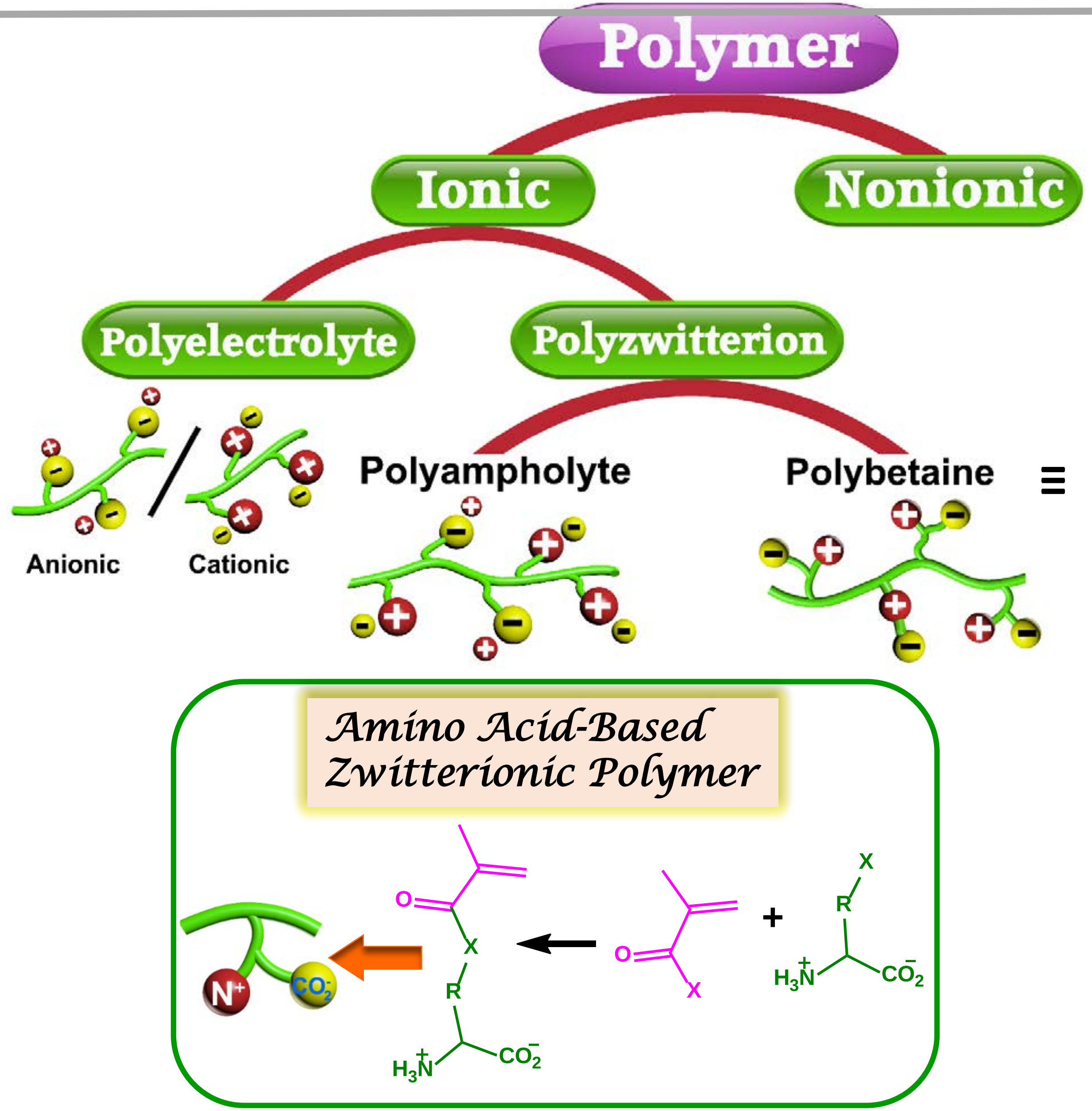
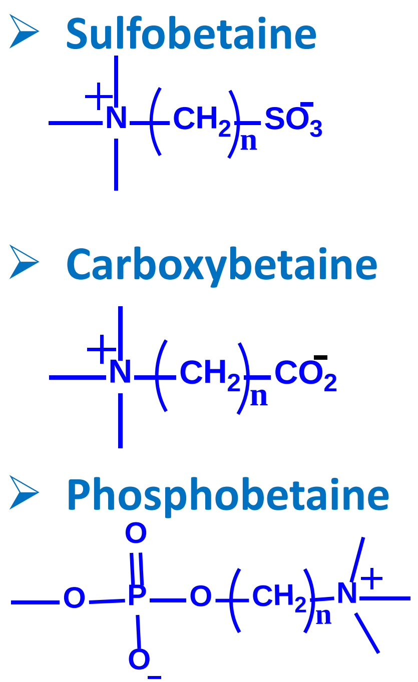
