined by the amino acid sequence, independent of their spatial arrangement in the polypeptide chain while the **secondary structure** is the local spatial arrangement of the main chain atoms.
4. Lauric acid, phospholipid, lipoprotein.
5. Natural bilayers are usually made mostly of phospholipids, which have a hydrophilic head and two hydrophobic tails. When phospholipids are exposed to water, they arrange themselves into a two-layered sheet (a bilayer) with all of their tails pointing toward the center of the sheet. The center of this bilayer contains almost no water and also excludes molecules like sugars or salts that dissolve in water but not in oil. The phospholipid bilayer of the cell membrane protects the cell, provides structural support and controls the flow of molecules into and out of the cell. When phospholipids are suspended in water they can form a variety of structures. In all cases the hydrophilic phosphate region interacts with water and the hydrophobic fatty acid regions are excluded from water and form hydrophobic interactions.