MicroNanoBio, Spring 2014

MidTerm Exam on Micro/Nano-Scale Engineering

Name: Answers

ID:_____

All questions (2.5 pts each)

Total (100): _____

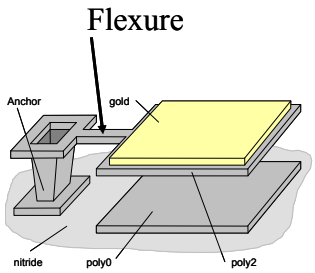
The EXAM is DOUBLE SIDED

Circle the best answer (selecting one answer from the multiple choices).

1. Intel Edison was announced on January 8, 2014. Edison is essentially a miniature smartphone crammed into an (credit card, SD card, business card).

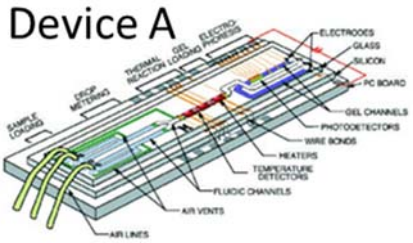
2. Atomic layer deposition (ALD) technology is an enabling technology for FinFETs because of its (nano-scaled coating that could replace a planar silicon oxide layer, nano-scale organic coating over a nano-scaled inorganic layer, conformal dielectric coating over a 3-D structure).

3. For an electrostatic-driven micro-mirror as shown, we would like to change its pull down voltage. A good design approach is to change (the length of the flexure, the thickness of the flexure, the thickness of the mirror, the length of the anchor).



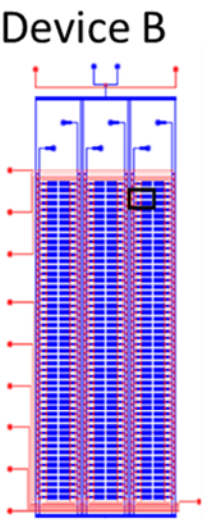
4. For the above-mentioned micro-mirror, its pull down voltage is usually (higher than, lower than, the same as) the release voltage.

5. Three devices are shown. Device (A, B, C) did not apply inertial effect for sorting or capturing cells.



6. Cell lysis was conducted in Device (A, B, C).

7. For RT-qPCR, the number of the target transcripts is related to C_t. The C_t of Chamber-A is 20 and the C_t of Chamber-B is 26. We know the number of copies (in Chamber-A is higher than that in Chamber-B; in Chamber-B is higher than that in Chamber-A; in Chamber-A is the same as that in Chamber-B).

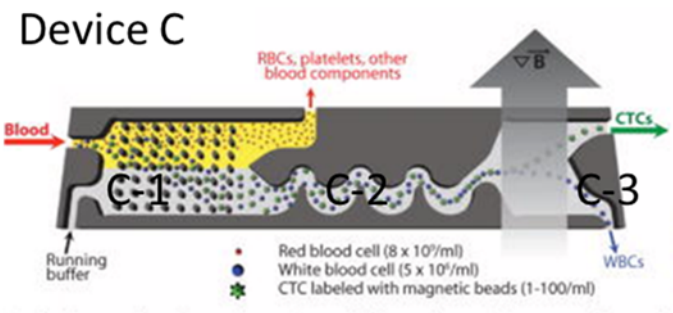


8. "RT" in RT-qPCR is for (Real Time, Right Time, Quick Process, Reverse Transcription).

9. The number of parallel cell processing units in Device B was (150, 300, 1000).

10. Magnetic beads were used in Device C. Such beads are commonly used in commercial products. This Device applied inertial focusing in region (C-1, C-2, C-3) to enhance the efficiency of the cell sorting.

