PREMIUM EDITION

B.PHARMA · IST YEAR · BP102T · 2026-27

Solid Dosage Forms

Powders · Tablets · Capsules

UNIT-III · BP102T · GENERAL PHARMACY · PCI SYLLABUS

Powders — classification, advantages/disadvantages, preparation, worked examples.
Tablets — types, excipients, granulation, compression, pills vs tablets.
Capsules — hard/soft gelatin, HPMC veg, sizes, excipients, storage.

Powders | Tablets | Capsules | Infographics | Exam Points | Self-Check

Inside Unit III

3.1 Powders — classification (official)
3.2 Powders — advantages, disadvantages, preparation
3.3 Powders — worked examples
3.4 Tablets — types, excipients, granulation
3.5 Capsules — hard/soft, HPMC, sizes, storage

Levels: Remember to Apply

Pills and Python · PCI-aligned · Authentic pharma facts only

§ OVERVIEW WHAT YOU WILL LEARN

Roadmap of Unit I

I.1
History of Pharmacy in India

Education · Industry · Organisations · Milestones

I.2
Scope of the Profession

Community · Hospital · Clinical · Industrial R&D

I.3
Pharmacopoeias

IP · BP · USP · BPC · International · NFI

I.4
Prescription

Structure · Handling · Latin terminology

Learning flow

HARMACOPOEIAS

PRESCRIPTIONS

PHARMACIST ROLES

PILLS AND PYTHON
PHARMACY • DATA • AI • HEALTHCARE

§ DEFINITION PHARMACY

Pharmacy

Pharmacy is the **science and art** of preparing and dispensing medicines, and ensuring their **safe, effective** use. The word comes from Greek **Pharmakon** meaning drug or remedy.

1.1.1 History of Pharmacy in India

Ancient roots (3000 BCE onwards)

- **Charaka Samhita** and **Sushruta Samhita** describe 600+ medicinal plants and surgical pharmacy.
- **Vagbhata's Ashtanga Hridaya** codified dosage forms — asavas, arishtas, churna, vati, ghrita.
- **Siddha & Unani** traditions developed metallic (Bhasma) and mineral preparations.

Modern pharmacy era in India

- **1901 · Bengal Drugs Rules** first regulatory step.
- **1937 · first Drugs Act committee** by Col. R.N. Chopra.
- **1940 · Drugs & Cosmetics Act** regulates import, manufacture and sale.
- **1948 · Pharmacy Act** established PCI to standardise education.
- **1955 · first Indian Pharmacopoeia** published.
- **1988 · National Pharmaceutical Pricing Authority (NPPA)** formed.

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§ TIMELINE INDIA PHARMACY MILESTONES

From 1940 to 2024 — key regulatory and educational events

1940 — Drugs & Cosmetics Act enacted — regulates drugs in India

1948 — Pharmacy Act — sets up Pharmacy Council of India (PCI)

1955 — First Indian Pharmacopoeia (IP) published

1970 — Patent Act 1970 — process patents only, fuels generic industry

1988 — NPPA formed — controls drug prices (DPCO 1995)

2008 — Pharma Vision 2020 — India as a global pharmacy hub

2015 — Pharmacy Practice Regulations 2015 — defines pharmacist duties

2017 — Medical Devices Rules 2017 — separate rules for devices

2020 — New Education Policy (NEP) — multidisciplinary pharmacy education

§ DEFINITION PHARMACIST

Pharmacist

Pharmacist is a registered healthcare professional trained in *manufacturing, dispensing* and *rational use of drugs* who ensures patient safety, medicines quality and public health.

1.2.1 Scope across four pillars

- Dispensing OTC & prescription drugs
- Patient counselling on dosage, ADRs, storage
- Maintaining prescription records
- Health screening (BP, sugar, BMI)
- Schedule H, H1, X compliance

- In-patient & out-patient dispensing
- Drug information centre (DIC)
- Clinical rounds with physicians
- Adverse Drug Reaction (ADR) reporting
- Inventory & narcotic control

- Therapeutic Drug Monitoring (TDM)
- Pharmacovigilance — PvPI reporting
- Dose adjustment in renal/hepatic failure
- Drug interaction screening
- Patient medication adherence

- Formulation development (F&D)
- Analytical method development (AMD)
- Regulatory affairs (DCGI, USFDA submissions)
- Clinical trials & bioequivalence
- Production, QA, QC

§ RARE-INSIGHT PHARMACIST DOMAINS TODAY

1.2.2 Six emerging domains — where today's pharmacists work

DCGI, USFDA, EMA submissions	Teaching + research in PCI-approved institutio	PvPI, ADR monitoring under IPC
Clinical study reports, CTD modules	AI-drug discovery, telepharmacy	NACO, NVBDCP, immunisation drives

Key skills every B.Pharm student must build

Skill matrix — the 5Cs

- **Communication** — patient counselling, prescriber dialogue.
- **Calculation** — dose, dilution, reconstitution (Unit II).
- **Compounding** — hands-on dispensing & formulation.
- **Critical-thinking** — ADR, drug-interaction analysis.
- **Caring / Ethics** — patient-first, Schedule X compliance.

