

Bionanoscience Landscape in South Africa and its Implications in the Development of a Post-Graduate Curriculum

Presented at UWC – Nano-biotechnology Seminar.

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CSIR – Synthetic Biology ERA.

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Nanoscience:

The study of phenomena to understand the effects, their influence on the properties and the manipulation of materials at the atomic, molecular and macro-molecular level.

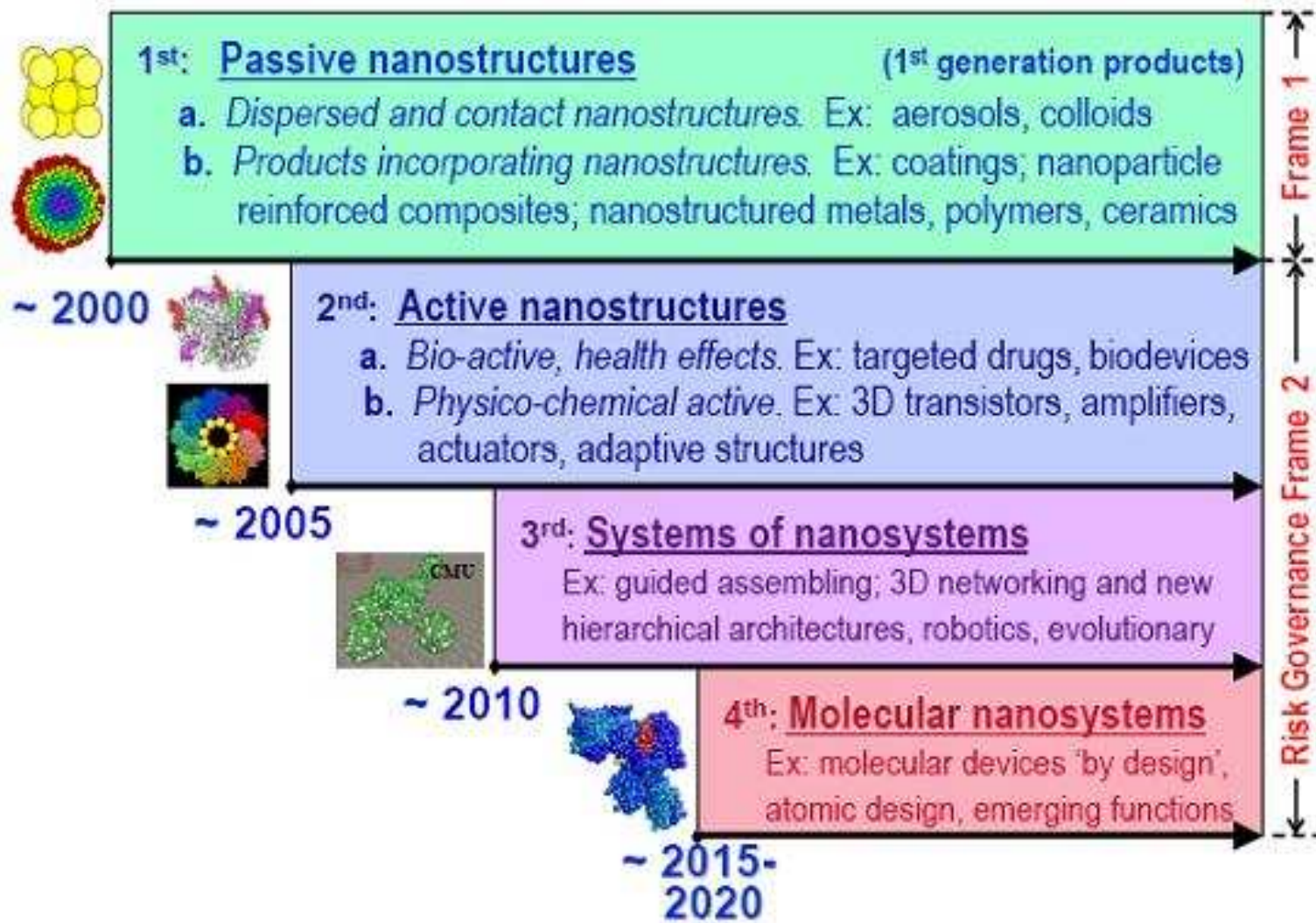
Nanotechnology:

The design, production, characterization and application of devices, structures and systems with novel properties and functions due to their nanoscale size.

- There is a constant drive to reduce the size of components and machines.
- The properties of materials at the nanoscale are very different to the properties in their bulk phase.
- Technology using components on the nanometer scale.
- Utilising and manipulating individual atoms or molecules.
- Bio-nanotechnology uses biological materials or systems.

