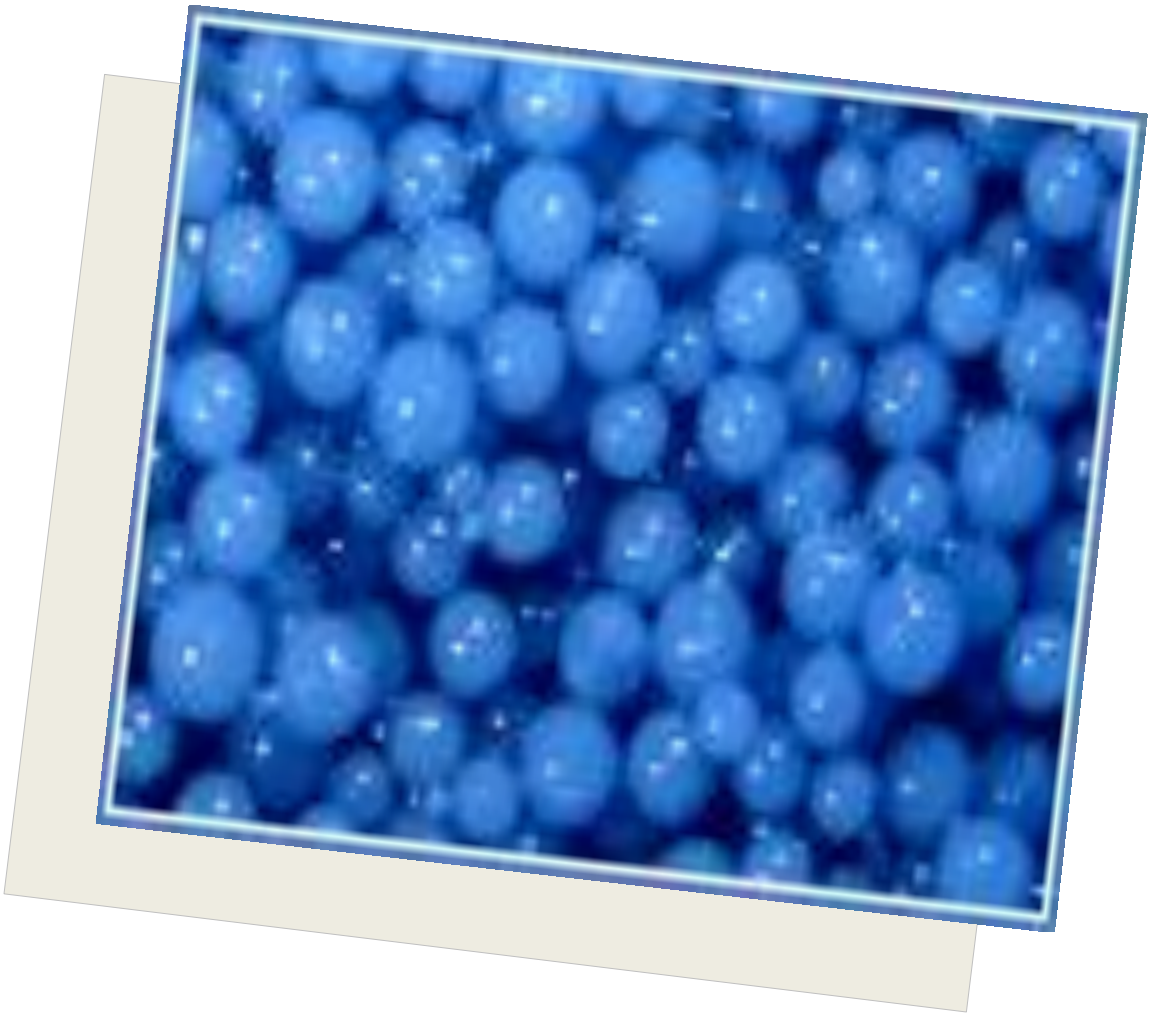
# MICROENCAPSULATION

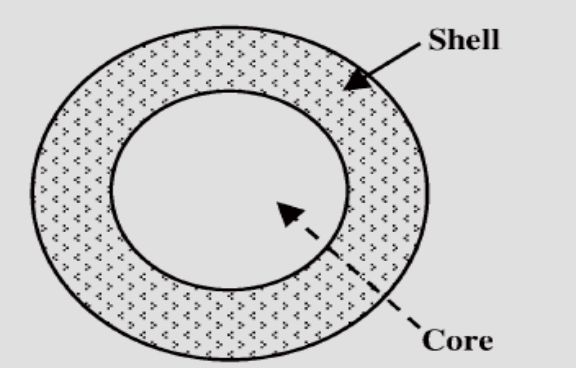
Lecture 3



# DEFNITION

- Microencapsulation is a mean of applying relatively thin coatings to small particle of solids or droplets of liquids and dispersions.

- Microencapsulation also means the process by which individual particles or droplets of solid or liquid material [the core] are surrounded or coated with a continuous film of polymeric