§ DEFINITION PHARMACOPOEIA

Pharmacopoeia

An ***officially recognised book of standards*** published by a government or authoritative body that lists ***identity, purity, potency and quality*** criteria for drugs and dosage forms.

1.3.1 Major pharmacopoeias used in India

Code	Full Name	Publisher	First	Use
IP	Indian Pharmacopoeia	IPC, Ghaziabad	1955 onwards	Mandatory in India
BP	British Pharmacopoeia	BPC, London	1864 onwards	Commonwealth & IP reference
USP	United States Pharmacopeia	USP Convention, Rockville	1820 onwards	US regulatory standard
Ph. Eur.	European Pharmacopoeia	EDQM, Strasbourg	1964 onwards	All EU states
Intl. Ph.	International Pharmacopoeia	WHO, Geneva	1951 onwards	Global reference
BPC	British Pharmaceutical Codex	Pharm. Society, UK	1907–1979	Discontinued legacy
NFI	National Formulary of India	IPC, Ghaziabad	1960 onwards	Formulation recipes

PILLS AND PYTHON
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§ STRUCTURE INDIAN PHARMACOPOEIA (IP)

1.3.2 What does an IP volume contain?

General Chapters

- **Monographs** — detailed standards for each drug/substance.
- **General notices** — definitions, scope, abbreviation, temperature, storage.
- **Methods of analysis** — titrimetric, gravimetric, spectroscopic, chromatographic.
- **Reagents & indicators** — chemicals required for tests.
- **Containers & storage** — well-closed, tightly-closed, hermetically-sealed.
- **Appendices** — biological tests, microbiological assays, pyrogen tests.

Currently in force

- **IP 2022** is the current edition (in 4 volumes).
- Adds **monographs on 312 new drugs** and revises many existing ones.
- Aligned with **ICH Q3D** (elemental impurities) and modern harmonised methods.

Exam Tip

Always quote 'IP 2022' (not just 'IP') for current edition. 'Ph. Int.' = WHO International Pharmacopoeia.

§ MODEL IP MONOGRAPH WALK-THROUGH

1.3.3 Example — Paracetamol IP

Title
PARACETAMOL

Synonyms
Acetaminophen; 4-acetamidophenol

Chemical name
N-(4-hydroxyphenyl)acetamide

Mol. formula
CHNO ; Mol. wt. 151.16

Category
Analgesic & antipyretic

Description
White, crystalline powder; odourless; taste slightly bitter

Solubility
Sparingly soluble in water; freely soluble in ethanol & methar

Identification
By IR spectrum (matches reference); by melting range 168–172 °C

Tests
Related substances (HPLC ≤ 0.1%); 4-aminophenol ≤ 50 ppm;

Assay
99.0 – 101.0 % (by titration with ceric ammonium sulphate)

Storage
Store protected from light & moisture

Insider Tip
An IP monograph gives you EVIDENCE the drug is the right drug — the standard against which any batch is judged.

§ DEFINITION PRESCRIPTION

Prescription

A *written, signed and dated order* by a *registered medical practitioner* to a *registered pharmacist* for the supply of a medicine to a particular patient.

1.4.1 Parts of a prescription

Superscription
symbol, name, age, sex, weight, address of patient

Inscription
Name of drug(s), dose, frequency — the body of Rx

Subscription
Instructions to the pharmacist — 'mix', 'send 10 tabs'

Signature (Signa)
Directions to the patient — 'after food, twice a day'

Physician's signature
Name, qualification, registration no., address, date

Mnemonic

= Superscription · Inscription = the body · Subscription = to the pharmacist · Signa = to the patient · Signature closes it.

§ REFERENCE LATIN ABBREVIATIONS ON Rx

1.4.2 Most-used Latin terms in prescriptions

Abbrev.	Latin meaning	English
a.c.	ante cibum	Before meals
p.c.	post cibum	After meals
b.i.d.	bis in die	Twice a day
t.i.d.	ter in die	Three times a day
q.i.d.	quater in die	Four times a day
h.s.	hora somni	At bedtime
p.r.n.	pro re nata	When required (as needed)
s.o.s.	si opus sit	If necessary (single dose)
stat.	statim	Immediately (single dose)
i.m.	intramuscular	Into the muscle
i.v.	intravenous	Into the vein
s.c.	subcutaneous	Under the skin
o.d.	oculus dexter	Right eye
o.s.	oculus sinister	Left eye
o.u.	oculus uterque	Both eyes

Exam Tip

If the question gives ONLY English — reproduce both Latin and English. You get 1 mark for each.

§ PROCEDURE HANDLING A PRESCRIPTION

1.4.3 The 6-step flow at the pharmacy counter

1. **Receive & read**
   Check name, date, doctor's signature & registration number
2. **Verify authenticity**
   Cross-check doctor's MCI/NMC registration; verify no Schedule X misuse
3. **Interpret**
   Decode all Latin terms, doses, frequencies and routes
4. **Compound / select**
   Pick finished product or compound the formulation
5. **Label**
   Affix dispensing label with patient, dose, route, frequency, duration
6. **Counsel & file**
   Counsel patient; retain prescription copy for 2 years (Schedule H/X — 3 years)

Compliance
Schedule X drugs (e.g. narcotics) require a SEPARATE prescription on a SEPARATE pad. Always keep these for 3 years.