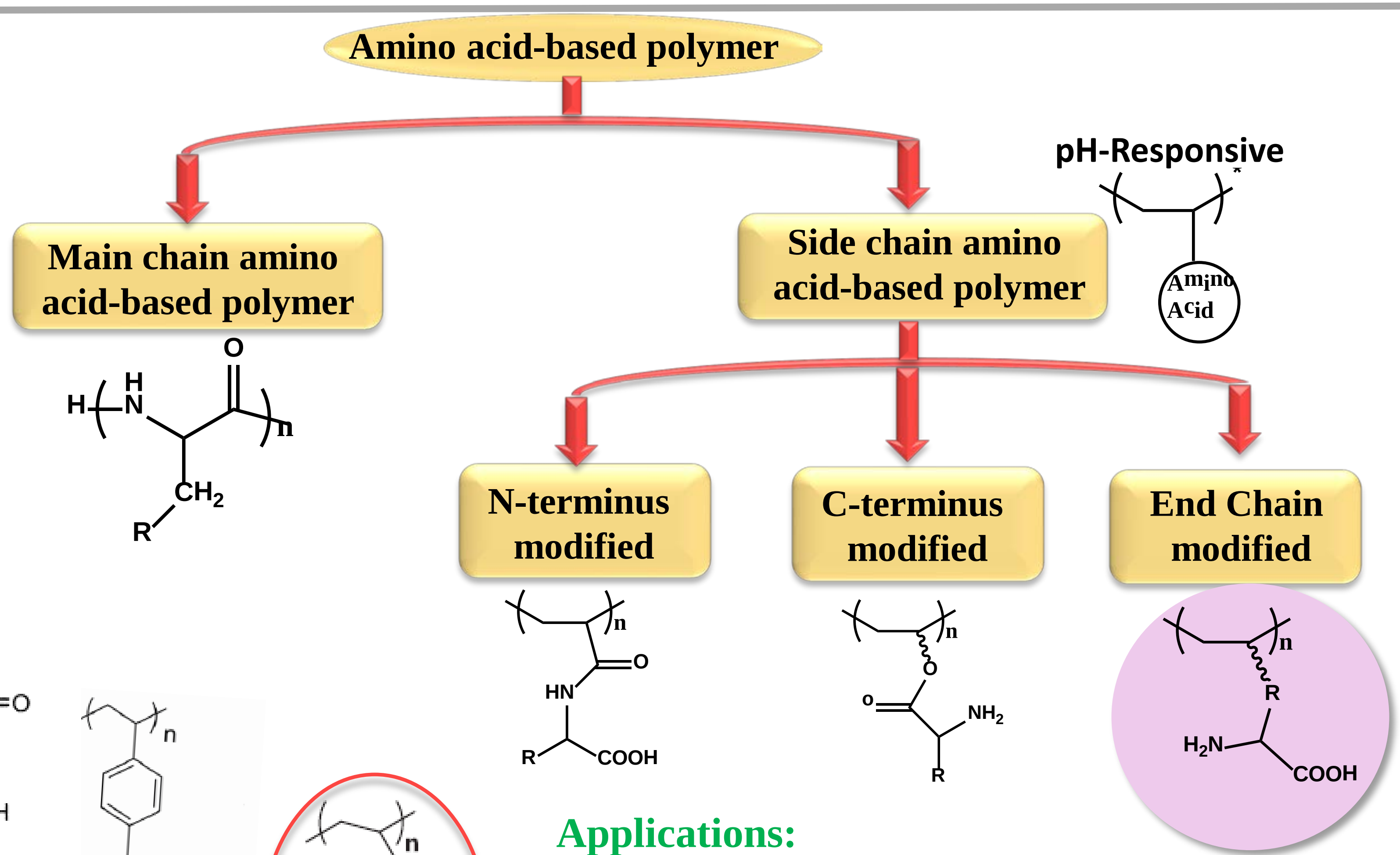
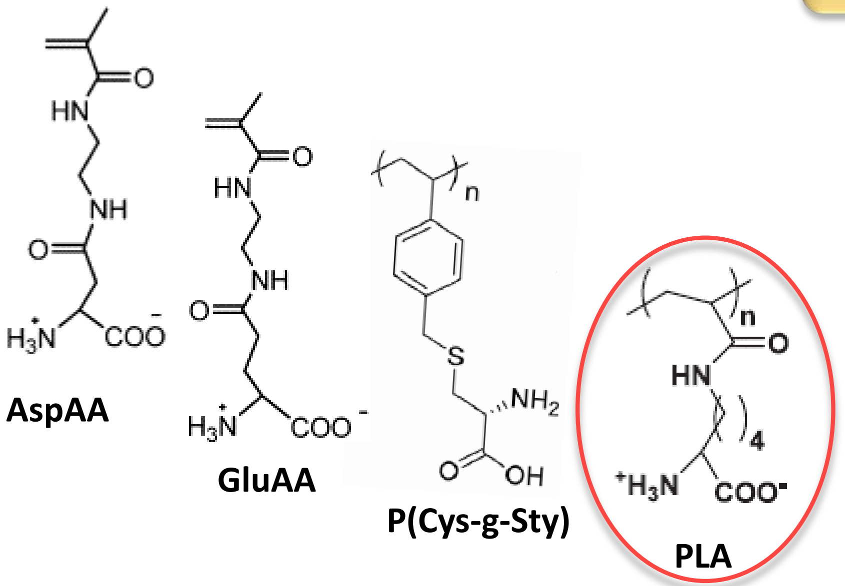
Zwitterionic Polymer





