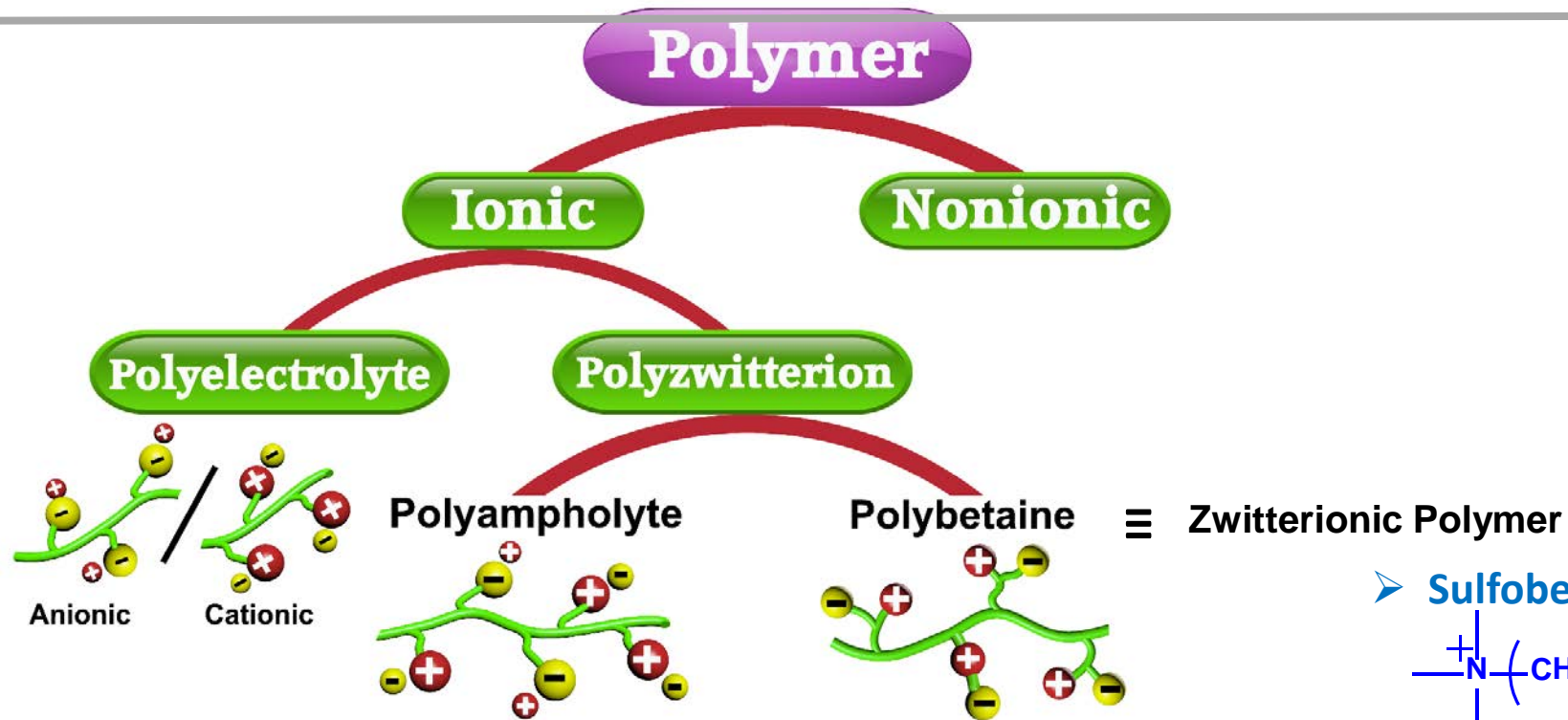
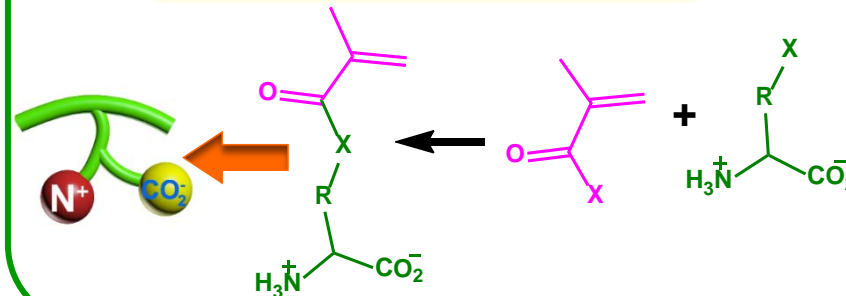


