BME 695 Engineering Nanomedical Systems
August 25, 2011

Lecture 2: "Designing nanomedical systems"

2.1 Elements of good engineering design
- 2.1.1 Whenever possible, use a general design that has already been tested
- 2.1.2 Whenever possible, take advantage of "biomimicry" – Nature has tried many designs!
- 2.1.3 Avoid "general purpose" design. Use multiple specific molecules to do specific tasks.
- 2.1.4 Control the order of molecular assembly to control the order of events
- 2.1.5 Therefore, perform the nano assembly in reverse order to the desired order of events

2.2 Building a nanodevice
- 2.2.1 Choice of core materials
- 2.2.2 Add drug or therapeutic gene
- 2.2.3 Add molecular biosensors to control drug/gene delivery
- 2.2.4 Add intracellular targeting molecules
- 2.2.5 Result is multi-component, multi-functional nanomedical device
- 2.2.6 For use, design to de-layer, one layer at a time
- 2.2.7 The multi-step drug/gene delivery process in nanomedical systems

2.3 The challenge of drug/gene dosing to single cells
- 2.3.1 Precise targeting of drug delivery system while protecting non-targeted cells from exposure to the drug
- 2.3.2 How to minimize mis-targeting
- 2.3.3 How to deliver the right dose per cell
- 2.3.4 One possible solution – in situ manufacture of therapeutic genes

2.4 Bridging the gap between diagnostics and therapeutics
- 2.4.1 how conventional medicine is practiced in terms of diagnostics and therapeutics
- 2.4.2 the consequences of separating diagnostics and therapeutics
- 2.4.3 a new approach – "theragnostics" (or "theranostics")

2.5 Examples of current theragnostic systems
- 2.5.1 example 1: Rituxan ("Rituximab)(an example of not using diagnostics to guide the therapy)
- 2.5.2 example 2: Herceptin ("terastuzumab")
- 2.5.3 example 3: Iressa ("Gefitinib)
- 2.5.4 other examples

2.6 How theragnostics relates to Molecular Imaging
- 2.6.1 conventional imaging is not very specific
- 2.6.2 types of In-vivo Imaging
  - 2.6.2.1 X-rays, CAT (Computed Axial Tomography) scans
  - 2.6.2.2 MRI (magnetic Resonance Imaging)
  - 2.6.2.3 PET (Positron Emission Tomography) scans
- 2.6.3 "molecular imaging" of nanoparticles in-vivo for diagnostics/monitoring of therapeutics

2.8 Engineering nanomedical systems for simultaneous molecular imaging
- 2.8.1 using nanomedical cores for MRI contrast agents
- 2.8.2 difficulties in using PET probes for nanomedical devices
- 2.8.3 using cell-specific probes for molecular imaging of nanomedical devices
- 2.8.4 breaking the "diffraction limit" – new nano-level imaging modalities

2.9 Theragnostic nanomedical devices
- 2.9.1 using nanomedical devices to guide separate therapeutic device
- 2.9.2 when might we want to combine diagnostics and therapeutics?

References

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