Bionanotechnology

- Many problems of nanoscale mechanisms have been overcome in nature.
- Act at the nanoscale.
- More energy efficient.
- Hence a great interest in investigating biological materials and systems.
 - Actin, Myosin, Kinesin (mechanical)
 - ATPsynthase, Photosynthetic pigments (Energy transduction)
 - Many biological systems are self assembly (Protein/DNA/Membranes)

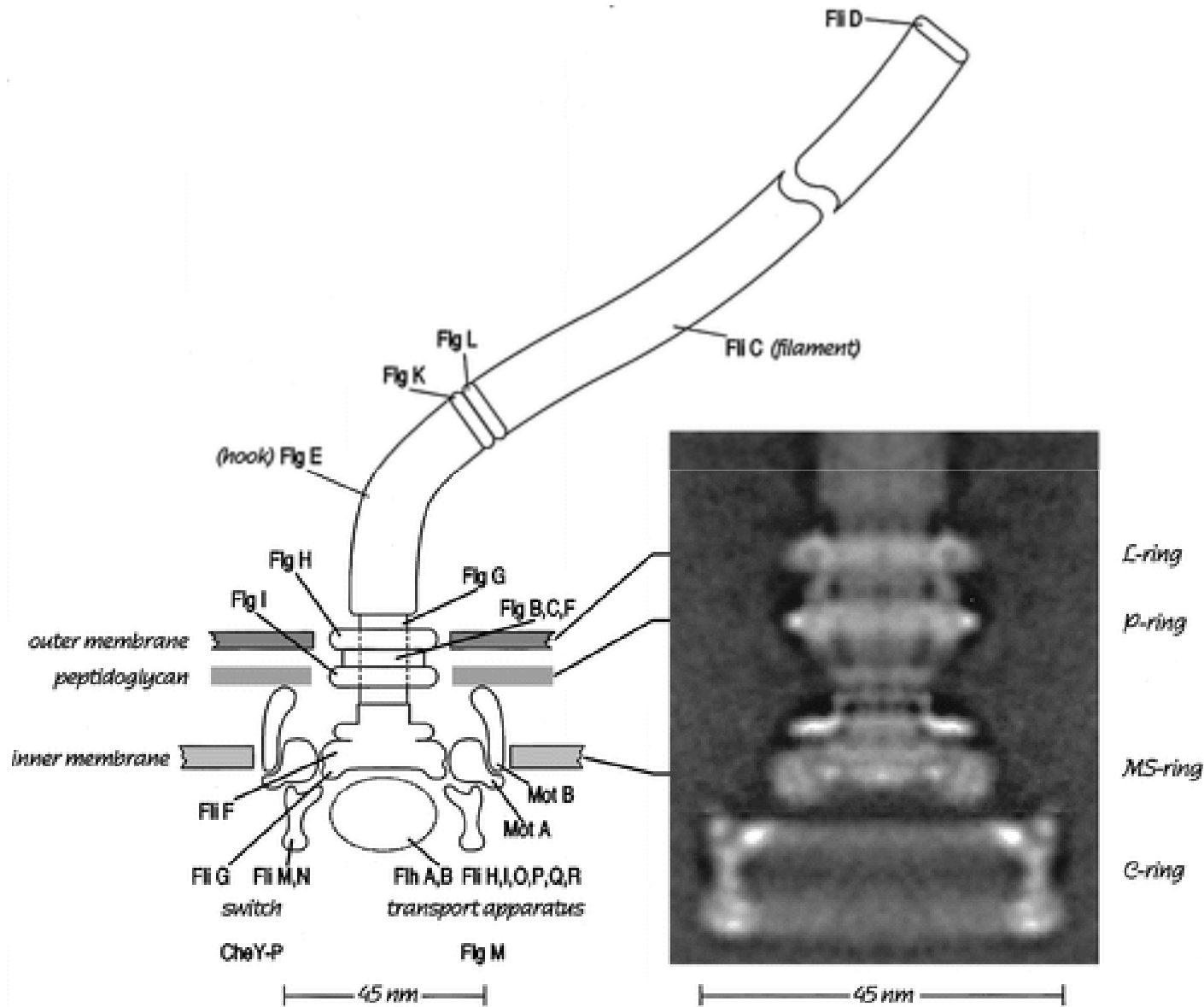


Composite materials

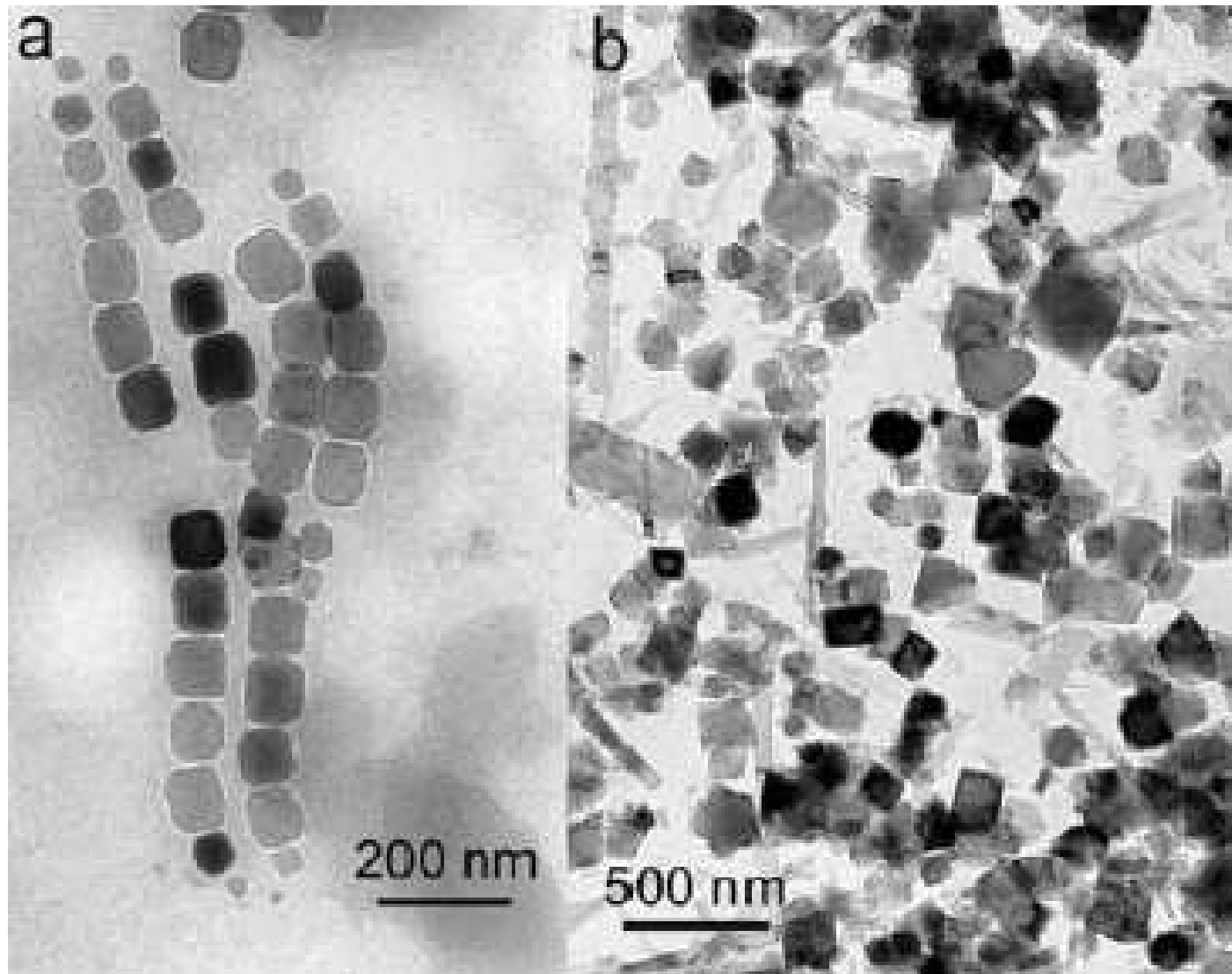


Mussel shells.

