Breakout Session on Unifying Themes

Nanoscience for Bio-Synthetic
Wireless Sensor Networks

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What are the converging scientific and research aspects for nano-based bio-synthetic wireless sensor networks? (1)

- **Recent advances:**
  - Self-assembly can be used to obtain complex structures.
  - Our basic understanding of biological sensing and signaling at the cellular level has significantly advanced.
  - This has led to biosynthetic sensors for almost every single signal in biology.
  - Ability to engineer special purpose wireless sensors is very advanced.

- **General challenges:**
  - Delivering sufficient energy to and from biological signals into the conventional microelectronic scale wireless signaling devices.
  - Building the actual signal transducer.
  - Finding applications of key importance in medicine.
  - Channel sharing, interference, addressing, scalability.
  - System level integration.
What are the converging scientific and research aspects for nano-based bio-synthetic wireless sensor networks? (2)

• Moderate challenge:
  – Read out every neuron of a C. elegans by using wireless transducers.
What are the promising avenues to integrate inorganic nano-devices and biological parts? (1)

- **Promising avenues:**
  - **Synthesis of inorganic nano-devices**
    - biological synthesis: Bacterial magnetosome
    - chemical synthesis
  - **Directed self-assembly:**
    - using tiles
    - scaffolds, e.g., DNA origami or a biological existing structure
    - assembly of or on inorganic membrane surfaces
  - **Novel biological sensors**
    - paramagnetic nano-particles
    - a combination of biological sensors with inorganic transducer (e.g., semiconducting quantum dots)
What are the promising avenues to integrate inorganic nano-devices and biological parts? (2)

• Promising avenues (continued):
  – Hybrid sensing device incorporating biological sensor with photonic transduction and inorganic transduction for wireless transmission.

• Challenges:
  – Power all components, particularly the inorganic transducers used for wireless transmission.
  – Component stability, environmental issues, e.g. regeneration of components
  – Information bandwidth limitations due to small scale and low energy.
  – Thermal noise.
  – Enhance transducer sensitivity, range, and longevity.
  – Interaction between inorganic surface and molecules
What are the benefits and limitations of bio-synthetic wireless sensor networks?

• Potential benefits:
  – Scalable
  – Less invasive
  – Allows for deep tissue sensing
  – Can use molecular scale effectors as sensors and vice versa
  – Lower energy requirements