Vaccines and medical countermeasures

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Trends in Science and Technology
Relevant to the BWC
Institute of Biophysics, CAS
Beijing, China
31 Oct - 3 Nov, 2010
Medical countermeasures

• Vaccines
• Antibiotics
• Antivirals
• Detection/diagnosis
Trends in science and technology

• 2006 (Royal Society)
  – synthetic biology
  – post-genomic technologies
  – Immunological research
  – Drug discovery
  – Delivery
  – Agricultural and environmental technology
  – Diagnosis and surveillance of infectious disease

• 2010 (this meeting)
  – synthetic biology
  – post-genomics
  – systems biology
  – bioreactors
  – transgenics
  – neurosciences
  – aerosols/aerobiology
  – nanocomposites/delivery
  – bioforensics
  – biosensors
  – vaccines
  – antivirals/antibacterials
Antibiotics and drug discovery

• Transition from empirical to rational
• Combinatorialial chemistry is now *in silico*

• Traditional targets:
  – DNA, RNA, *protein and cell wall synthesis*
New technologies/approaches

- Targeting virulence/pathogenesis
  - Toxin blocking
  - Secretion systems, quorum sensing

- Targeting host functions
  - CD45 signalling
  - Transient boosting of innate immunity

- Blocking/reducing resistance

- Delivery methodologies

- Permeation enhancers
misuse

• Drug-resistant (untreatable) strains
• Drug discovery includes toxicity analysis, which could be used to identify new toxic substances (Wheelis, 2002)
• Drug targets and virulence factors - enhance susceptibility of host populations
vaccines

• Remain most effective control of infectious disease (31 in use)
• Enormous expansion in understanding mechanisms
• From trial and error to rational design
• Supplement classical approaches with inducing appropriate responses
Modulation of immune response in context of immunization

- Dendritic cell targeting
- CD28 in T-cell expansion
- Cytokine-expressing viral vaccines
- Engineered MHC Class I single chain trimers
- Mucosal immunity
- Adjuvants
  - Quantitative: boosting immune response
  - Qualitative: directing the response pathway
Vaccine delivery

- Micro- and nano-particle delivery
- Gelling powder
- Bio Pharma
- Incorporation into bacterial spores
- Convergence of technologies:
  - nanotechnology
  - DNA shuffling
  - aerosolization
  - stabilization
  - microencapsulation
future vaccines

• Personalized vaccinology
• Non-communicable diseases
  – autoimmune and neurological disorders
  – cancer
  – cardiovascular disease
  – allergies
  – Alzheimer’s disease
• “lifestyle vaccines”
  – weight gain
  – conception
  – addiction to nicotine and other drugs
  – dental caries
Possible misuses

• Create vulnerabilities in immunity (over-stimulation or suppression)
• Modify neural circuitry
• Modify interaction among nervous, endocrine and immune systems
• Immunological and microbiological advances, as with the neurosciences, continue at a rapid pace.

• Vaccinology and drug discovery appear to be closing in on the design of therapeutics for infectious and other diseases by understanding host-pathogen interplay, the human immune system, the interactions between innate and adaptive immunity, and the value of adjuvants.

• The exquisite balance of biological control systems is highly susceptible to disruption.