Bionanotechnology for food packaging

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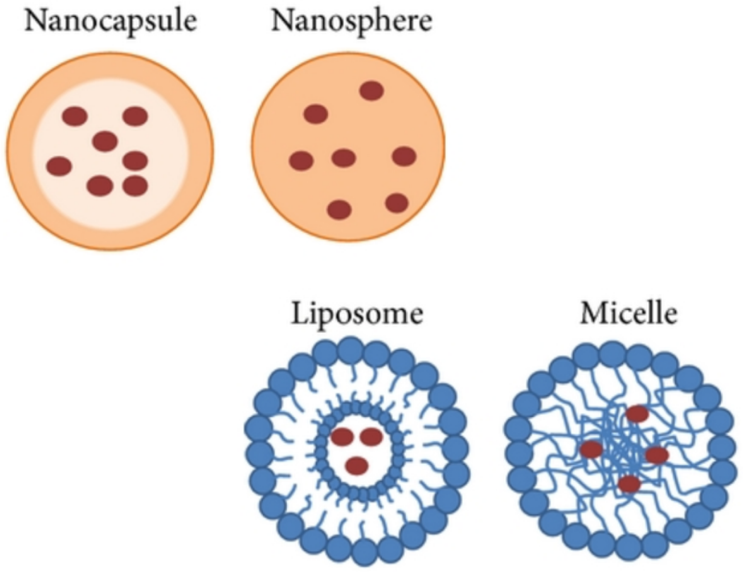
Bionanotechnology

- Intersection of nanotechnology and biotechnology
- Nanostructures that either incorporate biological elements or are entirely biological in origin
- Some examples
  - Nanofibrils
  - Archaeosomes
  - Nanospheres / nanocapsules
  - Polymersomes
  - Micelles / liposomes
  - Bacteriophage
  - Peptides / enzymes



Innovation in packaging

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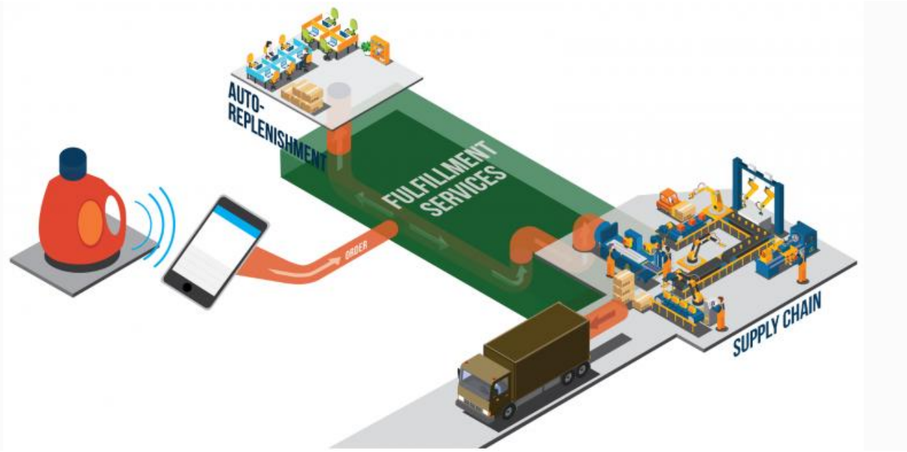
- Smart / intelligent packaging
  - Time-temperature indicators
  - Gas indicators
  - Microwave cooking indicators
  - Radiofrequency identification
  - Replenishment



Amazon Dash: credit Packaging Digest

- Active packaging
  - Oxygen scavengers
  - Modified / controlled atmosphere
  - Moisture absorbers
  - Insect repellents
  - Antimicrobials