The motor: Flagellum

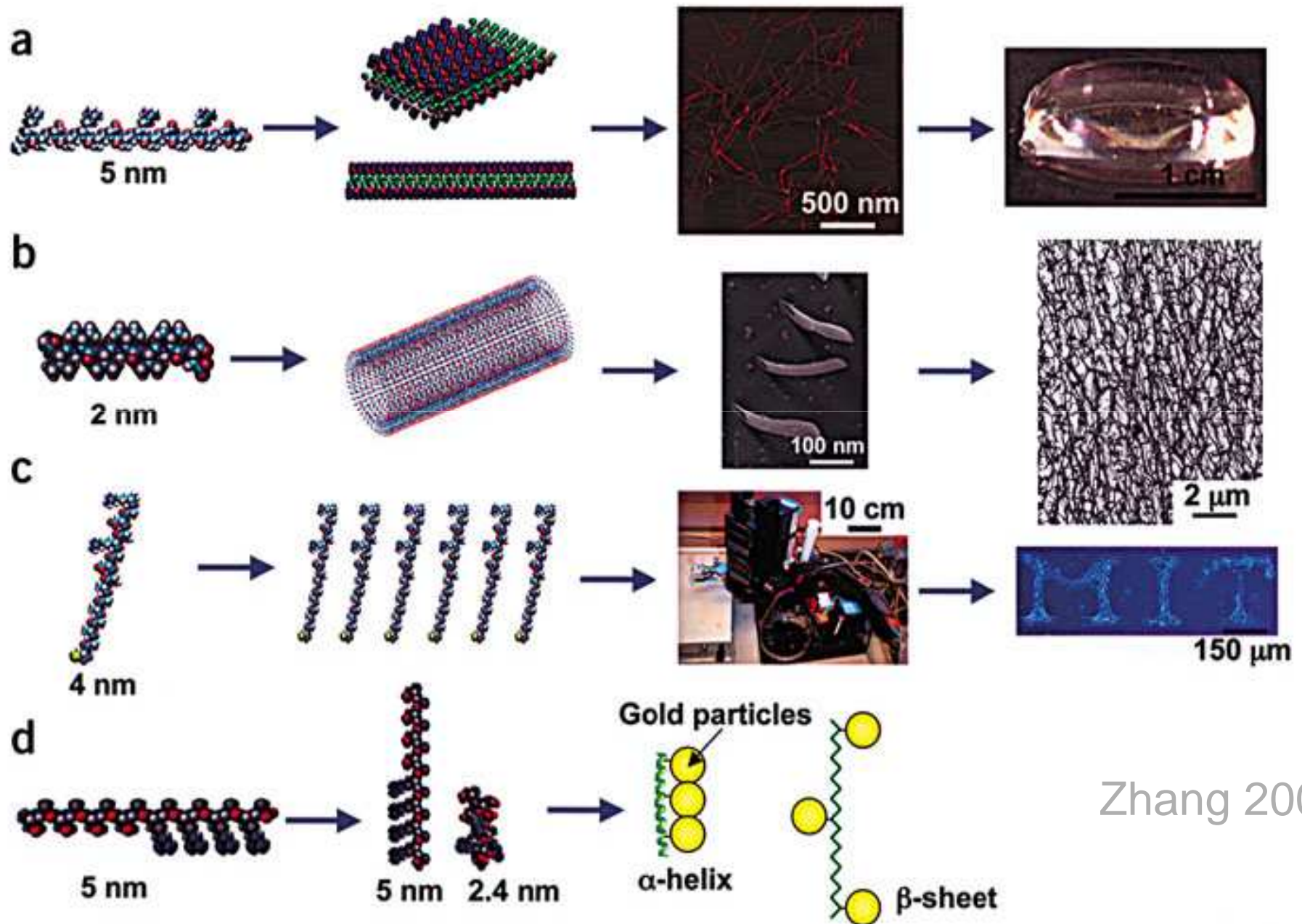


Nano-magnets biogenically deposited magnetite



(Arató *et al.*,
2005).