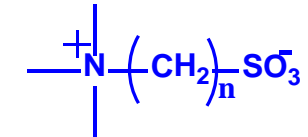
Zwitterionic Polymer



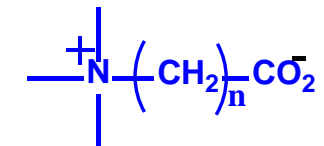
Amino Acid-Based Zwitterionic Polymer



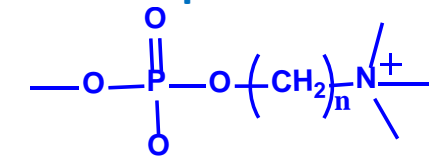
➤ Sulfobetaine



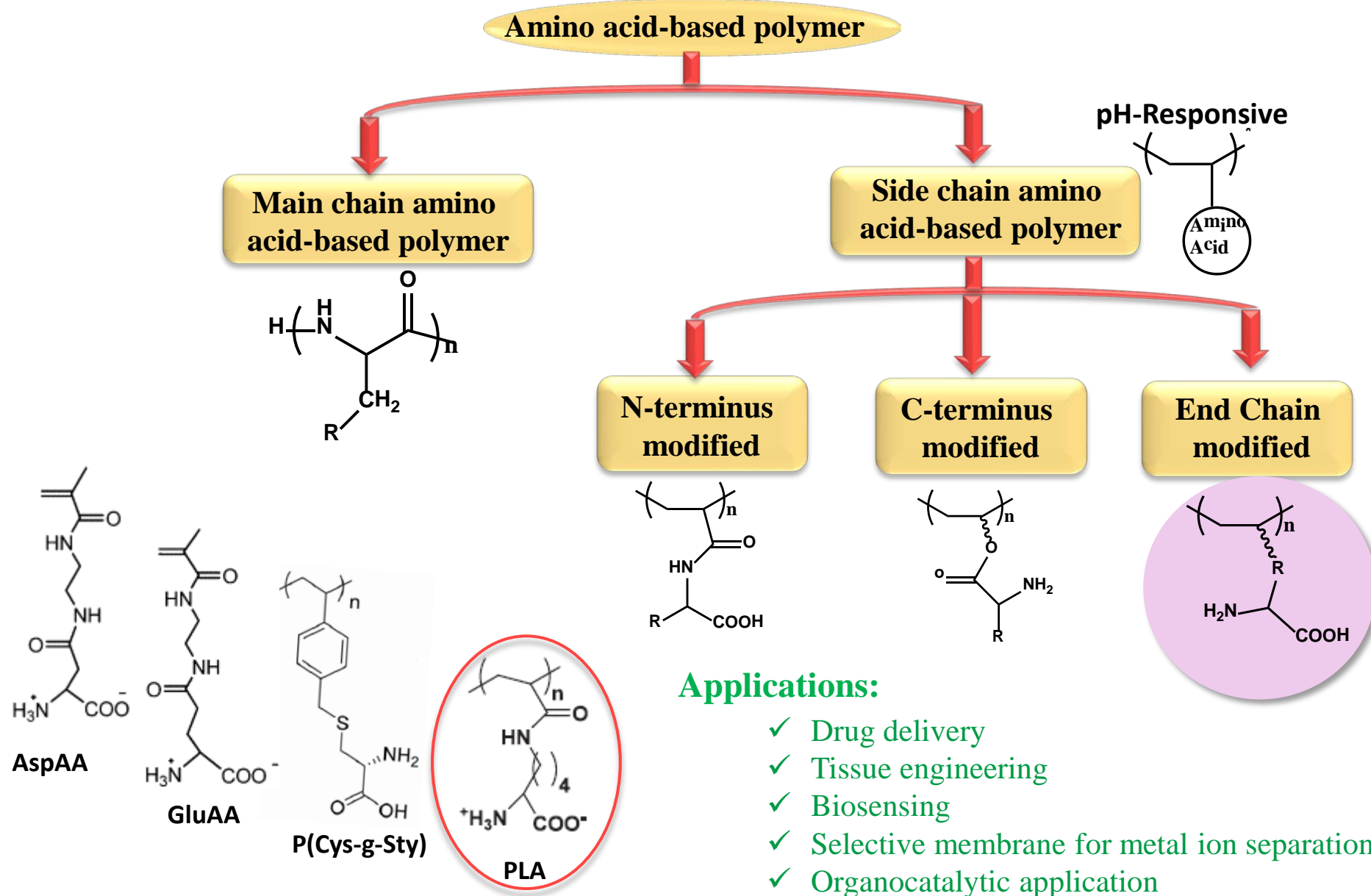
➤ Carboxybetaine



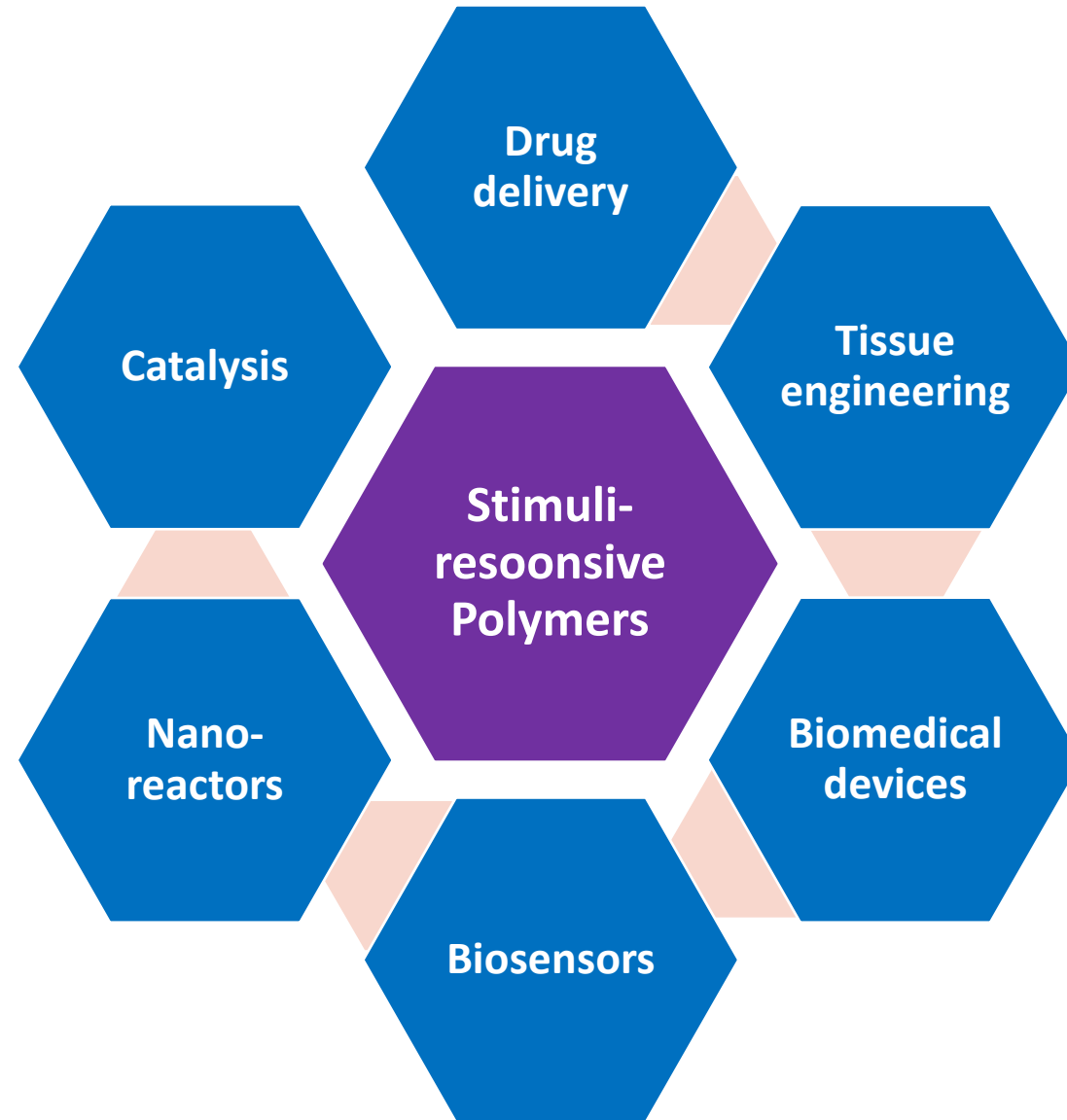
➤ Phosphobetaine



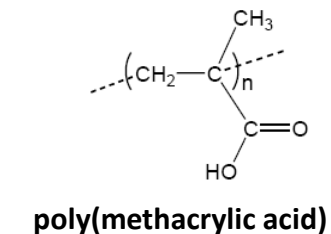
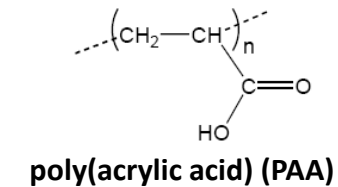
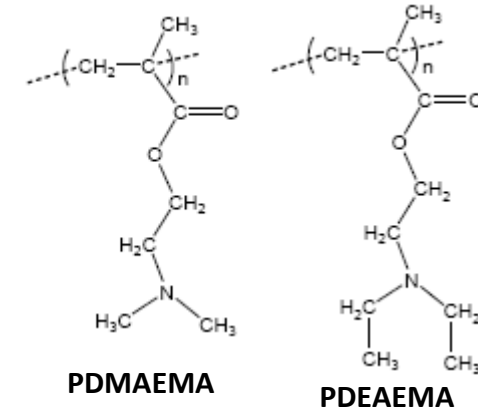
Amino Acid-based Polymers



Application of Stimuli 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 ($-\text{COOH}$, $-\text{SO}_3\text{H}$)