Incorporation of antimicrobial bionanotechnology into packaging

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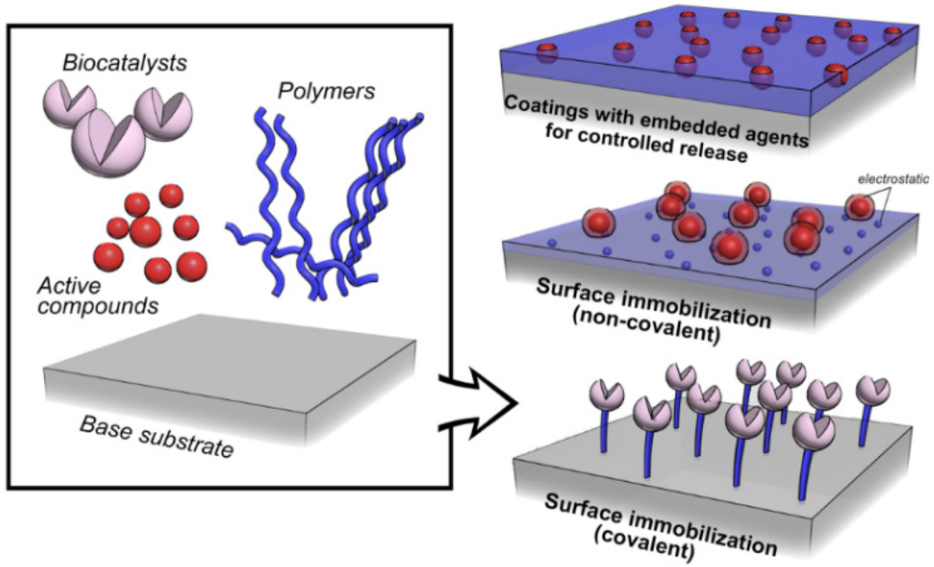
- Assure food safety and quality
- Improve shelf life

- Strategies
  - Coatings
    - Covalent
    - Non-covalent



Bastarrachea et al. Coatings 2015, *5*(4), 771-791

Incorporation of antimicrobial bionanotechnology into packaging

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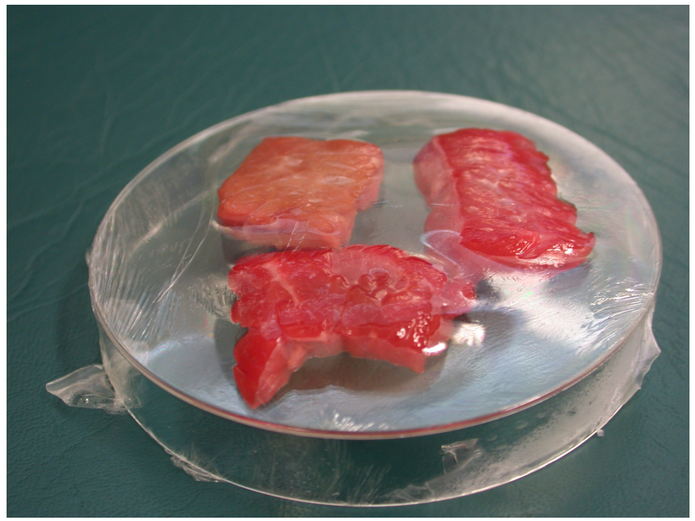
- Bacteriophage coated catering film
- Difficult producing film with phages, but some control was recorded
- Could combine bacteriophages with essential oils

Lysis of *E. coli* under bacteriophage-coated film



Meat overwrapped with bacteriophage coated film

Incorporation of antimicrobial bionanotechnology into packaging

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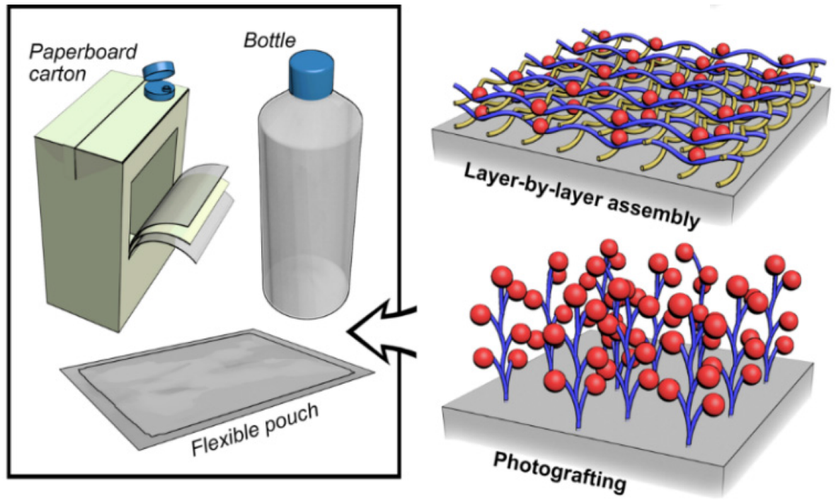
- Incorporate into polymers
  - Can release antimicrobials on contact with food
  - Example - bacteriocins
- Incorporate into edible films
  - Whey protein - bacteriocins, essential oils, lactate bacteriophages
  - Alginate – bacteriophages, essential oils and other plant extracts