Amino Acid-based Polymers

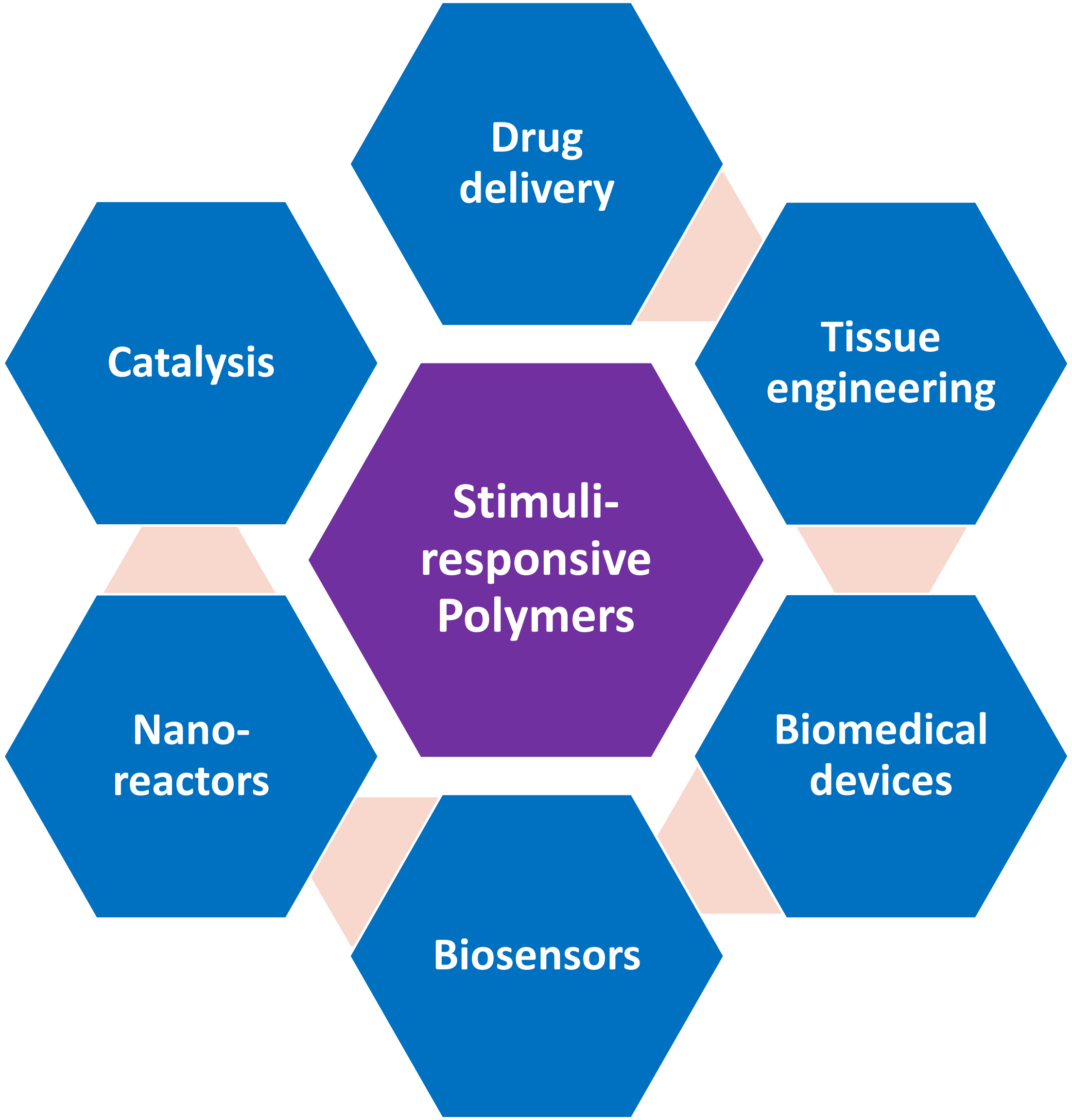




Applications:

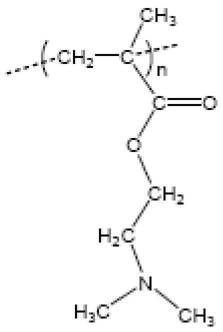
- ✓ Drug delivery
- ✓ Tissue engineering
- ✓ Biosensing
- ✓ Selective membrane for metal ion separation
- ✓ Organocatalytic application

Application of Stimuli Responsive Polymers

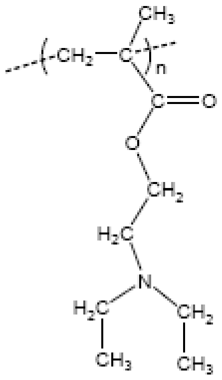


pH Responsive Polymers

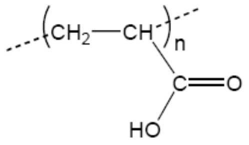
- Respond to the changes in the pH of surrounding medium
- Expand or collapse depending on the pH of the environment
- Due to presence of certain functional groups in the polymer chain
  - Acidic group (-COOH, -SO_3H)
  - Basic group (-NH_2)
- After ionization of these groups: hydrodynamic volume increase due to electrostatic repulsion
- Application in Drug delivery systems and biomimetics