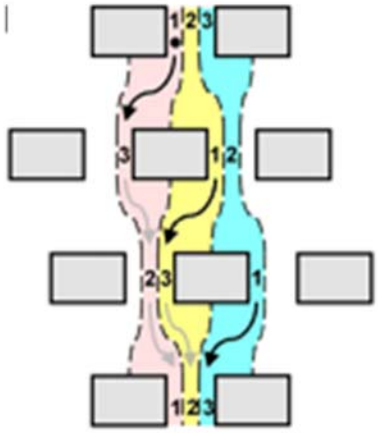
11. In Device C, an array with 32-µm gaps retained only 60% of WBCs. This array was chosen for the device because of (its 60% retention rate, its operating range for cells between 8 and 30 µm, its excellent manufacturability).



12. For the above-mentioned array with 32-µm gaps, the characteristic

diameter of the posts was about 24 µm. Its Reynolds number is about 0.01 for a flow velocity of 0.5 mm/sec. If the diameter is changed from 24 to 48 µm, the Reynolds number would be close to (1, 0.1, 0.005, 0.02, 0.04, 1000).

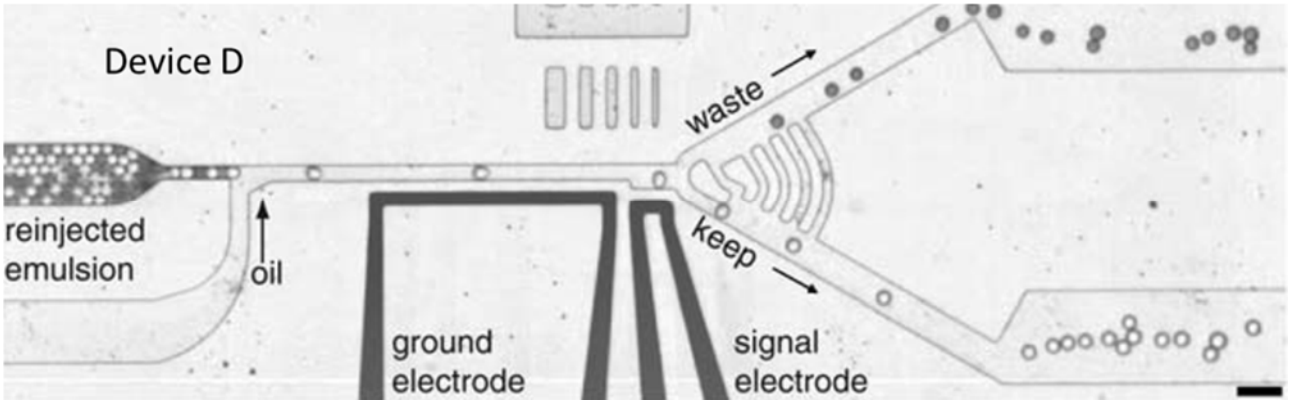
13. Hydrodynamic cell sorting is illustrated by the figure shown right. Assume the gap is 32µm. For a cell with a size around 5µm, its path moving from row 1 to 3 could not be (2→1→3; 3→2→1; 1→3→2; 3→2→3).



14. To collect LBX1: Epithelial-mesenchymal transition (EMT) master regulator in Device C, magnetic beads should be labelled for the attachment to (white blood cells, red blood cells, cancer cells).

15. RNA expression between CTCs isolated by Device C from a prostate cancer patient could vary significantly. Such variations explain (how we can apply Device C in clinical applications; why we have to improve Device C further; why we do not see any opportunity to use Device C in clinical applications).

16. Device D as shown was for directed evolution. Compared to state-of-the-art robotic screening, this was 1000-fold faster and uses 10-million-fold less volume of reagent, representing a cost savings estimated to be about 10-million-fold. Device D's screening throughput rate was about (1000, 1, 150, 1000000) assays per second.

