**Alginates**

**Source**
- A brown seaweed, *Macrocystis pyrifera*
- Alginate constitutes 18–40% of the dry weight of brown seaweeds

**Structure**
- D-mannuronic acid, L-guluronic acid
- Poly M blocks
- Poly G blocks
- Alternating M-G blocks
- M/G ratio differs depending on the source
  - As M/G ratio decreases, gel strength increases
  - As M/G ratio increases, gel strength decreases
**Macrocystis pyrifera**

- Grows in coastal waters from just north of San Diego south into northern Mexico
- Fronds grow to a length of more than 120 feet
- Fronds may grow up to 2 feet per day

**Alginate processing**

- Seaweed washed
- $\text{Na}_2\text{CO}_3$
- Na alginate
  - $\text{HCl}$
  - Precipitate as insoluble Ca alginate
  - Wash
- Na alginate (purified)
Alginate structures

- Poly-D-mannuronic acid block of alginate
- Poly -L-guluronic acid block of alginate

Alginate properties

- Low MW fractions show nearly Newtonian flow
- Non-Newtonian behavior (pseudoplasticity) increases with
  - Increasing degree of polymerization (DP)
  - Increasing concentration
  - Presence of Ca++ instead of Na+
- As temperature increases, viscosity decreases

Alginate properties

- Good stability in the pH range 5-10
  - Maximum viscosity occurs between pH 6-8
  - Degradation may occur at low pH (1-4)
  - At pH less than 3 viscosity increases, then precipitation occurs due to increased intermolecular association (loss of Coulombic repulsion at pH < pK_u)
- Alginate is fairly resistant to microorganisms
Alginate gelation
- Ca\(^{++}\) gels
- Acid gels
- Combination gels
- These are all called chemically set gels

Alginate gels
- Unlike gelatin, alginate gels are not thermoreversible and can be used in dessert gels in warm climates

Alginate-protein interaction
- Strong complexes between algin and proteins occur at pH values below the isoelectric point of the protein
- Examples
  - Alginate-whey
  - Alginate-minced fish
Alginate uses

- Food applications
  - Ice cream
  - Bakery icings
  - Bakery jelly
  - Meringues
  - Salad dressings

- Pimento stuffed olives
  - Diffusion setting

- Frozen reformed onion rings
  - Diffusion setting

- Beverages
  - Thickens and suspends juice insolubles

- Structured fruit pieces
  - Uses internal setting

Alginate labeling

- Algin
- Alginic acid
- Sodium alginate
- Potassium alginate
- Ammonium alginate
Propylene glycol alginates

- PGAs are made by reacting moist alginic acid with propylene oxide
- This esterifies 50-85% of the carboxyl groups in the polysaccharide

\[
\begin{align*}
R\text{-OH} + \text{CH}_3\text{CH(OH)}\text{CH}_2\text{O} & \rightarrow R\text{-O-CH}_2\text{CH(OH)}\text{CH}_2\text{OH} \\
\end{align*}
\]

PGA properties and uses

- PGA dispersions are thixotropic
- Less sensitive to low pH values and presence of polyvalent ions (e.g. Ca++)
- Can be used in
  - Dairy products (due to reduced Ca++ ion reactivity)
  - Foaming, emulsifying, and emulsion-stabilizing applications
    - Low calorie salad dressings

PGA labeling

- Propylene glycol alginate
- Algin derivative