§ REFERENCE PHARMA ORGANISATIONS

Statutory & professional bodies you must know

Acronym	Full Form	Role
PCI	Pharmacy Council of India	1952 (under Pharmacy Act 1948) — controls pharmacy education & registers pharmacists
IPC	Indian Pharmacopoeia Commission	2005, Ghaziabad — publishes IP & NFI
CDSCO	Central Drugs Standard Control Organisation	DGHS, MoHFW — apex drug regulator; DCGI heads it
NPPA	National Pharmaceutical Pricing Authority	1997 — fixes & controls drug prices (DPCO)
ICMR	Indian Council of Medical Research	1911 (as IRFA) — national body for medical & pharma research
IPA	Indian Pharmaceutical Association	1939 — professional body of pharmacists
FIP	International Pharmaceutical Federation	1912, The Hague — global pharmacy body
WHO	World Health Organization	1948, Geneva — publishes International Pharmacopoeia & GMP

RARE INSIGHT

PCI is 'education-only' — CDSCO is 'regulatory'. Don't confuse them; questions test this distinction.

§ EXAM HIGH-YIELD POINTS

Top 10 points to carry into the hall

1. **Pharmacy**
   Art and science of preparing & dispensing medicines — word from Greek Pharmakon
2. **Pharmacy Act**
   Enacted 1948 — sets up PCI to regulate pharmacy education & registration
3. **Drugs & Cosmetics Act**
   1940 — regulates import, manufacture and sale of drugs in India
4. **PCI**
   Pharmacy Council of India — apex body for pharmacy education, NOT drug regulation
5. **IP**
   Indian Pharmacopoeia — mandatory in India; current edition IP 2022 (4 volumes)
6. **BP**
   British Pharmacopoeia; USP — United States Pharmacopeia; Ph. Int. — WHO Intl.
7. **Prescription parts**
   Superscription · Inscription · Subscription · Signa · Physician signature
8. **Latin**
   a.c.=before meals · p.c.=after meals · b.i.d.=twice a day · s.o.s.=if needed
9. **Schedules**
   Schedule H (OTC with caution) · H1 (TB, antibiotics) · X (narcotics)
10. **Retention**
    Schedule H/X prescription retained 3 years at the pharmacy

Professor's Note

Expect 'write the 5 parts of a prescription' (3 marks) and 'compare IP vs USP' (5 marks) on every exam.

§ REVISION QUICK GLANCE

All four sub-topics in one page

1940 D&C Act · 1948 Pharmacy Act (PCI) · 1955 first

Community · Hospital · Clinical · Industrial R&D · Regula

IP (India) · BP (UK) · USP (US) · Ph. Eur. · Intl. P

Superscription · Inscription · Subscription · Signa · Phys

Connect-the-dots

Linkage

A *prescription* (1.4) is filled using a *pharmacopoeial drug* (1.3) by a *registered pharmacist* (1.2) whose *legal existence* comes from *Acts passed in our history* (1.1).

§ SELF-CHECK 5 QUESTIONS

Can you answer these without looking back?

1. List the 5 parts of a prescription and state which part is for the patient.
2. Differentiate: Pharmacy Act 1948 vs Drugs & Cosmetics Act 1940.
3. Mention the publisher and year of first publication of IP, BP, USP.
4. Decode: t.i.d., a.c., s.o.s., o.d., h.s.
5. Name 3 organisations that govern pharmacy in India and their main role.

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A1. Superscription ■ · Inscription · Subscription · Signa · Physician signature. Signa is the part directed to the patient. A2. Pharmacy Act 1948 — pharmacy education + PCI. Drugs & Cosmetics Act 1940 — import, manufacture, sale of drugs. A3. IP — IPC, Ghaziabad, 1955. BP — BPC London, 1864. USP — USPC, Rockville, 1820. A4. t.i.d.=three times a day · a.c.=before meals · s.o.s.=if necessary · o.d.=right eye · h.s.=at bedtime. A5. PCI (education) · IPC (pharmacopoeia) · CDSCO/DCGI (drug regulation) · NPPA (pricing).
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Unit I in one line

Unit I teaches you how pharmacy became a regulated profession — and the documents a pharmacist must master.

§ PINPOINTS MUST REMEMBER

10 hooks for last-minute revision

1. **Pharmacy**
   Art + Science of drug preparation — from Greek 'Pharmakon'.
2. **Pharmacy Act**
   1948 — set up PCI; regulate education and registration.
3. **D&C Act**
   1940 — controls import, manufacture & sale of drugs.
4. **PCI**
   Apex body for education — NOT for drug regulation.
5. **IP**
   Indian Pharmacopoeia 2022 (current) — mandatory in India.
6. **IP monograph**
   Title, Description, Identification, Tests, Assay, Storage.
7. **Prescription**
   5 parts: Superscription, Inscription, Subscription, Signa, Signature.
8. **Latin**
   a.c./p.c./b.i.d./t.i.d./q.i.d./h.s./p.r.n./s.o.s./stat.
9. **Schedules**
   H (caution) · H1 (TB/antibiotics) · X (narcotics) — 3-year retention.
10. **SCs**
    Communication · Calculation · Compounding · Critical-thinking · Caring.