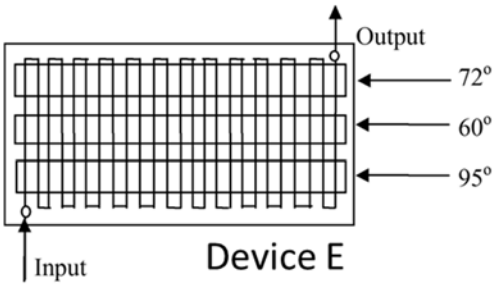


17. For the Device D, a suspension of (bacteria, stem cells, cancer cells, yeast cells) displaying the HRP on their surface was combined with a second aqueous stream containing the fluorogenic substrate.

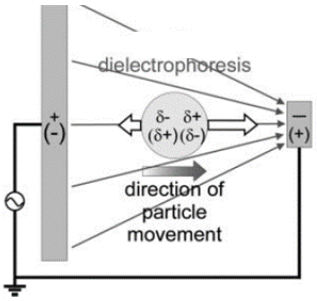
18. For the Device D, the droplets would move to the waste channel unless they were pulled by dielectrophoresis to the keep channel. The (length, width, thickness) of the narrow part of the channels at the sorting junction was designed for such movements.

19. For the Device D, the electrodes were fabricated as channels filled with (PDMS, cells, metal).

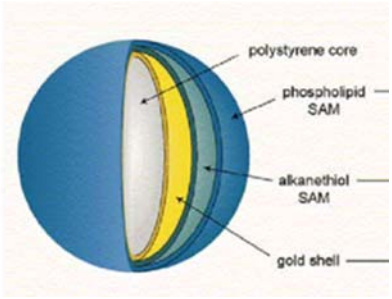
20. Device E as shown is for PCR. It is different from the PCR units used in the above-mentioned Device B because it has to use (droplets, controlled temperatures, electric field, magnetic field).



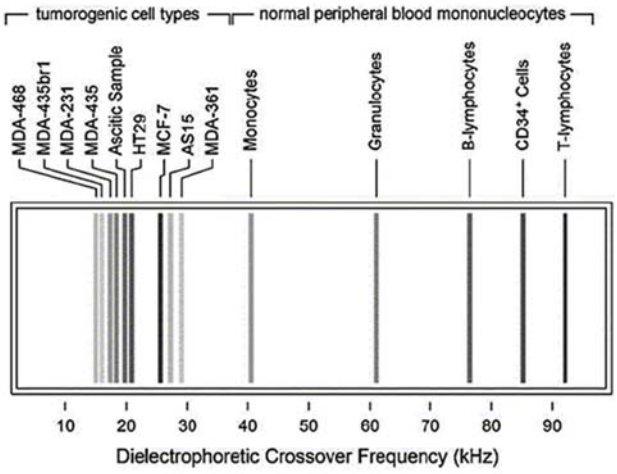
21. The figure as shown below left illustrates dielectrophoresis. It is for (positive, negative, neutral) dielectrophoresis.



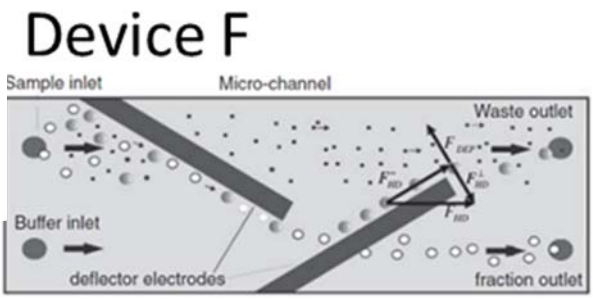
22. A nanoparticle as shown right is important to apply (magnetophoresis, electrophoresis, dielectrophoresis) to sort cells.



23. The cross-over frequencies of different cells are shown in the figure below. We should apply an AC at frequencies around (10kHz, 35kHz, 95kHz) if we would like to collect all the cancer cells without normal cells by using dielectrophoresis.