material [the shell] to produce capsules in the micrometer to millimeter range.



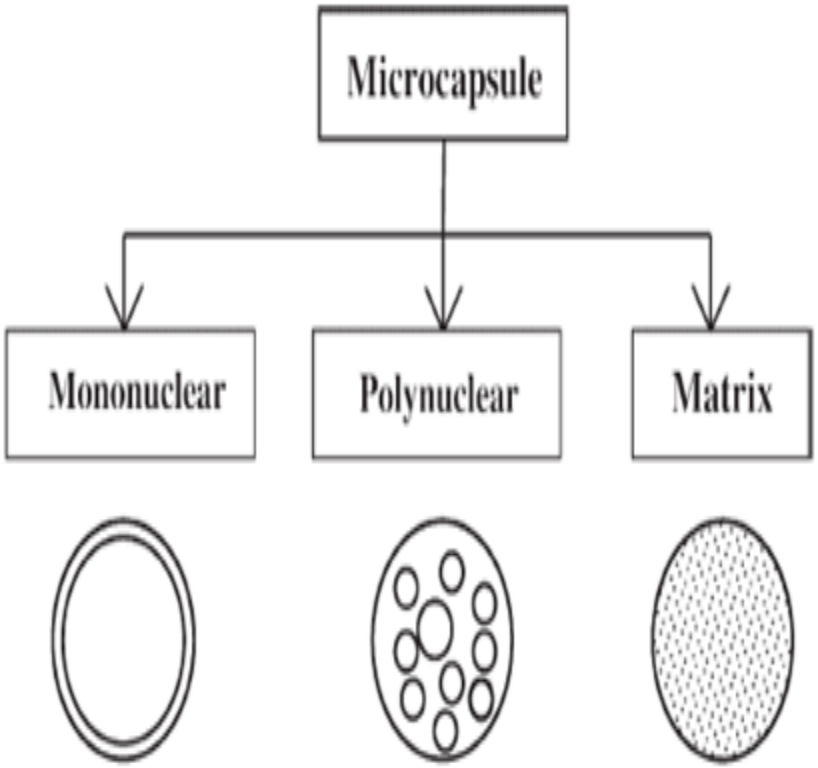

- Microencapsulation differ from macrocoating technique in the former involves coatings of particles ranging from several tenths of a micron to 5000 micron in size

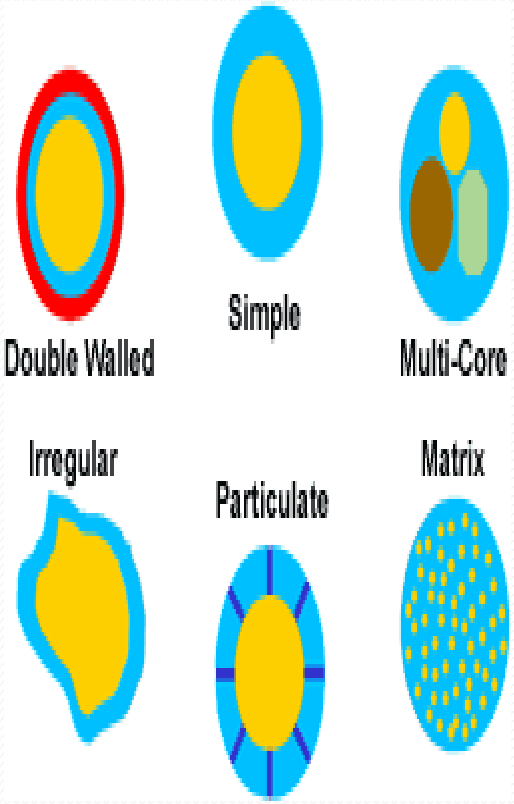
# Morphology of Microencapsulation

- Depends mainly on the core material and the deposition process of the shell.