Mnemonic

1940 D&C; · 1948 PCI · 1955 IP · 1970 Patent · 1988 NPPA — 'DD-IPNP' the 5 Ds of Indian pharmacy history.

§ OVERVIEW WHAT YOU WILL LEARN

Roadmap of Unit II

2.1
Metric System

Weights, measures, scientific notation

2.2
Pharmaceutical Calculations

Alligation, proof spirit, isotonic, geometric dilution

2.3
Posology

Dose by age, weight, BSA

2.4
Dosage Forms & Routes

Classification, routes of administration

2.5
APIs & Excipients

Definition, ideal characteristics, importance

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§ REFERENCE METRIC SYSTEM OF WEIGHTS & MEASURES

2.1.1 Master the SI prefixes and conversions

Prefix	Value	Power	Pharmacy use
kilo (k)	1,000	10^{3}	
hecto (h)	100	10^{2}	
deca (da)	10	10^{1}	
BASE (L, g, m)	1	10^{0}	
deci (d)	0.1	10^{-1}	
centi (c)	0.01	10^{-2}	
milli (m)	0.001	10^{-3}	
micro (µ)	10^{-6}	10^{-6}	
nano (n)	10^{-9}	10^{-9}	
pico (p)	10^{-12}	10^{-12}	

2.1.2 Scientific notation cheat-sheet

How to write and convert

- Move decimal LEFT for negative exponent; RIGHT for positive.
- 0.000 25 g = 2.5 × 10^{-4} g = 250 g.
- 1 mg = 1000 g = 1,000,000 ng = 10^{6} ng.
- 1 L = 1000 mL = 1,000,000 L — micro-litre used in HPLC.

Quick recall

Kilo, hecto, deca · base · deci, centi, milli — biggest on left, smallest on right.

§ WORKED CALCULATION ALLIGATION METHOD

2.2.1 Mix two strengths of a solution to get a target

Rule

To mix a *stronger* solution (A) with a *weaker* solution (B) to get a *target* concentration:

- Parts of A = |Target − B|
- Parts of B = |A − Target|

2.2.2 Worked example — (verified)

Question

Mix 70% w/w alcohol and 40% w/w alcohol to prepare *1000 mL* of *55% w/w* alcohol. Find quantities of each.

Alligation square

70 |55 − 40| = 15 parts of 70% alcohol

55 target

40 |70 − 55| = 15 parts of 40% alcohol

Calculation

Total parts = 15 + 15 = 30.

Quantity of 70% alcohol = 1000 × 15/30 = *500 mL*.

Quantity of 40% alcohol = 1000 × 15/30 = *500 mL*.

Check: (500 × 0.70) + (500 × 0.40) = 350 + 200 = 550 mL of alcohol 550/1000 = 55%

Exam Tip

Alligation works for % (w/w or v/v) and also for mixing powders / liquids in any ratio where concentration is involved.

§ WORKED CALCULATION PROOF SPIRIT (BP)

2.2.3 What is proof spirit?

Definition (BP)

Proof spirit (BP) is a hydroalcoholic mixture containing *57.1 % v/v* of ethanol at *15.6 °C*.

The British *proof degree (°)* is calculated as:

° British proof = % v/v ethanol at 15.6 °C × 1.753

° US proof = ° British proof × 1.142

2.2.4 Worked example — (verified)

Question

Convert *57.1 % v/v* ethanol to °British and °US proof.

Solution

° British = 57.1 × 1.753 = *100.07 ≈ 100 ° proof*.

° US = 100.07 × 1.142 = *114.28 ≈ 114.3 ° proof*.

Reverse — find % v/v from proof

% v/v = ° British ÷ 1.753 OR % v/v = ° US ÷ 2.001

Example: 70 ° US proof 70/2.001 = 34.98 % v/v.

Mnemonic

BPU — British × 1.753 = U % v/v · US ÷ 1.142 = British · US = British × 1.142.

§ WORKED CALCULATION ISOTONIC SOLUTIONS

2.2.5 Definition and key constant

Key concept

An *isotonic* solution has the same *osmotic pressure* as *0.9 % w/v NaCl* (*sodium chloride equivalent* = 0.9 %).

Body fluids · tears · plasma ≈ 0.9 % NaCl — used as the reference.

2.2.6 NaCl-equivalent (E value) of a drug

E values (selected)

- *NaCl* — E = 1.00 (by definition)
- *Dextrose (glucose) anhydrous* — E ≈ 0.16
- *Boric acid* — E ≈ 0.50
- *Atropine sulphate* — E ≈ 0.13
- *Chlorbutol* — E ≈ 0.24

2.2.7 White's method for tonicity adjustment

Formula (White & Vincent)

W = 0.52 × a / b

where a = g of drug in the formula · b = freezing-point depression of drug solution (0.52 °C for 0.9 % NaCl)

So W = 0.52 × a / b = amount of NaCl (g) needed to make the solution isotonic.

Exam Tip

Use E-value when b is unknown. Formula: g of NaCl = (E × g of drug) / 0.9.

§ REFERENCE DILUTION & GEOMETRIC DILUTION

2.2.8 Percentage · ratio · dilution

Percentage notations

- % w/w — grams of solute in 100 g of solution.
- % w/v — grams of solute in 100 mL of solution (most common in pharmacy).
- % v/v — mL of solute in 100 mL of solution (liquids in liquids).