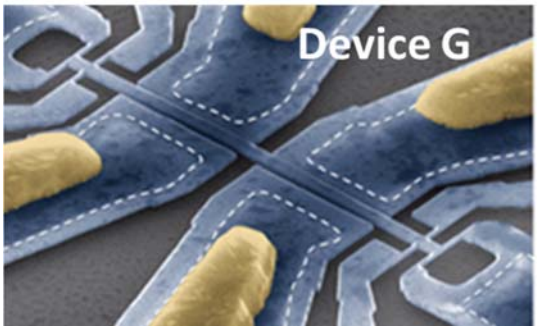


24. Device F as shown below is a dielectrophoresis (DEP)-based collection device. Some cells would pass through its electrodes as waste due to several effects; however, (positive DEP, negative DEP, inertial) is not one of these effects.



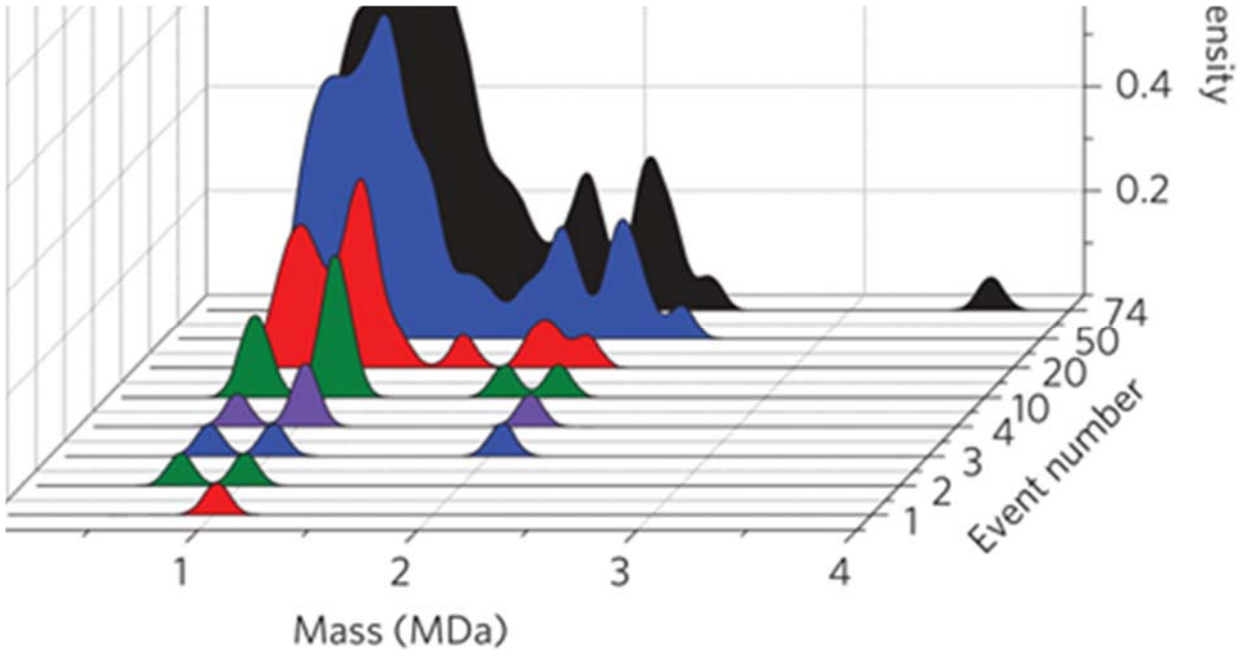
25. For the ABC molecular layer deposition (MLD) process, (ethyleneglycol, trimethylaluminum, ethanolamine, maleic anhydride) was not one of the three precursors used.

26. Device G was for single molecule detection enabled by several features; however, (biotinylated beam, doubled-clamped beam, measurement of two resonant modes) was not one of its features.



27. We can apply atomic layer deposition (ALD) technology to improve Device G by (increasing the area of the beam, increasing the thickness of the beam, increasing the length of the beam).