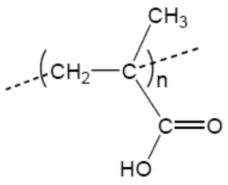
PDMAEMA



PDEAEMA



poly(acrylic acid) (PAA)



poly(methacrylic acid)

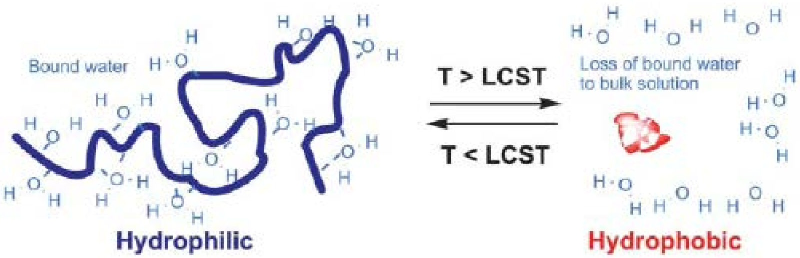
Y. Qiu, and K. Park, “Environment-sensitive hydrogels for drug delivery”, Adv. Drug Deliver Rev., Vol.53, 2001; 321-329

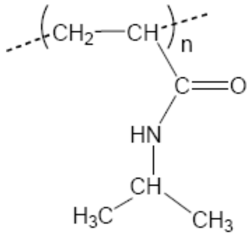
Temperature Responsive Polymers

- Respond to temperature changes
- A critical solution temperature:
  - Phase of the polymer and solution is changed
- Phase of the polymers and solution is changed
- Types:
  - TRP which shows UCST
    - One phase above certain temp
    - Phase separation below it
  - TRP which shows LCST
    - Monophasic below a specific temp
    - Biphasic above this temp
- Find applications again as biomaterials mostly