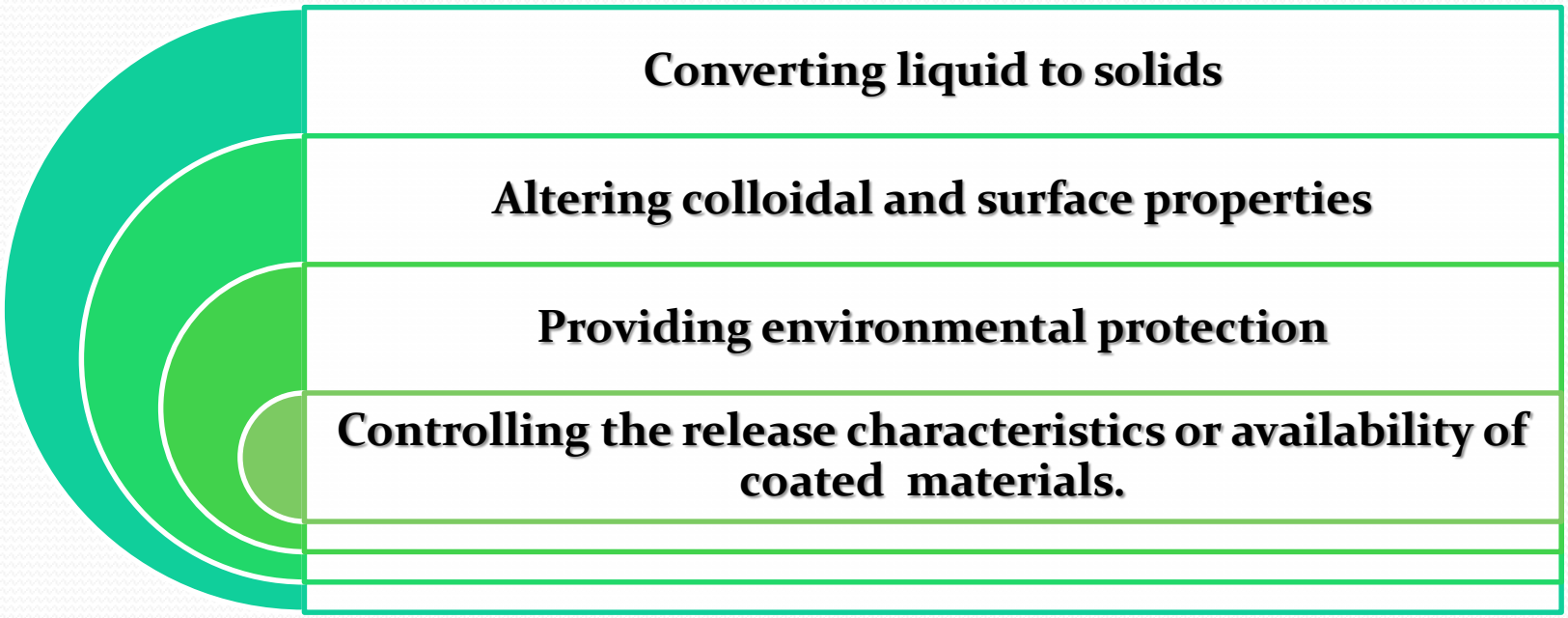
1. **Mononuclear** (core-shell) microcapsules contain the shell around the core.
2. **Polynuclear** capsules have many cores enclosed within the shell.
3. **Matrix encapsulation** in which the core material is distributed homogenously into the shell material.

In addition to these 3 basic morphologies, microcapsules can also be **mononuclear with multiple shells** or they may be **clusters of microcapsules**.