 - Basic group ($-\text{NH}_2$)
- After ionization of these groups: hydrodynamic volume increase due to electrostatic repulsion
- Drug delivery systems and biomimetics

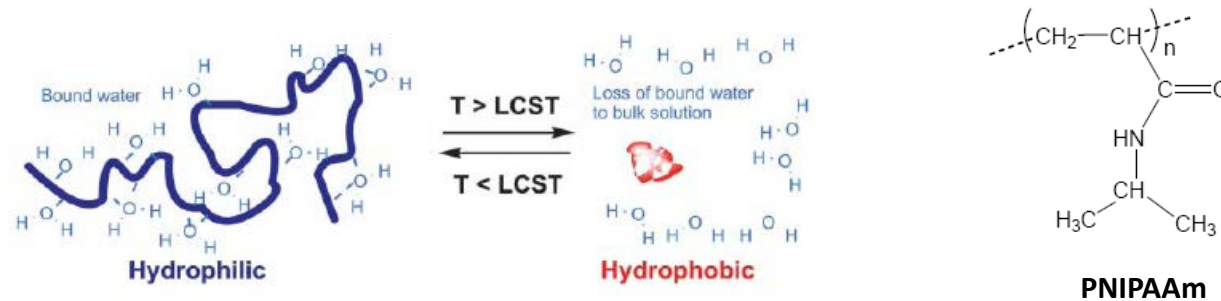


Temperature Responsive Polymers

- 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

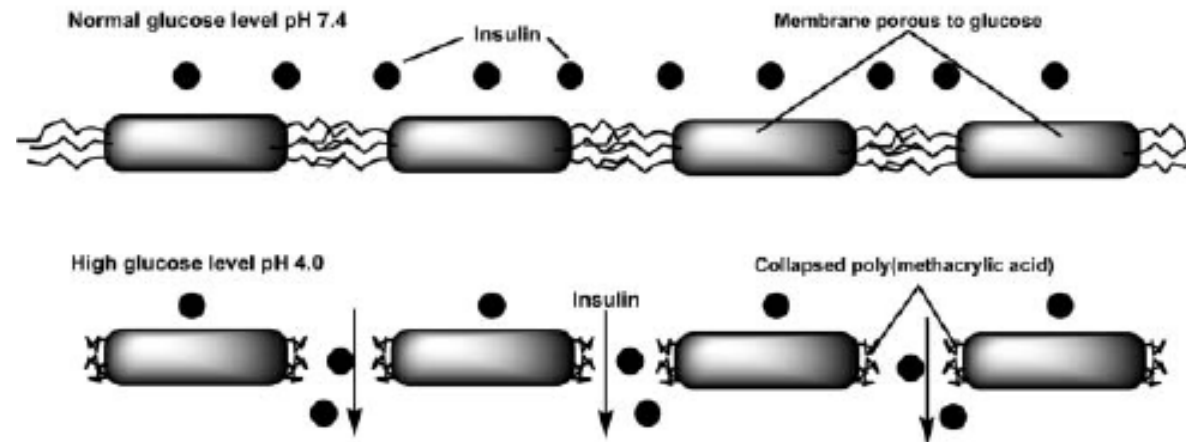
- The first established LCST is 32°C for poly(N-isopropylacrylamide) (PNIPAAm) in water solution
- At this temp:
 - Undergoes a sharp coil-globule transition
 - Changes from hydrophilic state to hydrophobic state as temperature is increases
 - In aqueous solutions, it is soluble below LCST and less soluble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



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 entrances for delivery of insulin
- When pH drops, there occurs the release of protons causing the gates to be opened for transportation of insulin.

- The reversible collapse and expansion behavior
- PNIPAAm incorporated into cross-linked polymer gel above the LCST of the homopolymer
- 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