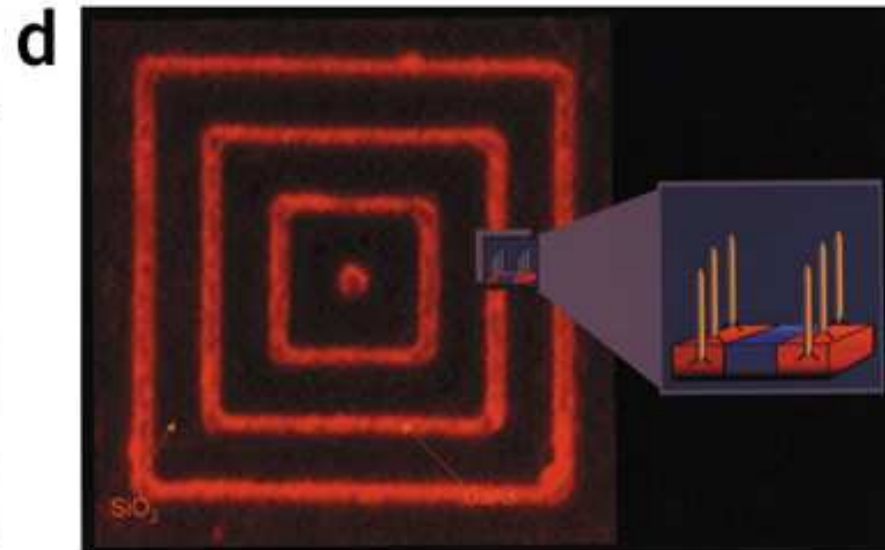
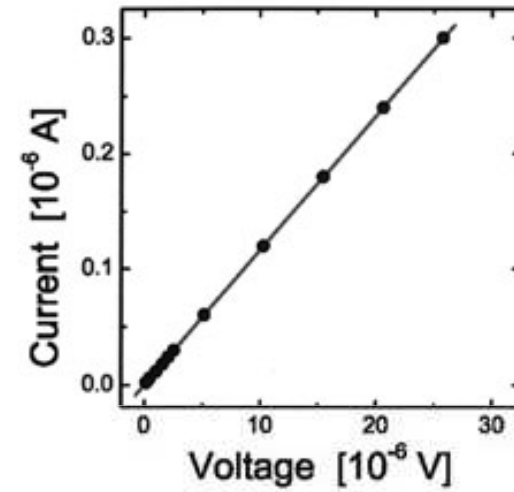
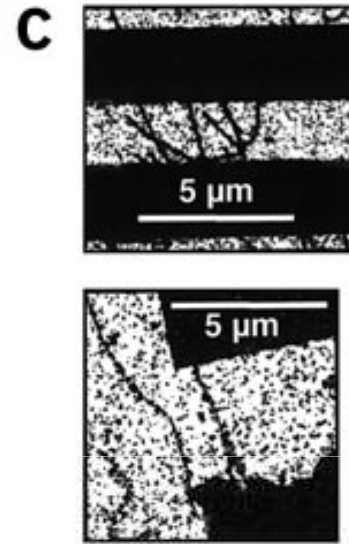
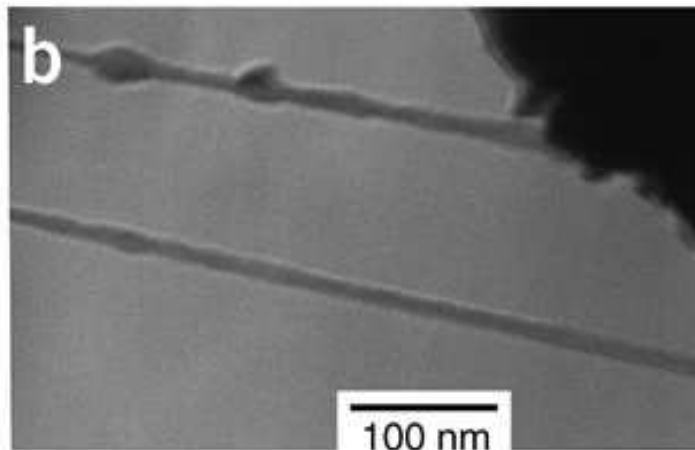
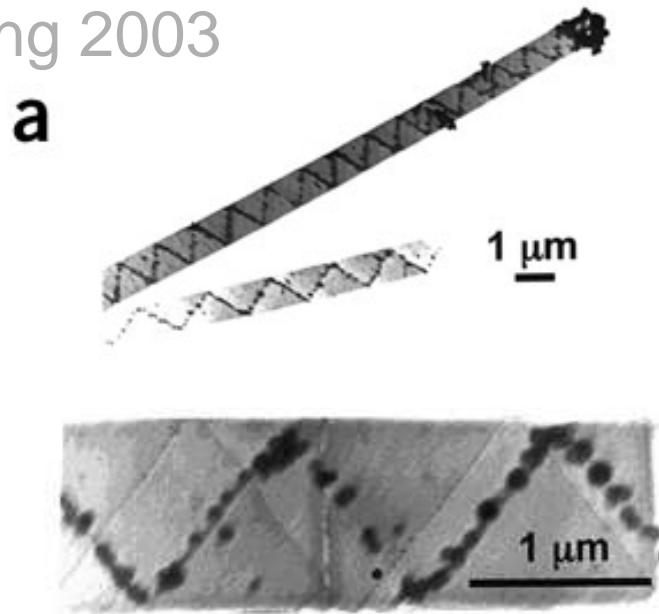
Molecular self-assembly