Temperature Responsive Polymers

- The first established LCST is 32°C for poly(N-isopropylacrylamide) (PNIPAAm) in water solution
- At this temp:
  - Undergoes a sharp coil-globule transition
  - Changes from hydrophilic state to hydrophobic state as temperature is increases
  - In aqueous solutions, it is soluble below LCST and less soluble above it



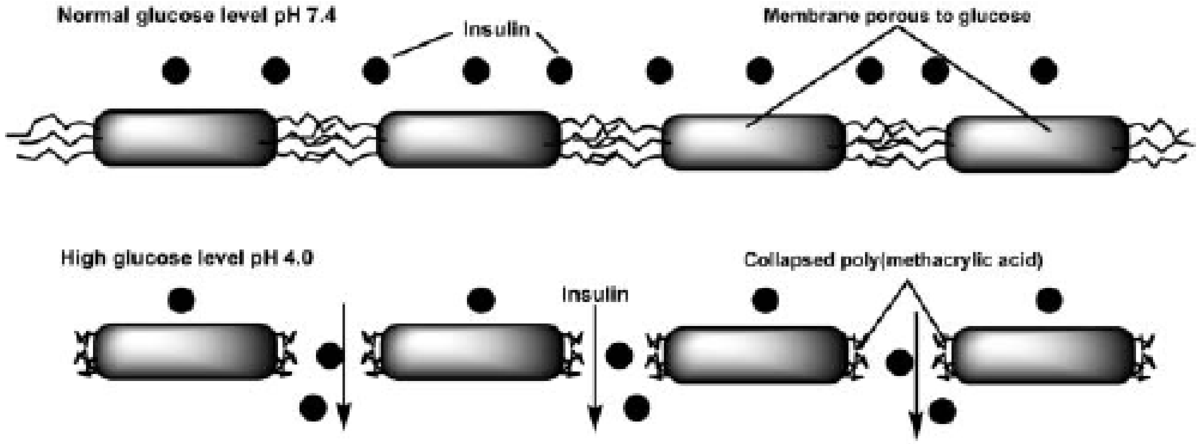


PNIPAAm

X. Zhang, R. Zhuo, Y. Yang, “Using mixed solvent to synthesize temperature sensitive poly(N-isopropylacrylamide) gel with rapid dynamic properties”, Biomaterials, Vol.26, 2002; 1313

C. H. Alarcon, S. Pennadam and C. Alexander, “Stimuli responsive polymers for biomedical applications”, Chem. Soc. Rev. Vol.34, 2005; 276

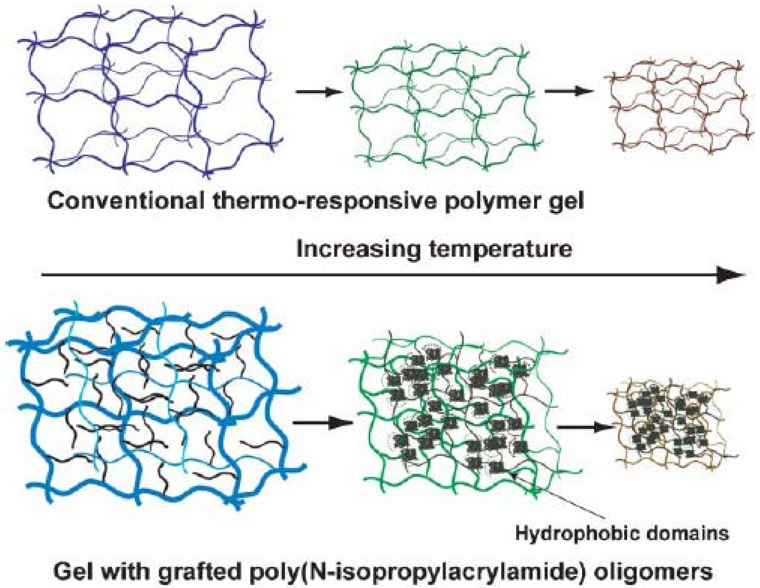
- Controlled release of insulin
- Hydrogel works as insulin containing reservoir within (P(MAA-*g*-EG)) copolymer in which glucose oxidase was immobilized.