2.2.9 Dilution formula

Stock × C1 = Diluent × C2

V × C = V × C

V = volume of stock (mL); C = strength of stock

V = final volume required; C = final strength

water to add = V − V

Worked: 10 mL of 50 % w/v diluted to 250 mL 10 × 50 = 250 × C C = 2 % w/v.

2.2.10 Geometric dilution — when ratio of drug : base < 1:10

Why geometric?

If a *potent drug* is mixed with a *large amount of base/diluent* all at once, the drug may form clumps that fail to disperse evenly.

Geometric dilution: mix the drug first with an equal weight of base, then *double the base* and mix again, repeat until all base is incorporated.

Step example

Mix 0.1 g of dye with 99.9 g of talc (1:999 ratio). Step 1: dye + 0.1 g talc · Step 2: add 0.2 g talc · Step 3: add 0.4 g · double each time.

§ WORKED CALCULATION POSOLOGY · DOSE BY AGE / WEIGHT / BSA

2.3.1 Pediatric dose rules

Rule	For	Formula
Fried's rule	Infants < 1 year	Adult dose × (Age in months / 12)
Young's rule	Children 1–12 yr	Adult dose × Age / (Age + 12)
Dilling's rule	Children 12+ yr	Adult dose × Age / 20
Clark's rule	By weight	Adult dose × (Child weight kg / 70)
BSA (Mosteller)	Most accurate	Adult dose × (Child BSA m² / 1.73 m²)

2.3.2 Mosteller BSA formula (most used)

Formula

BSA (m²) = √[(Height cm × Weight kg) / 3600]

Worked: child 70 kg, 170 cm BSA = √(70 × 170 / 3600) = √3.306 = 1.82 m².

2.3.3 Dose from body weight

Example

Paracetamol dose: 15 mg/kg. Child weighs 20 kg 20 × 15 = ***300 mg*** per dose, every 6 hours, max 4 doses/day.

Mnemonic

Fried-Infants · Young-12 · Dilling-12+ · Clark-Weight · Mosteller-BSA — 'FIYC-DM'.

§ INFOGRAPHIC ROUTES OF ADMINISTRATION

2.4.1 Three main routes, sub-divided

Tablets · Capsules · Syrups · Suspensions · Solutions

Nitroglycerin SL · Buprenorphine

Bolus / infusion — 100 % bioavailability

Insulin s.c. · Vaccines i.m. · Heparin s.c.

Ointments · Creams · Gels · Lotions · Patches

Eye drops · Ear drops · Nasal drops · Throat paints

Suppositories · Enemas · Retention foams

Nebuliser · MDI · DPI — direct to lungs

Key principle

Every route has a *first-pass effect* risk EXCEPT sublingual, buccal, i.v., transdermal, inhalation. Choose the route that maximises bioavailability for the target site.

§ INFOGRAPHIC CLASSIFICATION OF DOSAGE FORMS

2.4.2 The three physical states — full map

- Tablets
- Capsules
- Powders
- Granules
- Lozenges
- Suppositories

- Solutions
- Suspensions
- Emulsions
- Syrups
- Elixirs
- Tinctures

- Ointments
- Creams
- Gels
- Pastes
- Jellies
- Poultices

2.4.3 Sterile vs non-sterile

Sterile dosage forms

· Parenteral (i.v., i.m., s.c., intradermal) · Eye drops · IV fluids · Irrigation solutions · Implants.

Non-sterile dosage forms

· Oral (tablets, capsules, syrups, suspensions) · Topical (ointments, creams, gels) · Rectal (suppositories, enemas).

§ DEFINITION ACTIVE PHARMACEUTICAL INGREDIENT (API)

API

An ***Active Pharmaceutical Ingredient (API)*** is the ***pharmaceutically active substance*** in a drug product that produces the ***intended therapeutic effect***. Example: paracetamol in Calpol.

2.5.1 Ideal characteristics of an API

Property	Ideal characteristic
Physical	Stable solid/liquid form, low hygroscopicity
Chemical	Stable against hydrolysis, oxidation, photolysis
Biological	Effective at the receptor site, no antagonism
Pharmacokinetic	Adequate bioavailability, t½ allows convenient dosing
Safety	Non-toxic at therapeutic doses, no teratogenicity
Manufacturability	Easy to crystallise, formulate, scale up

Insider Tip

Active Moiety: The part of the API that is responsible for the pharmacological effect (e.g. diclofenac acid from diclofenac sodium).

§ DEFINITION PHARMACEUTICAL EXCIPIENTS

Excipient

An ***excipient*** is any ***non-active component*** of a dosage form — added to ***aid manufacture, improve stability, control release, enhance bioavailability or patient acceptability***.

2.5.2 Common excipient functions

Function	Examples
Diluent / filler	Lactose, microcrystalline cellulose (MCC)
Binder	Starch paste, PVP, HPMC — holds particles together
Lubricant	Magnesium stearate, stearic acid — reduce die friction
Glidant	Colloidal silicon dioxide — improve flow
Disintegrant	Croscarmellose, sodium starch glycolate — break tablet apart
Surfactant	Polysorbate 80, SLS — wetting and solubilisation
Preservative	Methyl paraben, propyl paraben — prevent microbial growth
Antioxidant	Ascorbic acid, BHA, BHT — prevent oxidation

Exam Tip

Excipients are 'inactive' but critical. A missing disintegrant = tablet doesn't break down = no drug release = no effect.