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Incorporation of antimicrobial bionanotechnology into packaging

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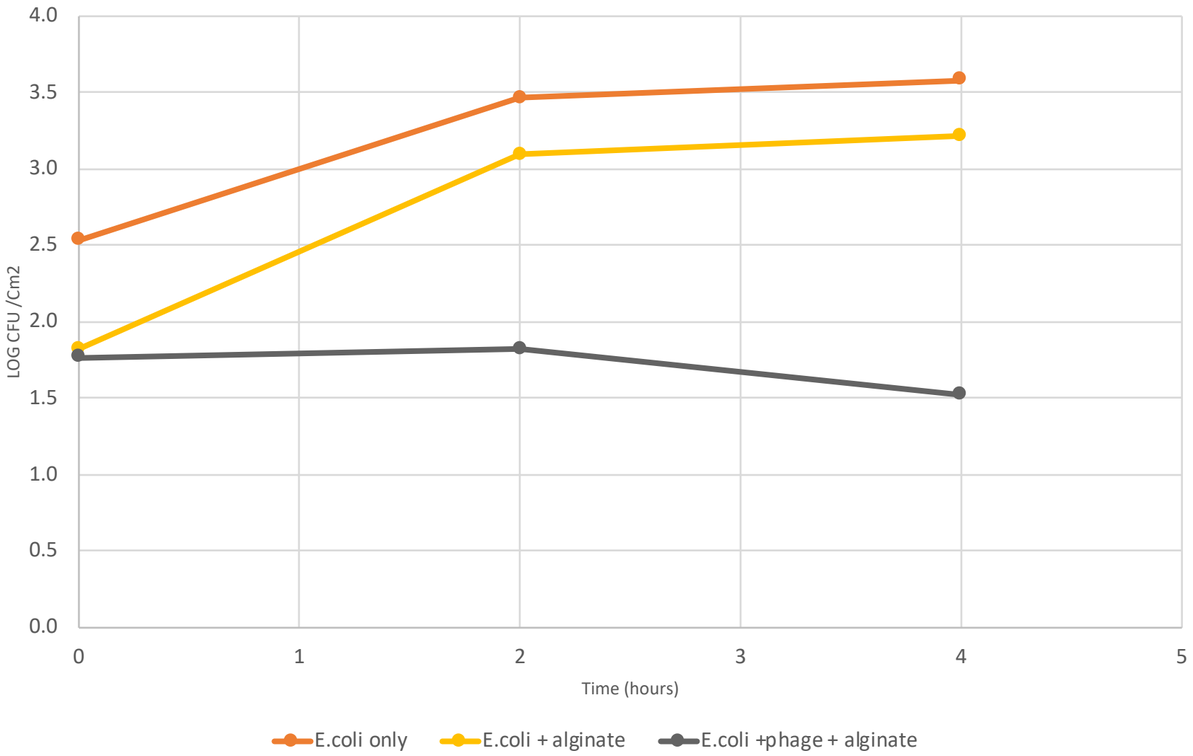
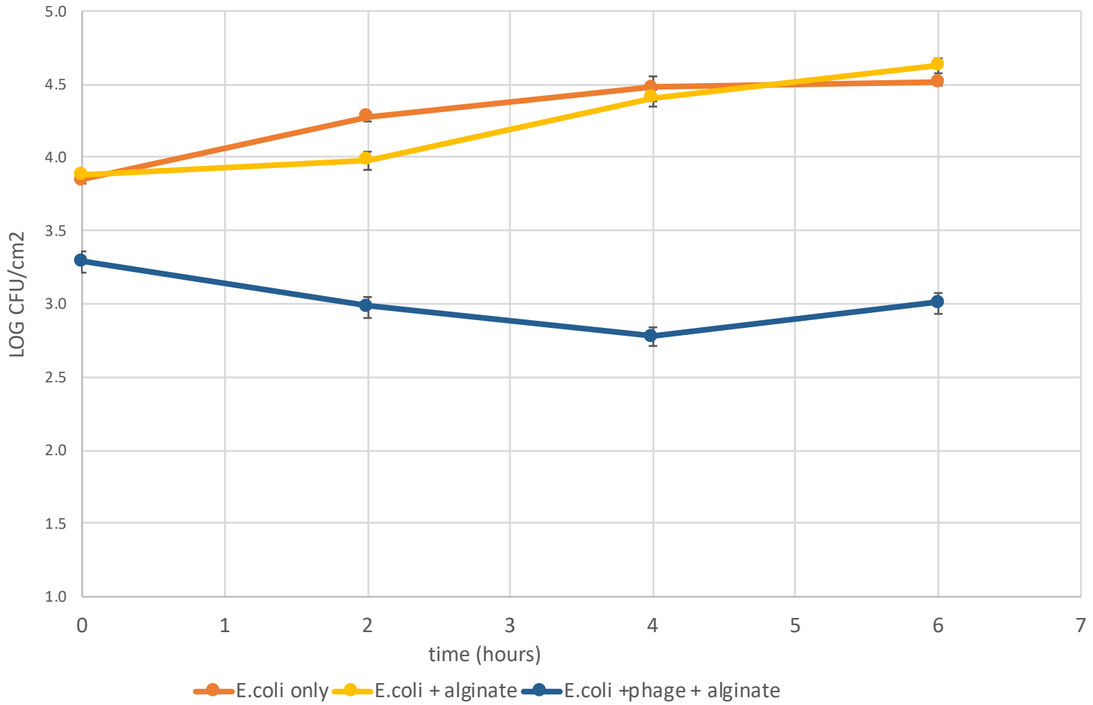
E.coli survival on cooked beef



