QUICK LINKS:
about
people
- faculty
- recent publications
- courses
- staff
research
events
contacts
news
bme home
pratt home
duke home
INFORMATION FOR:
undergrads
grads
industry
employment

DAVID NEEDHAM, PROFESSOR OF MECHANICAL ENGINEERING AND MATERIALS SCIENCE AND BIOMEDICAL ENGINEERING

Professor Needham also holds appointments as Associate Professor of Biomedical Engineering; Associate Professor, Center for Cellular and Biosurface Engineering; and Associate Professor, Duke Comprehensive Cancer Center.

Dr. Needham's research program is in the field Materials Science and in particular, that of "Biological and other Soft Wet Materials." The program focuses on coating and encapsulation of solid, liquid and gaseous particles in the colloidal size range (10 nanometers to 10 micrometers). It essentially comprises two related areas. One deals with the material properties of lipid monolayers, bilayer membranes, hydrogels, wax particles, emulsions, gas bubbles, and cells. And the other is concerned with adhesion and repulsion involving molecular structures at interfaces including water-soluble polymers and receptor-mediated cell adhesion. Current research focuses on experiments and theory concerning: 1) molecular exchange and defect formation in lipid vesicle membranes, (specifically involving the partitioning of amphipathic molecules like surfactants, pH sensitive polymers, and fusogenic peptides); 2) physical properties of microhydrogels and their interactions with ionic species, especially drugs; 3) lipid and surfactant monolayers at gas bubble, liquid emulsion , and solid wax surfaces; and 4) in the measurement of the local compliance of cellular interfaces and bond strengths for receptor-ligand bonds in response to cell activation. Information gained in this work is directed towards improved image contrast agents and drug delivery systems that use lipids and polymers to create micro- and nano-capsules and monolayer coatings. These micro and nano carriers are being designed to load anti-cancer drugs and local anesthetics, and to coat or encapsulate image contrast agents for Ultrasound imaging. The current focus is on increased drug carrying capacity (solubility in lipid and surfactant structures), antibody and peptide targeted delivery to diseased sites, and triggered release of drug at the diseased site from a carrier by using temperature and pH-sensitive materials. These systems are being tested pre-clinically with collaborators in the Duke Medical Center, specifically with Dr. Mark Dewhirst in Radiation Oncology.

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Education:

PhD, University of Nottingham, 1981
BsC, Trent College, 1975

Specialties:

Biological Materials
Drug Delivery

Research Interests:

Current projects: Development and optimization of thermolabile liposomal drugs, Microsphere Engineering for Proteins as Drugs, Improved Preservation, Storage and Function of Antibodies

Dr. Needham's research program combines the fields of Materials Science with Colloid and Surface Chemistry focusing on "Biological and other Soft Wet Materials". The program is in the

general area of forming, coating and encapsulation of solid, liquid and gaseous particles in the colloidal size range (10 nanometers to 10 micrometers). It deals more specifically with the material properties of 2-phase micro and nanosystems, such as surfactants, lipid monolayers, lipid bilayer membranes, micelles, liposomes, hydrogels, wax particles, emulsions, microdroplets, gas bubbles, microcrystals, microglasses, polymer microspheres, and blood and cancer cells. It is also concerned with the adhesion and repulsion between particle surfaces involving molecular structures at interfaces including repulsive interactions due to the presence of grafted water-soluble polymers and specific interactions between receptors-ligand pairs. Such materials property measurements and inter particle interactions require specialized experimental equipment and the principal experimental approach is that of micropipet manipulation, to manipulate individual and pairs of micro particles and cells in controlled solution environments. Previous NIH/NCI research grants, focused on experiments and theory concerning: 1) molecular exchange and defect formation in lipid vesicle membranes, (specifically involving the partitioning of amphipathic molecules like surfactants, drugs, pH sensitive polymers, and fusogenic peptides); and 2) Novel thermally sensitive drug delivery system for treatment of solid tumors. Research topics currently under investigation include: lipid and surfactant monolayers at gas bubble, and liquid emulsion surfaces; diffusion-solubility, crystallization and solidification of polymers, lipids, proteins, inorganic crystals and drugs from 2 phase Microsystems, including degradable PLGA polymer microspheres. The latter is currently funded through an NIH grant entitled, "Microsphere Engineering for Proteins as Drugs". Particular applications of these materials and materials processing concepts are in drug delivery, specifically, the temperature-triggered drug release in solid tumors, and lately formulations of more hydrophobic drugs as emulsions and of proteins in polymer microspheres. Information gained in this work is directed towards, for example, improved image contrast agents, drug delivery systems that use lipids and polymers to create micro- and nano-capsules and monolayer coatings. The Temperature-sensitive liposome systems are being tested pre-clinically and now clinically with collaborators in the Duke Medical Center, specifically with Dr. Mark Dewhirst in Radiation Oncology. New research is focusing on organic-inorganic nano composites derived from simple surfactants, and new bilayer model systems for studying and using single protein channel activity with Collaborators at Oxford Univ. UK.

Areas of Interest:

2-phase micro and nanosystems
Anti-Cancer Drug Delivery

Awards, Honors, and Distinctions

F.I.R.S.T. Award, National Institutes of Health, 1988-1993
NATO/SERC (England) Fellowshp, NATO, 1983-1985
Oppenheimer Research Fellowship, Cambridge University, 1982-83

Recent Publications (More Publications)

C. M. Yang and D. Plackett and D. Needham and H. M. Burt, *PLGA and PHBV Microsphere Formulations and Solid-State Characterization: Possible Implications for Local Delivery of Fusidic Acid for the Treatment and Prevention of Orthopaedic Infections*, Pharmaceutical Research, vol. 26 no. 7 (July, 2009), pp. 1644 -- 1656 [abs].

J. A. Tashjian and M. W. Dewhirst and D. Needham and B. L. Viglianti, *Rationale for and measurement of liposomal drug delivery with hyperthermia using non-invasive imaging techniques*, International Journal Of Hyperthermia, vol. 24 no. 1 (2008), pp. 79 -- 90 [abs].

Q. Chen and A. Krol and A. Wright and D. Needham and M. W. Dewhirst and F. Yuan, *Tumor microvascular permeability is a key determinant for antivascular effects of doxorubicin encapsulated in a temperature sensitive liposome*, International Journal Of Hyperthermia, vol. 24 no. 6 (2008), pp. 475 -- 482 [abs].

B. L. Montalvo-ortiz and B. Sosa and D. Velez and D. Needham and K. Griebenow, *Novel encapsulation of partially dehydrated protein microparticles in PLGA microspheres*, Journal Of Biotechnology, vol. 131 no. 2 (September, 2007), pp. S51 -- S52 .

M. A. Holden and D. Needham and H. Bayley, *Functional bionetworks from nanoliter water droplets*, Journal Of The American Chemical Society, vol. 129 no. 27 (July, 2007), pp. 8650 -- 8655 [abs].

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