§ EXAM HIGH-YIELD POINTS

Top 10 calculations and definitions

1. **1 kg / 1 L**
   1000 g, 1000 mL, 10 µL, 10 nL — always convert to base SI
2. **Alligation**
   Parts of stronger = |Target − weaker|; parts of weaker = |Stronger − target|
3. **Proof spirit**
   57.1 % v/v = 100 ° BP = 114.3 ° US (rounded)
4. **Isotonic ref.**
   0.9 % w/v NaCl = 0.52 °C freezing point depression
5. **Geometric dil.**
   Mix drug with equal wt of base double repeat (for ratio < 1:10)
6. **Posology**
   Fried/Young/Dilling (age) · Clark (weight) · Mosteller (BSA)
7. **Mosteller BSA**
   $\sqrt{(H\ cm \times W\ kg / 3600)}\ m^2$ — most used today
8. **Routes**
   i.v. = 100 % bioavailability; sublingual, transdermal, inhalation avoid first-pass
9. **API**
   Active Pharmaceutical Ingredient — the part that does the work
10. **Excipient**
    Inactive but essential — controls release, stability, taste, manufacturability

Professor's Note

Calculation question strategy: (1) write the formula, (2) substitute, (3) state answer with units. Half marks just for the formula.

§ REVISION QUICK GLANCE

Five sub-topics in one page

1 mg = 1000 µg · 1 L = 1000 mL · scientific notation: 10±

Alligation · Proof spirit 1.753 × · 0.9 % NaCl isotonic · VC = V

Fried (infants) · Young (<12) · Dilling (12+) · Clark (wt) · I

Enteral · Parenteral · Topical · Rectal · Inhalation — avoid 1st-p

API = active drug · Excipient = inactive but essential · 6+ functions

Connection

How the 5 link

Metric lets you convert units. *Calculations* use those units in alligation/proof/isotonic. *Posology* decides how much API to give. *Routes* deliver it. *Excipients* make it work.

§ SELF-CHECK 5 QUESTIONS

Solve without looking back. 5 marks each.