E.coli survival on Raw Beef



Incorporation of antimicrobial bionanotechnology into packaging

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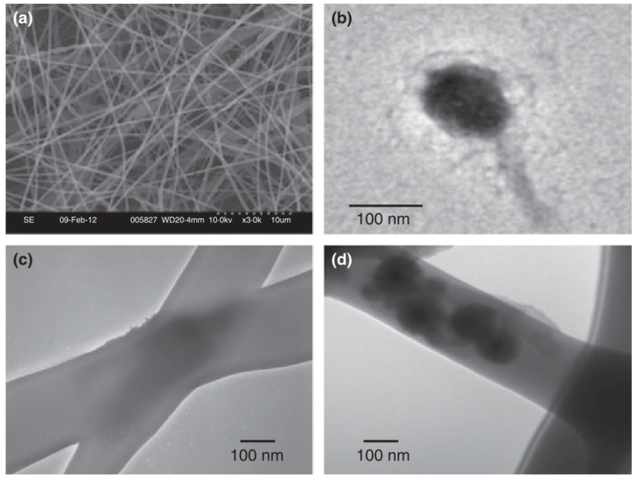
- Electrospinning
  - Nanobiomaterials added directly or protected (heat)



Korehei et al, JAM, 2013

- Inkjet printing
  - Successfully printed bacteriophages on cationic papers

Bionanosensing for packaging

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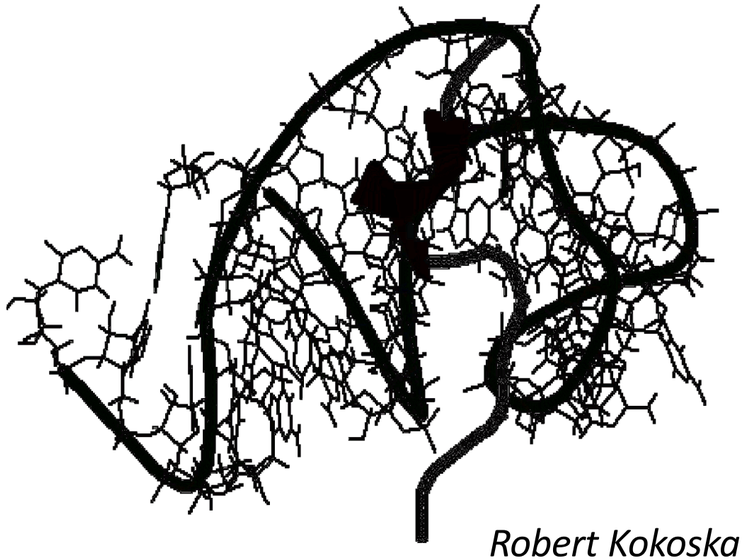
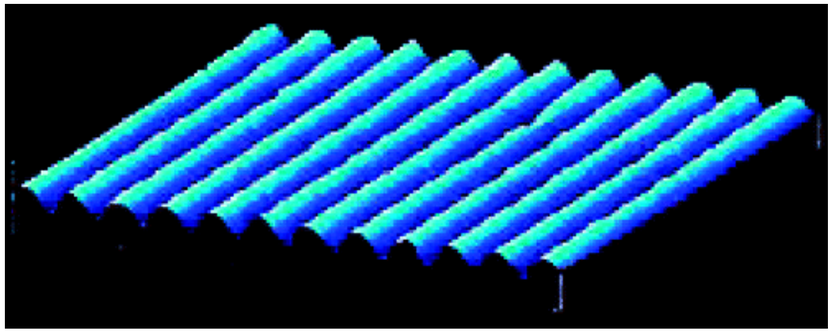
- Concept: bionanosensors incorporated into packaging
- Able to detect gases, microbes, pH
- Bionanosensor platforms which may be amenable to adapting to packaging
  - Silk protein lenses
  - Aptamers
  - Nanospheres