28. Device G could detect single molecules attached to the beam as demonstrated in the figure below. Based on this figure, the mass of the second molecule attached to the beam should be around (0.7, 1.0, 1.7, 2.0) MDa.



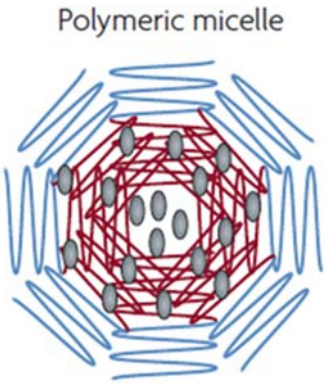
29. For nanoparticle therapeutics, (IT-101, SP1049C, Doxil, Abraxane) has mechanisms to control the release of the drug.

30. The drug carried in SP1049C and NK911 is (paclitaxel, camptothecin, doxorubicin).

31. Multivalent binding to the surface of cells with high receptor density is a good design because (low-affinity ligands, high-affinity ligands, any ligands) can be used for nanoparticle therapeutics with reduced side effects.

32. For high circulation times, we would like to select drug-carrying nanoparticles with a clearance that is (lower than, higher than, the same as) the drug's clearance.

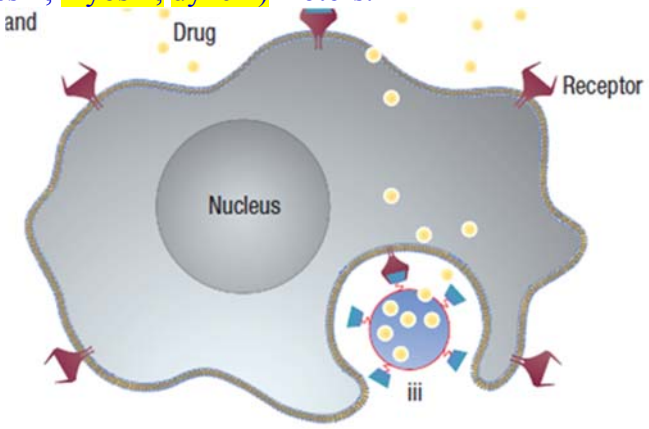
33. Polymeric micelles as shown can carry and deliver drugs for nanoparticle therapeutics. The copolymer molecules used for such micelles should have (one hydrophilic end and one hydrophobic end; both ends hydrophilic; both ends hydrophobic).



34. A CU-ME research study is developing an ultrasound-mediated delivery with plasmid DNA transfection to tumor cells *in vivo* using polyplex-microbubbles. One of the advantages of this approach is that (cancer cells can be degraded by ultrasound; the delivery system can be integrated with an imaging system; ultrasound signals can be converted into audio signals).

35. The maximum energy conversion efficiency of a biomolecular motor could reach a level up to (90%, 50%, 10%), and such an energy conversion process occurs at room temperatures.

36. Endocytosis as shown is an important mechanism for drug-carrying nanoparticles to get into a cell. This mechanism is actuated by (kinesin, myosin, dynein) motors.



37. In vitro, kinesin motors walk along microtubules at speeds of (100, 10, 5, 1) μm/s with saturating ATP concentrations.

38. For effective motion control of microtubule-based molecular shuttles, different technologies and materials have been developed. However, (undercut, rectifier, caged ATP, ferrite, biotinylated kinesin, diffuser) is not one of the technologies or materials.

39. Biomolecular motors-based biosensing can be much better than diffusion-based biosensing due to its ability to carry (large, small) nanoparticles over a long distance.

40. In an example of loading/unloading of cargos from microtubule-based molecular shuttles, single strand DNA fragments with 23 bases are attached to the cargo. Among the following statements, circle the one that is incorrect: (A. single strand DNA fragments with 15 bases could be attached to the molecular shuttles for the loading function; B. single strand DNA fragments with 23 bases could be attached to the area for unloading the cargos; C. single strand DNA fragments with 23 bases could be attached to the molecular shuttles and the unloading area.