Zhang 2003

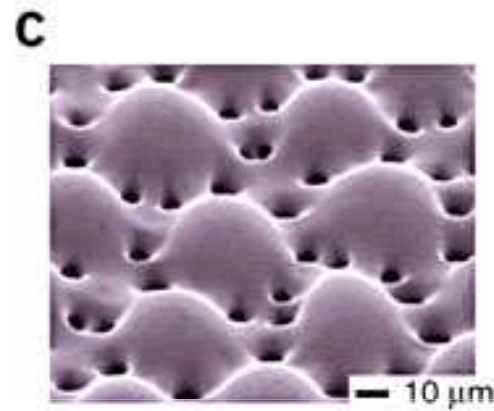
Deposition of metal nano-wires

Zhang 2003

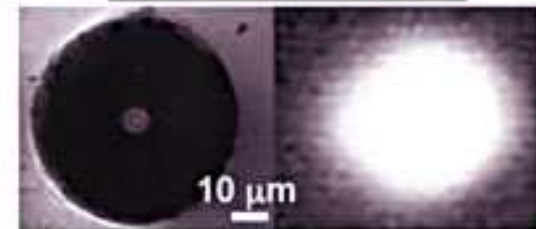
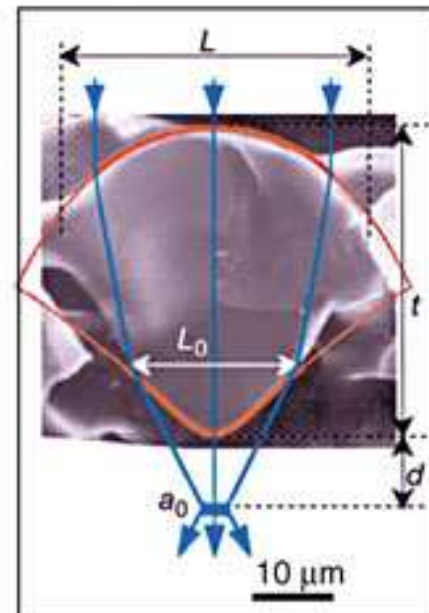
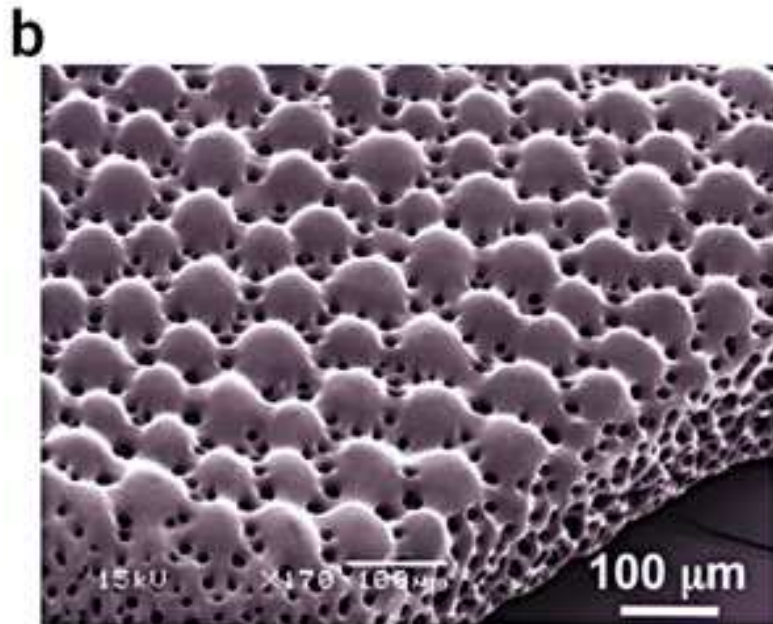
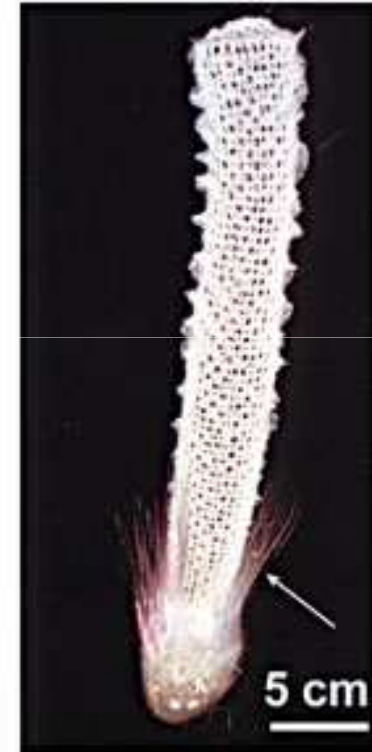