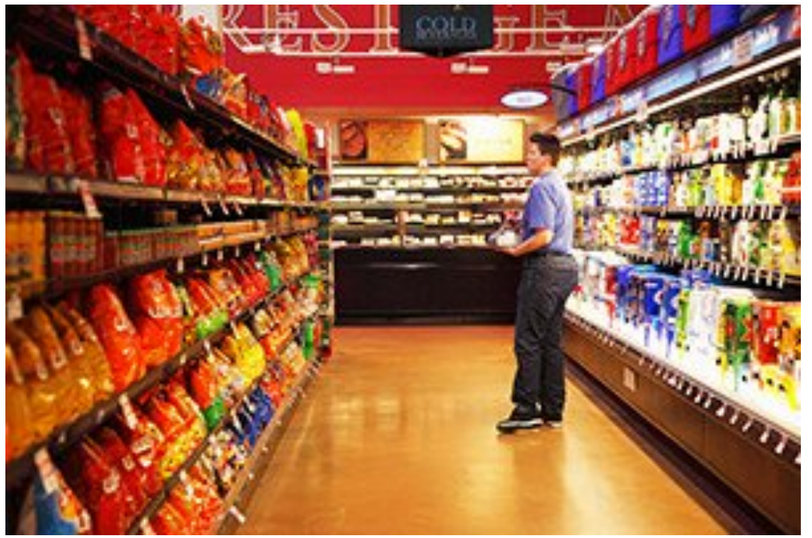
Robert Kokoska



Lawrence, Biomacromolecules, 2008

Consumer perceptions

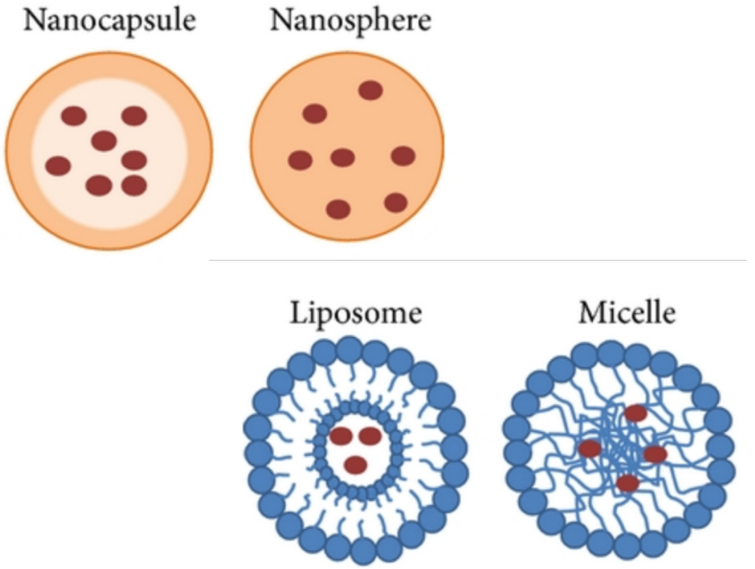
- Acceptance yet to be established
  - Nano ?
  - Bio ?
- Willingness to pay ?
  - Themes to be explored in China catalyst project (Dr Mirosa)



Sharon & Nikki McCutcheon

Conclusions

- Bionanotechnology is an emerging area
  - Can be harnessed to improve safety and quality of packaged food
  - Many different types of possible technical developments
  - Need to consider consumer perceptions
  - Bionanosensors are being developed



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