Microcapsule
Mononuclear
Polynuclear
Matrix


Double Walled
Simple
Multi-Core
Irregular
Particulate
Matrix

Microencapsulation provide the mean of :

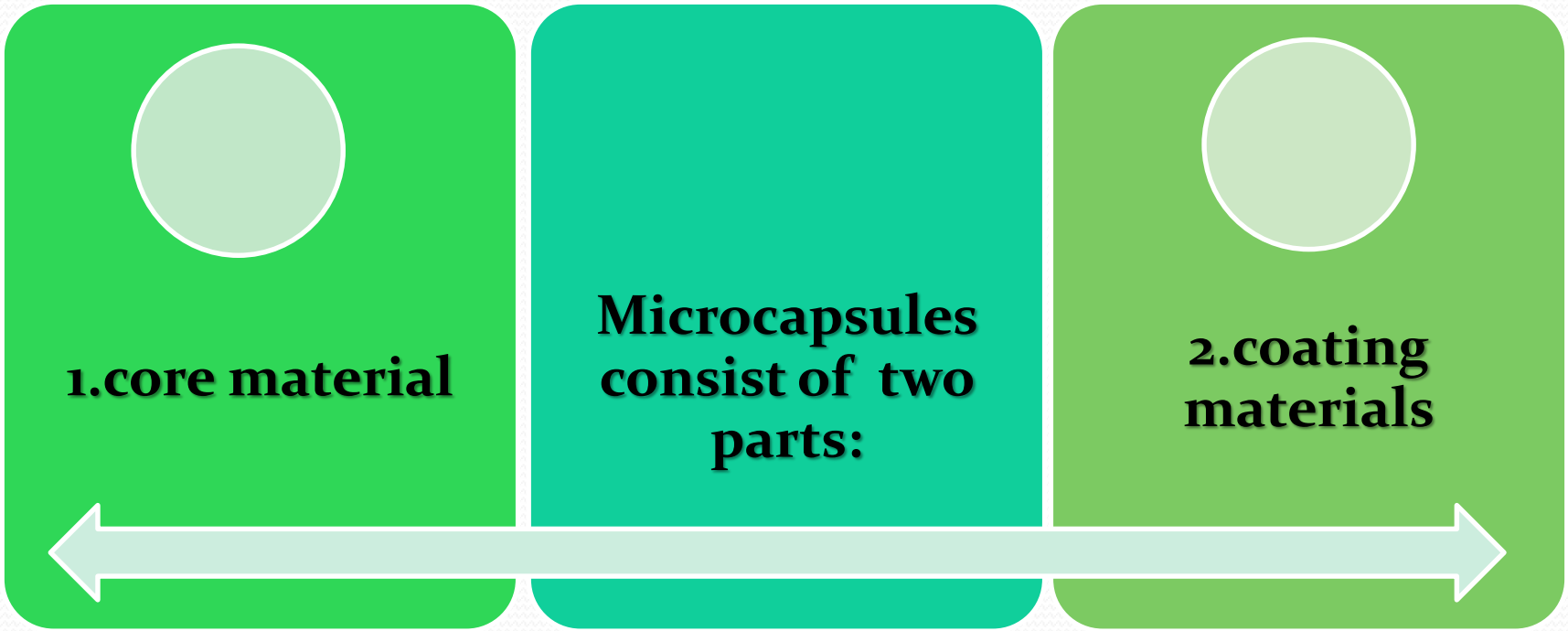



Note: Uniqueness of microencapsulation is the smallness of the coated particles and their subsequent **use in variety of dosage forms.**

# Applications

| | |
|---|---|
| 1 | Sustained release or prolonged action medications |
| 2 | Single layer tablet containing chemically incompatible ingredients |
| 3 | Pharmaceutically related areas such as hygiene, diagnostic aid, and medical equipment design. |
| 4 | Taste masked chewable tablets, powders and suspension |
| 5 | New formulation for creams, ointment, aerosols, injectables, plasters, dressings and suppositories. |
| 6 | Decrease the gastric irritation e.g.: KCl |

# Fundamental considerations



# Core material :

**It is defined as the specific material to be coated, can be liquid or solid in nature .**

The composition of core material can be varied:

