

Introduction to Packaging

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Key concepts, purposes, types, and trends

1. What Is Packaging?

Aspect	Description
Definition	A system of materials and processes used to contain, protect, handle, deliver, and present a product.
Core Functions	1. Protection – shields goods from damage, contamination, and spoilage.
	2. Containment – holds product in a defined shape/volume.
	3. Preservation – extends shelf-life (e.g., barrier properties, aseptic sealing).
	4. Convenience – eases transport, storage, opening, and use.
	5. Communication – conveys brand identity, legal information, usage instructions.
	6. Sustainability – minimizes environmental impact through material choice and design.

2. Main Components of a Packaging System

Component	Typical Materials	Primary Role
Primary packaging	Glass, PET, HDPE, aluminum, paperboard, flexible films	Direct contact with product; protects and contains.
Secondary packaging	Corrugated cardboard, shrink wrap, trays	Groups multiple primary units; facilitates handling and display.
Tertiary (or transport) packaging	Pallets, crates, bulk containers, stretch film	Supports bulk movement, warehousing, and logistics.

3. Classification by Material

Category	Examples	Advantages	Limitations
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Paper & paperboard	Cartons, folding boxes	Lightweight, printable, recyclable.	Poor moisture barrier; limited strength.
Plastics	PET, HDPE, PP, PVC, biodegradable polymers	Versatile, strong, good barrier properties.	Environmental concerns; may need recycling infrastructure.
Glass	Bottles, jars	Excellent barrier, inert, reusable.	Heavy, breakable, high energy for production.
Metal	Aluminum cans, steel drums	Superior barrier, durable, recyclable.	Cost, potential for corrosion, limited shape flexibility.
Composite / Multilayer	Tetra Pak, flexible laminates	Tailored barrier combinations.	Difficult to recycle; often require specialized streams.

4. Design Considerations

1. Product Requirements

- Physical (size, shape, weight)
- Chemical (reactivity, pH, volatility)
- Biological (sterility, shelf?life)

2. Regulatory & Safety

- Food contact approvals (FDA, EFSA, etc.)
- Hazard communication (GHS labels)
- Transportation regulations (UN/DOT codes)

3. Logistics

- Stackability, pallet configuration, transport mode constraints.

4. Consumer Experience

- Ease of opening, resealability, portion control, ergonomics.

5. Branding & Marketing

- Visual identity, tactile feel, storytelling elements.

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6. Sustainability

- Material selection (recyclable, biodegradable, renewable).
 - Design for minimal material use (lightweighting).
 - End-of-life strategy (reuse, refill, circular loops).
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5. Packaging Development Process

1. **Brief & Market Research** – Define product, target market, regulatory landscape.
2. **Concept Generation** – Sketches, material scouting, preliminary cost modeling.
3. **Prototype Creation** – 3D printing, mockups, pilot runs.
4. **Testing & Validation**
 - Mechanical (