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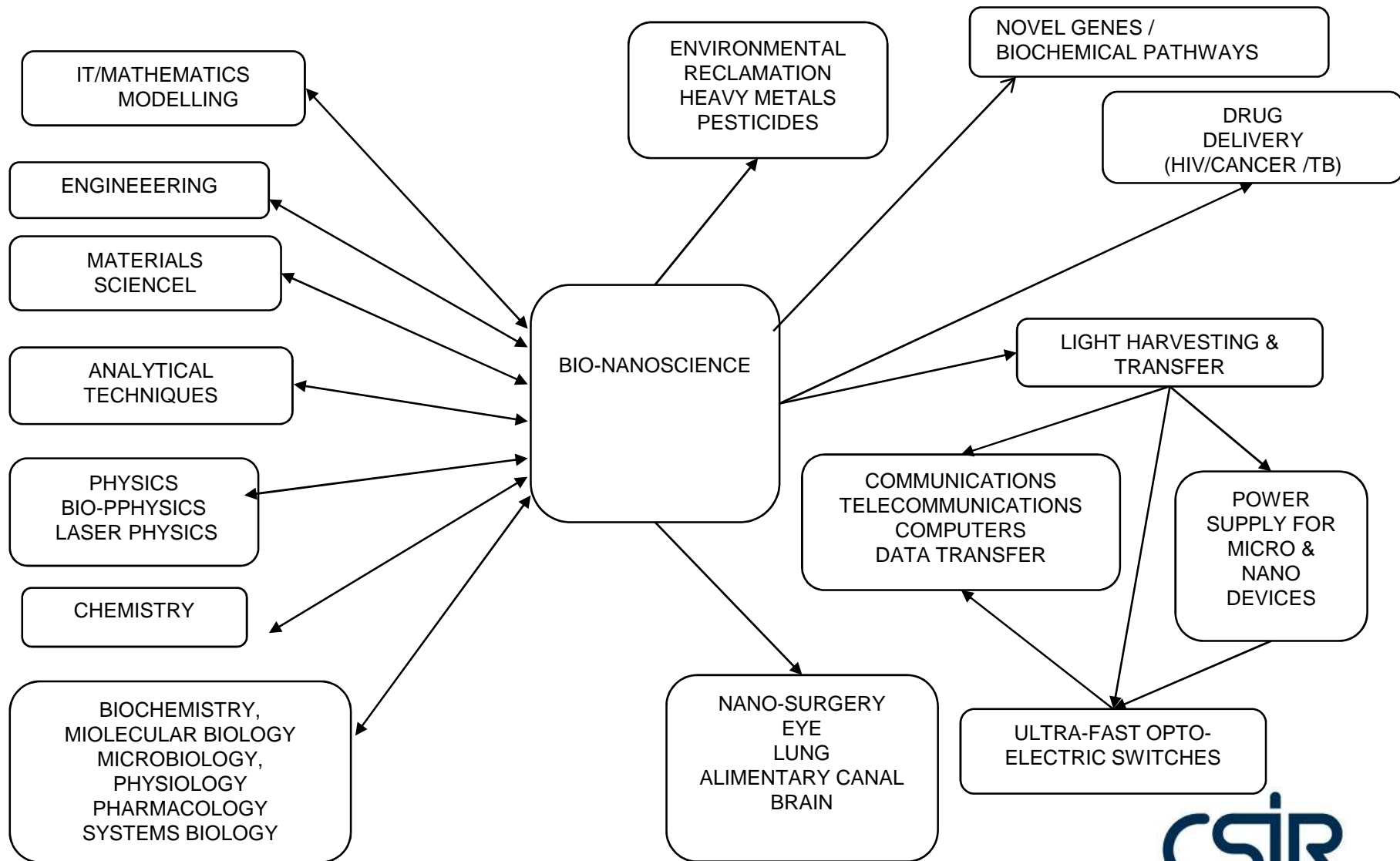
Optical fibres and lenses



d Zhang 2003



Research Inputs and Potential Applications



SYNBIOTIC

Priorities:

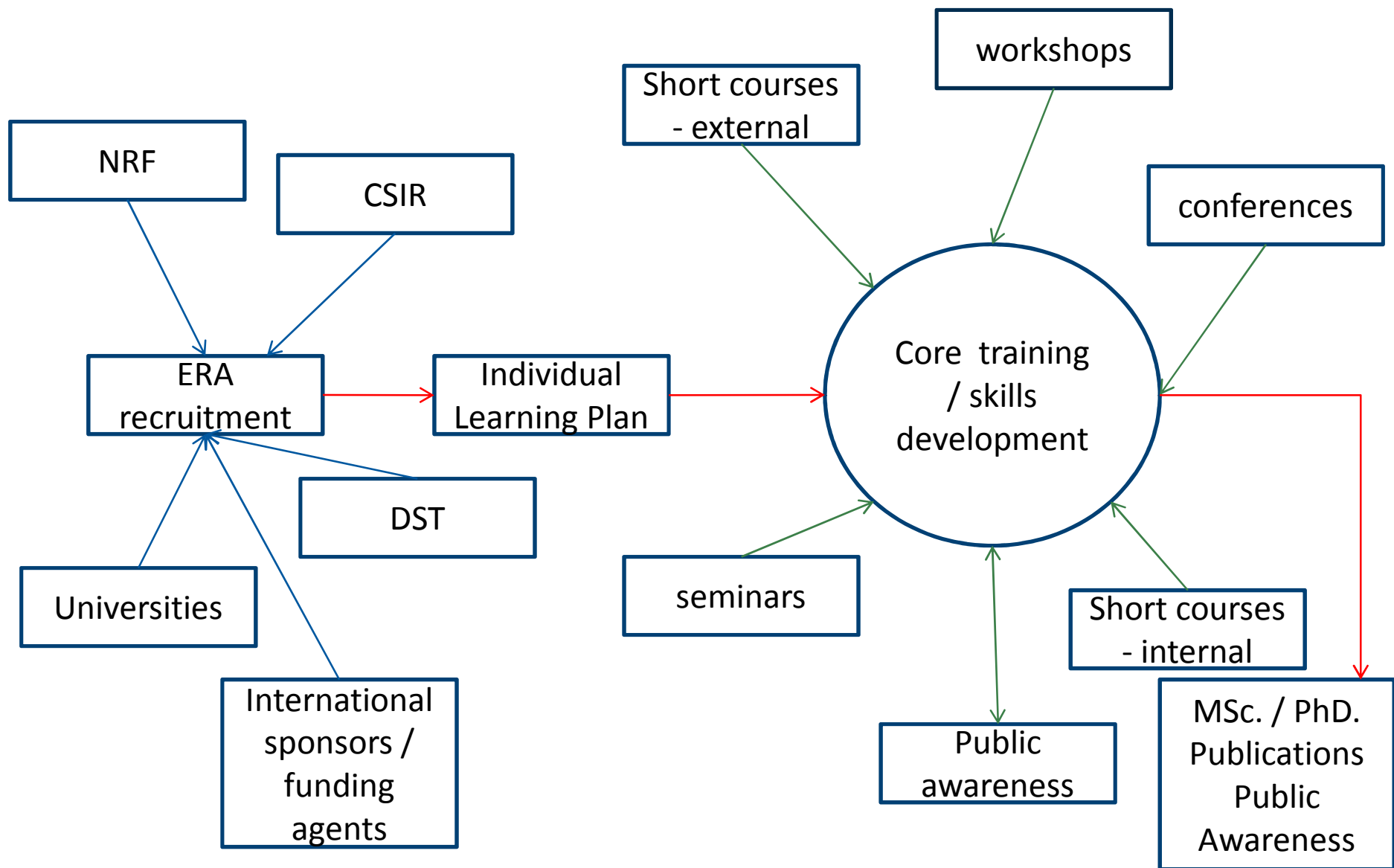
- Skills development.
- Scientific excellence.
- Recruitment of high quality candidates.

Recruitment:

- Recruiting high skilled students at all levels.
- Focus on research of scientific excellence.
- There will be a separate / complementary Post-Doctoral programme.

Skills development training programme to include:

- Individual learning programmes.
 - Focused on research project.
 - the student undertaking the project.
- Short courses, workshops, seminars – invited presenters who are leaders in the field.
- Cross disciplinary environment that supports Synthetic Biology.
- Develop programmes with Universities and other Institutes.
 - e.g. with UWC, iThemba Labs, NWU, US, UP.
- Student / Researcher exchange programme.
- An academic based QA system.
 - Developed an internal and external verification process.
- Assessment and Tracking of skills development and progress.
 - Evidence derived from the research being conducted.



Synthetic Biology Training Programme – Pathway.

Specialization	Topics	Content	Description/Comments
Nanobiotech.	Biology for non-biologists	Biomolecules (proteins / nucleic acids / lipids / carbohydrates)	Actuators, motors, sensors, containers
		Metabolism	Self-assembly
	Bio-energetics	Light activated	Photosynthetic - Light Harvesting. Bacteriorhodopsin Rhodopsin
		Transfer / transport	Electron, proton, ion, channel.
		mechanical	Actin, myosin, kinestin, ATPsynthetase.
	Techniques	Imaging (microscopy)	Fluorescence, confocal, non-linear, EM (TEM/SEM), AFM
		Spectroscopy (Steady state and time resolved).	UV-VIS, CD, FTIR, Raman, NMR.
		Isolation / purification	HPLC / Affinity / centrifugation.
	Physics	Quantum mechanics	Molecular level interactions / dynamics Energy transfer
		Coherence phenomena	
		Thermodynamics	
	Mathematics for Nanoscience	Modelling and computation.	Molecular level interactions / dynamics Energy transfer

Thank you



NANOTECHNOLOGY

ADVANTAGES

- New materials
- New properties
- Greater efficiency
- Reduced size (compactness)

PROBLEMS

- The assembly of components.
- Interconnecting components into working mechanisms
- The control of components