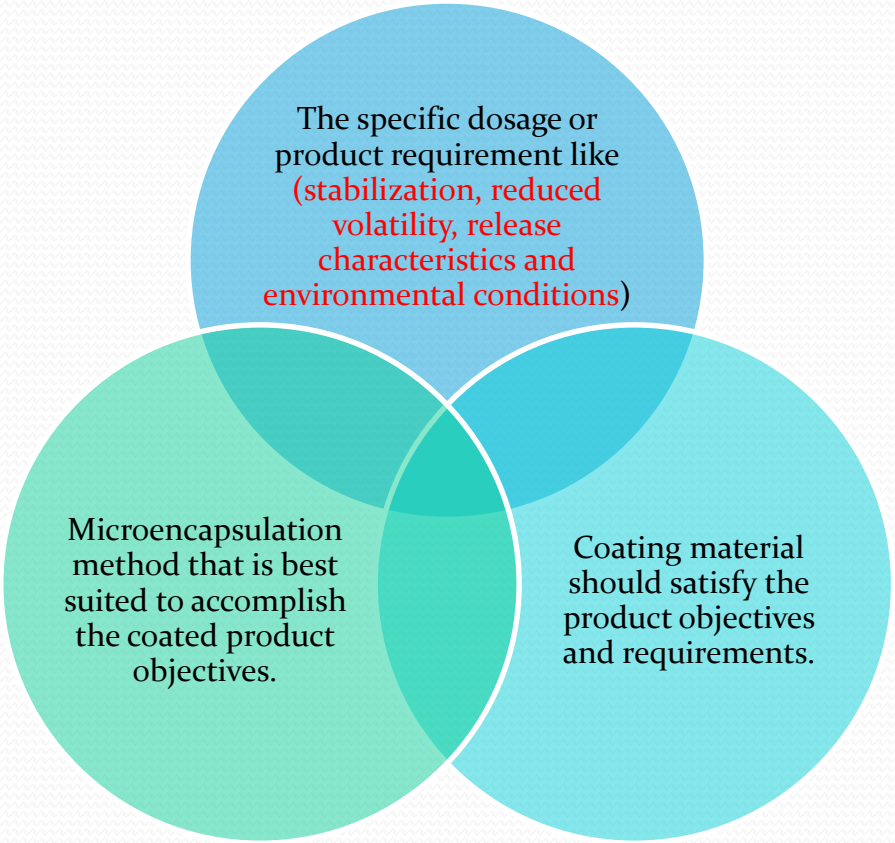
- **Liquid core:** dispersed or dissolved materials
- **Solid core:** mixture of active constituents, stabilizers, diluents, and release retardants or accelerators.

*Properties of Some Microencapsulated Core Materials*

| *Core Material* | *Characteristic Property* | *Purpose of Encapsulation* | *Final Product Form* |
|---|---|---|---|
| Acetaminophen | Slightly water-soluble solid | Taste-masking | Tablet |
| Activated charcoal | Adsorbent | Selective sorption | Dry powder |
| Aspirin | Slightly water-soluble solid | Taste-masking; sustained release; reduced gastric irritation; separation of incompatibles | Tablet or capsule |
| Islet of Langerhans | Viable cells | Sustained normalization of diabetic condition | Injectable |
| Isosorbide dinitrate | Water-soluble solid | Sustained release | Capsule |
| Liquid crystals | Liquid | Conversion of liquid to solid; stabilization | Flexible film for thermal mapping of anatomy |
| Menthol/methyl salicylate camphor mixture | Volatile solution | Reduction of volatility; sustained release | Lotion |
| Progesterone | Slightly water-soluble solid | Sustained release | Varied |
| Potassium chloride | Highly water-soluble solid | Reduced gastric irritation | Capsule |
| Urease | Water-soluble enzyme | Permselectivity of enzyme, substrate, and reaction products | Dispersion |
| Vitamin A palmitate | Nonvolatile liquid | Stabilization to oxidation | Dry powder |

# Coating materials:

The selection of a specific coating material from a list of candidate materials depends on the following:



# Classification of coating material

**Water soluble resin**

Gelatin
Gum Arabic
PVP
CMC
MC
Hydroxy ethyl - cellulose

**Water insoluble resin**

Ethyl cellulose
Polyethylene
Polyamide (nylon)
Polymethacrylate
Cellulose nitrate - silicones