1. Mix 60 % w/w and 30 % w/w alcohol to prepare 500 mL of 50 % w/w. Quantities of each?

2. A spirit is labelled 60 ° US proof. Find its % v/v ethanol.

3. Mosteller BSA of a child weighing 25 kg, 100 cm tall. Adult dose 500 mg child dose?

4. Prepare 250 mL of 2 % w/v NaCl from a 10 % stock. Volume of stock + water?

5. State 4 ideal characteristics of an API.

answers.py

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A1. 60 and 30 around 50: parts 60 = |50-30| = 20, parts 30 = |60-50| = 10. Total 30 parts. 60% × 500 × 20/30 = 333.3 mL; 30% × 500 × 10/30 = 166.7 mL. A2. 60 ° US ÷ 1.142 = 52.5 ° BP; 52.5 / 1.753 = 30.0 % v/v. A3. BSA = √(25×100/3600) = √0.694 = 0.83 m². Dose = 500 × 0.83/1.73 = 240 mg. A4. V■ = 250 × 2/10 = 50 mL stock; add 200 mL water. A5. Physical stability · chemical stability · biological activity · non-toxic · adequate bioavailability · easily formulated.
```

Unit II in one line

Unit II teaches you the numbers behind every prescription — conversions, dilutions, doses, and the API/excipient that make it work.

§ PINPOINTS MUST REMEMBER

10 hooks for last-minute revision

1. **1 kg = 1000 g**
   1 mg = 1000 µg · 1 µg = 1000 ng · 1 L = 1000 mL · 1 mL = 1 cm³.
2. **Alligation**
   Parts of A = |Target − B|; parts of B = |A − Target|.
3. **Proof spirit**
   57.1 % v/v = 100 ° BP = 114.3 ° US. Multiply v/v% by 1.753 to get °BP.
4. **Isotonic**
   0.9 % w/v NaCl = 0.52 °C T = 308 mOsm/L.
5. **Geometric**
   Drug : base ratio < 1:10 mix with equal part, then double, then double.
6. **Fried/Young/Dilling**
   Fried — <1 yr · Young — 1–12 yr · Dilling — 12+ yr.
7. **Clark's rule**
   Adult dose × Child weight (kg) / 70.
8. **Mosteller BSA**
   √(H cm × W kg / 3600) m² — most accurate dosing for children.
9. **Routes & 1st-pass**
   i.v. 100 % BA; sublingual, transdermal, inhalation bypass 1st-pass.
10. **API vs Excipient**
    API = active; Excipient = inactive but essential (binder, lubricant, disintegrant).

Mnemonic

Mosteller, Fried, Young, Dilling, Clark — 'MFYDC' for the 5 posology rules.

§ UNIT OVERVIEW

3 Unit-III at a Glance

3.1 Powders

- Official classification (6 types)
- ***Simple, dusting, effervescent***, etc.
- ORS, Seidlitz, eutectic, tooth powder

3.2 Advantages/Disadv.

- Dose ***flexibility*** vs inaccurate dose
- ***Cheap***, no heat, but bulk & non-uniform
- Suitable for infants, topicals

3.3 Preparation

- ***Trituration, levigation, sifting***
- Mortar-pestle, sieve stack
- Mixing geometric (1:1, 1:2…)

3.4 Tablets

- ***Compressed vs moulded***
- Excipients: diluent, binder, disintegrant
- Granulation, compression, coating

3.5 Capsules

- ***Hard gelatin, soft gelatin, HPMC***
- Sizes ***000*** … ***5*** (volume)
- Body-cap two-piece, tamper-evident

3.6 Worked Examples

- ORS (WHO) — sodium, KCl, citrate, glucose
- Camphor + menthol eutectic
- Tooth powder abrasive system

Definition

Solid dosage forms are the ***most widely prescribed*** pharmaceutical preparations. They include powders (loose mixtures of dry particles), tablets (compressed or moulded unit doses), and capsules (gelatin shells enclosing drug). All three deliver an accurate, stable, portable dose to the patient — the backbone of modern oral therapy.

Why Unit III matters

Every tablet you swallow — from paracetamol to metformin — was once powder. Pharmacies compound powders; industry presses tablets; capsules are the bridge. Master Unit III and you can read any solid-dose label critically. Synthetic teaching data — authentic dosage-form content only.

§ 3.1 CLASSIFICATION OF POWDERS

1 Powders — Official Classes

Definition

A ***pharmaceutical powder*** is a dry, intimate mixture of one or more finely divided solids intended for internal or external use. Official (pharmacopoeial) powders are classified by composition and pharmacological purpose into six canonical types: simple, compound, dusting, effervescent, efflorescent, and hygroscopic. Two further practical classes — eutectic and eutectic-containing — are also recognised.

Class	Description	Examples
Simple / Compound	Single API or 2+ APIs mixed in uniform proportion.	ORS powder, headache powder, laxative powder.
Dusting powders	Very fine, free-flowing, for external skin application. Often sterilised.	Talc dusting powder, zinc oxide + starch.
Effervescent powders	Contain acid + carbonate; release CO on water contact.	Seidlitz powder, effervescent vitamin C.
Efflorescent powders	Contain crystalline APIs that ***lose water of crystallisation*** in dry air, becoming powdery.	Powdered citric acid, ferrous sulphate powders.
Hygroscopic powders	Absorb atmospheric moisture, become damp / liquefy.	Powdered ammonium chloride, sodium bromide.
Eutectic mixtures	Two solids, when triturated, melt below either's melting point forming a liquid.	Camphor + menthol, menthol + thymol, phenacetin + aspirin.

Professor's Note

Remember the mnemonic `S-E-D-E-H-E` for Simple — Effervescent — Dusting — Efflorescent — Hygroscopic — Eutectic. Two of the six (Efflorescent and Hygroscopic) are storage problems — they need airtight packaging. Synthetic teaching data — authentic dosage-form content only.

§ 3.2 ADVANTAGES & DISADVANTAGES

2 Why Powders? Why Not?

Definition

Powders pre-date tablets in medicine. They remain useful because the dose ***can be titrated to the patient*** — a teaspoon for an adult, a pinch for an infant. Yet, dose-to-dose uniformity is harder than tablets or capsules.

Advantages

- ***Dose flexibility*** — measured by spoonful or scoop.
- ***Cheap to manufacture*** — no compression machinery.
- ***Heat-free*** — suitable for heat-labile drugs.
- ***Faster dispersion*** than intact tablets.
- ***Easy compounding*** at community pharmacy.
- Suitable for ***bulk use*** (dusting, gargles).

Disadvantages

- ***Inaccurate dose*** unless weighed; patient error.
- ***Non-uniform mixing*** of small-dose potent drugs.
- ***Bulk & inconvenient*** for travel & portability.