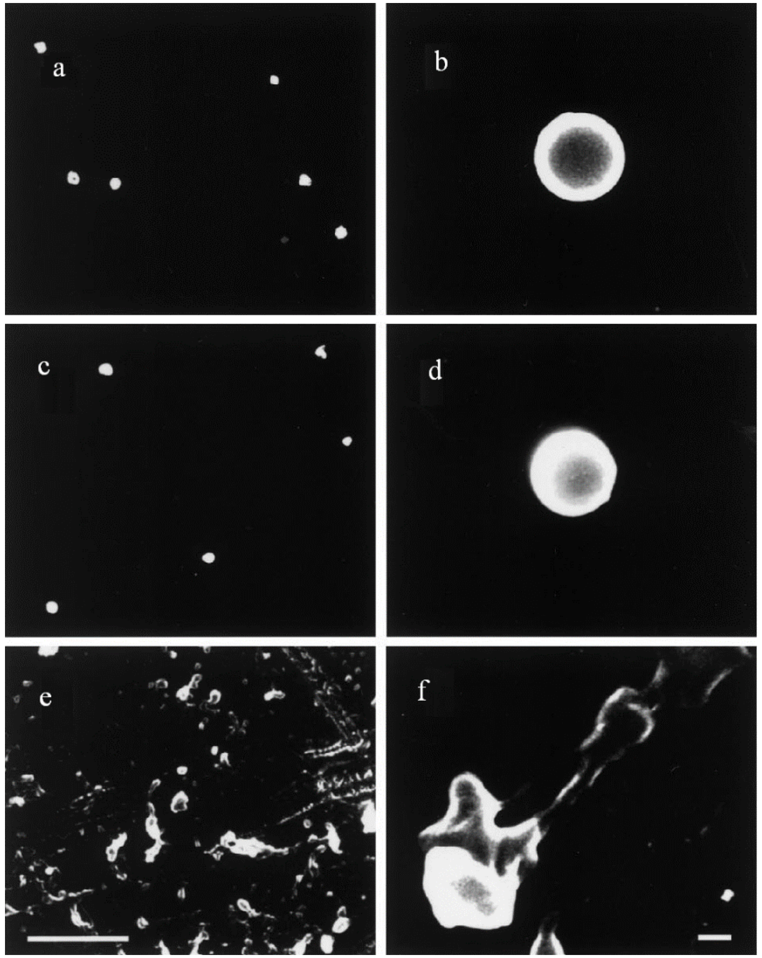
- The surface of polymer contains a series of molecular entraces for delivery of insulin

C. H. Alarcon, S. Pennadam and C. Alexander, “Stimuli responsive polymers for biomedical applications”, Chem. Soc. Rev. Vol.34, 2005; 276

- The reversible collapse and expansion behavior
- PNIPAAm incoroprated into cross-linked polymer gel above the LCST of the hompolymer
- At low temperatures, swollen PNIPAAm hydrogels kept in drug solutions and at elevated temperatures, rapid initial drug release is observed as a result of fast matrix contraction



C. H. Alarcon, S. Pennadam and C. Alexander, "Stimuli responsive polymers for biomedical applications", Chem. Soc. Rev. Vol.34, 2005; 276



- Platelets on PEG-grafted tissue culture of polystyrene (TCPS) retain a rounded shape at 37ºC
- The platelets exhibit rounded and unspread morphology at 12ºC on PNIPAAm-grafted TCPS
- By contrast, platelets on PNIPAAm-grafted TCPS dramatically change their behavior depending on temperature as platelets adhere, spread and develop characteristic pseudopodia on PNIPAAm-grafted TCPS at 37ºC
- Hydrophilic/hydrophobic switching of PNIPAAm-grafted surfaces on TCPS

Scanning electron microscopic views of blood-platelets contact with polymer grafted surfaces, 20 min after platelet initial contact with their surfaces: ungrafted TCPS surfaces at 373C (a, b), PEG-grafted TCPS surfaces at 373C (c, d), PIPAAm-grafted TCPS surfaces at 123C (e, f), and PIPAAm-grafted TCPS surfaces at 373C (g, h). Bars in left and right column represent 20 and 1 lm, respectively.

K. Uchida, K. Sakai, E. Ito, O. H. Kwon, A. Kikuchi, M. Yamato and T. Okano, “Temperature-dependent modulation of blood platelet movement and morphology on poly(*N*-isopropylacrylamide)-grafted surfaces”, Biomaterials, Vol.21, 2000, 923