**Waxes and Lipids**

Paraffin
Carnauba
Beewax
Stearic acid
Stearyl alcohol
Glyceryl stearates

**Enteric resin**

Shellac
Cellulose acetate-phthalate
Zein

*Representative Coating Materials and Applicable Microencapsulation Process*

| *Coating Materials* | *Processes* | | | | | |
|---|---|---|---|---|---|---|
| | *Multiorifice—Centrifugal* | *Phase Separation—Coacervation* | *Pan Coating* | *Spray Drying and Congealing* | *Air Suspension* | *Solvent Evaporation* |
| Water-soluble resins | | | | | | |
| Gelatin | X | X | X | X | X | X |
| Gum arabic | | X | X | X | X | X |
| Starch | | X | X | X | X | |
| Polyvinylpyrrolidone | X | X | X | X | X | |
| Carboxymethylcellulose | | X | X | X | X | |
| Hydroxyethylcellulose | | X | X | X | X | X |
| Methylcellulose | | X | X | X | X | |
| Arabinogalactan | | X | X | X | X | |
| Polyvinyl alcohol | X | X | X | X | X | X |
| Polyacrylic acid | | X | X | X | X | X |
| Water-insoluble resins | | | | | | |
| Ethylcellulose | | X | X | X | X | X |
| Polyethylene | X | | | | X | X |
| Polymethacrylate | | X | X | X | X | X |
| Polyamide (Nylon) | | | | | X | X |
| Poly [Ethylene-Vinyl acetate] | X | X | X | X | | X |
| Cellulose nitrate | X | X | X | X | | X |
| Silicones | | | X | X | | |
| Poly (lactide-co-glycolide) | | X | X | | | X |
| Waxes and lipids | | | | | | |
| Paraffin | X | X | X | X | X | |
| Carnauba | | | X | X | X | |
| Spermaceti | | X | X | X | X | |
| Beeswax | | | X | X | X | |
| Stearic acid | | | X | X | | |
| Stearyl alcohol | | | X | X | X | |
| Glyceryl stearates | | | X | X | X | |
| *Enteric resins* | | | | | | |
| Shellac | | X | X | X | X | |
| Cellulose acetate phthalate | | X | X | X | X | X |
| Zein | | X | | | X | |

# The coating material should be:

- Capable of forming a film that is cohesive with the core material
- Be chemically compatible and non reactive with the core
- Provide the desired coating properties, such as strength, flexibility, impermeability, optical properties and stability.

# Selected stability, release and other properties:

- **The three important areas of microencapsulation application are:**

✓ **Stabilization of core materials:** stabilization of vitamin A palmitate oil against oxidation and to retard degredative loses.

✓ **The control of the release or availability of core materials:** e.g. (sustained release of small aspirin crystals by ethylcellulose coating and release of aspirin is achieved by diffusion since the polymer is inert and pH-insensitive coating)

✓ **Separation of chemically reactive ingredients within a tablet or powder mixture :** An example of stability enhancement accomplished by microencapsulation of incompatible admixed constituents (aspirin and chlorpheniramine maleate).

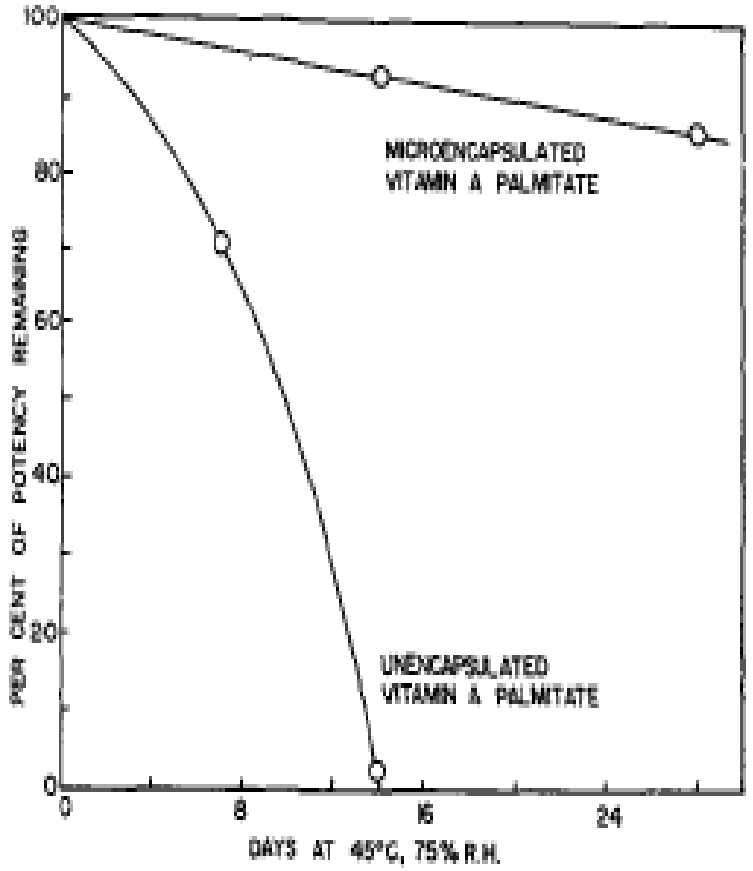



**FIG. 13-32.** *Stability of a microencapsulated vitamin A palmitate corn oil prepared by phase-separation/coacervation technique, compared with an unencapsulated control. (From Bakan.[3])*

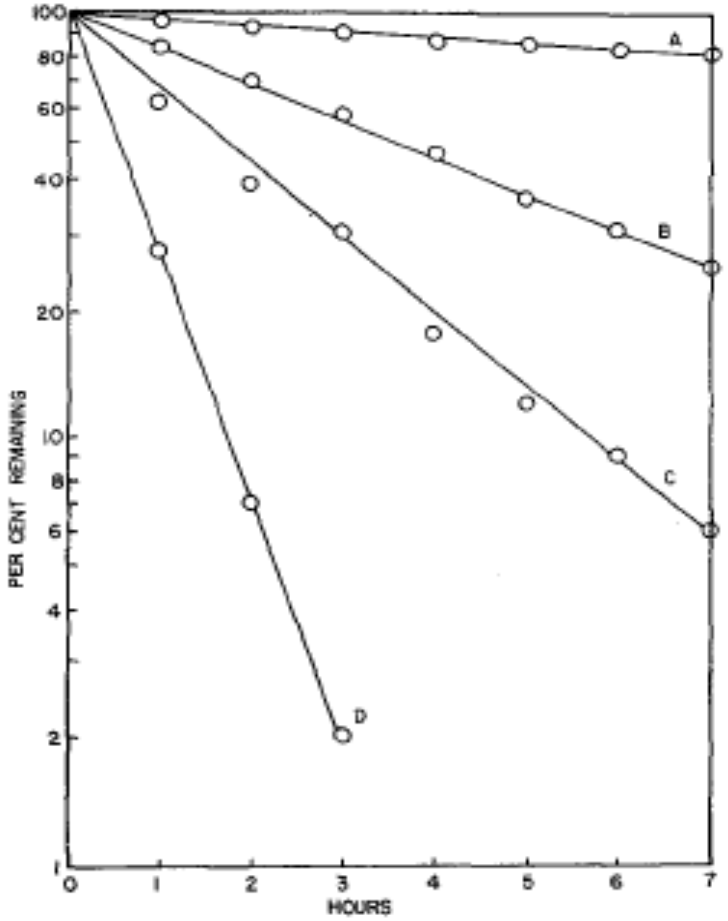



**Fig. 13-35.** *In vitro release patterns of crystalline aspirin coated with various amounts of ethylcellulose using phase-separation/coacervation techniques. A, 52% coating; B, 29% coating; C, 16% coating; D, 13% coating. (From The NCR Corporation.[4])*

# Equipment and processing

- **Processing:** Microencapsulation of bulk materials is either as a dry powder or as a dispersed form and processed to final product form.

- **Equipment:** Microencapsulation done by either simple laboratory equipments or complex machines specially designed for e.g. (**V-blenders, Tab. Machines, granulators, homogenizers, kneaders, H.G.C. filling machines or coating equipments**).

⇩

**To avoid rupture, attrition, dissolution**


THANK
YOU