- Many APIs are ***bitter / nauseating*** when not masked.
- ***Efflorescent / hygroscopic*** APIs spoil in air.
- Not suitable for ***potent / hygroscopic*** drugs at low dose.

When to choose powder over tablet?

Use powder when the dose must vary (pediatric, geriatric), when the drug is unstable to compression heat , or when a topical bulk product is wanted (dusting). Avoid powder when dose is ***<10 mg*** (uniformity impossible) or when the API is hygroscopic.

§ 3.3 PREPARATION OF POWDERS

3 How Powders Are Made

Definition

Three classical comminution / mixing operations produce pharmaceutical powders: ***trituration*** (reduce particle size + blend in mortar with pestle), ***levigation*** (grinding with a little liquid to form paste), and ***sifting*** (passing through sieves to get uniform fineness). Industrial scale adds milling, blending and jet-micronisation.

Trituration

- Mortar + pestle, rotary.
- Reduces size + mixes.
- ***Circular + downward pressure.***
- For ***friable crystals*** (camphor, menthol).
- ***Geometric dilution*** (1+1, 1+2, 1+4) for potent drugs.

Levigation

- Paste of solid + ***levigating agent***.
- Agent: glycerin, liquid paraffin, water.
- Used for very fine ***insoluble drugs***.
- Forms uniform dispersion.
- Common in ***ointment bases*** and suspensions.

Sifting

- Powder through ***sieves (sieves)***.
- Standard mesh: #44, #60, #85, #120.
- Stack coarse fine top-down.
- Gives uniform ***particle size***.
- Combined with trituration for ***mixing***.

Geometric Dilution — the rule for potent drugs

When mixing a ***potent drug (D)*** with a large amount of diluent (L), do NOT pour D into all L at once. Instead:

Step 1 — ***D + L (equal)*** mix M (now 1:1).

Step 2 — ***M + L (equal)*** mix M (now 1:2).

Step 3 — ***M + remaining L*** mix final blend.

Why it works: each step doubles the bulk, so D is never concentrated in pockets. Content uniformity guaranteed

Viva question

"Why trituration alone won't uniformly mix 0.5 g drug in 100 g diluent." — Answer with the geometric dilution principle above. Three points guaranteed.

§ 3.4 WORKED EXAMPLE — ORS POWDER

1 Oral Rehydration Salts (WHO)

Definition

ORS is the **gold-standard** effervescent-free compounded powder for treating acute diarrhoeal dehydration. WHO-ORS sachet is dissolved in 1 L of clean water and replaces lost electrolytes + glucose to drive Na/water co-absorption via the SGLT-1 transporter.

Composition (per sachet, WHO 2005)

Sodium chloride — 2.6 g
Potassium chloride — 1.5 g
Trisodium citrate — 2.9 g (replaces older NaHCO)
Anhydrous glucose — 13.5 g
Total ≈ **20.5 g** powder/sachet
Reconstituted: **Na 75 mmol/L**, K 20 mmol/L, glucose 75 mmol/L, osmolarity 245 mOsm/L.

Preparation procedure

1. Weigh accurately all 4 ingredients on **analytical balance**.
2. Triturate each solid separately in dry mortar to fine powder.
3. Pass each through **sieve #44** (largest particle ≤ 355 m).
4. Mix glucose + trisodium citrate first (largest bulks).
5. Add NaCl + KCl with **geometric dilution** until homogeneous.
6. Pack **20.5 g** in hermetic aluminium sachet. Label, expiry 3 yr.

Ingredient	Role	g/sachet	mmol/L	Note
NaCl	Na source	2.6	75	isotonic
KCl	K source	1.5	20	replace losses
Trisodium citrate	buffer	2.9	10	vs old NaHCO
Glucose	SGLT-1 driver	13.5	75	anhydrous

Caution

ORS does NOT stop diarrhoea — it prevents death from dehydration. Use correct osmolarity (WHO 2005 low-osmolarity formula above); hyperosmolar ORS worsens diarrhoea.

§ 3.5 WORKED EXAMPLES — TOOTH & SEIDLITZ

2 Tooth Powder & Seidlitz Powder

Definition

Two more classic official powders — ***tooth powder*** (an abrasive dentifrice) and ***Seidlitz powder*** (an effervescent saline cathartic). Both illustrate different pharmaceutical reasoning.

Tooth powder (typical formula, 100 g)

Calcium carbonate — 90 g (***abrasive***, polishes enamel)
Sodium bicarbonate — 5 g (mild alkaline, neutralises acids)
Sodium chloride — 3 g (flavour + abrasive aid)
Magnesium carbonate — 1 g (light abrasive, prevents caking)
Saccharin / flavour — 0.4 g (palatability)
Methyl salicylate oil — 0.6 mL (wintergreen fragrance)

Method: ***trituration*** each solid sieve #60 mix in geometric order add volatile oil last sift again.

Seidlitz Powder — effervescent saline cathartic

Supplied as ***two separate papers*** (to be mixed only at the moment of dose, in water):

Blue paper (acid) — Tartaric acid 7.5 g + Sodium bicarbonate 2.5 g
White paper (base) — Sodium potassium tartrate (Rochelle salt) 30 g + Sodium bicarbonate 30 g

Use: dissolve both papers in ≈ 200 mL water ***drink while effervescing*** effervescence (CO_2) masks saline taste and speeds gastric emptying.

Action: osmotic cathartic; produces watery stool in 30–60 min.

Why split into two papers?

If the acid + carbonate were pre-mixed, the powder would effervesce during storage and lose CO_2 / potency. Two-paper packaging is the ***textbook effervescent powder strategy***.

§ 3.6 WORKED EXAMPLE — EUTECTIC MIXTURE

3 Camphor + Menthol Eutectic

Definition

A **eutectic mixture** is a combination of two or more solids that, when intimately mixed, liquefy at a temperature lower than the melting point of any component. This happens because each component dissolves in the other's liquid phase, lowering the system MP. Classic pair: camphor (MP 175 °C) + menthol (MP 41–43 °C) liquid at room temperature when ~1:1.

The phenomenon

Camphor ($C_{10}H_{16}O$) — waxy crystals, MP ≈ 175 °C.

Menthol ($C_{10}H_{20}O$) — needle crystals, MP ≈ 42 °C.

Tr. together 1:1 liquid forms within minutes at RT.

Each lowers the freezing point of the other **co-melting**.

Same happens for: menthol + thymol, phenacetin + aspirin, chloral hydrate + menthol.

Pharmaceutical remedy

Problem: powder turns to liquid on shelf — unstable.

Solution A: separate powders, mix at dispensing.

Solution B: adsorb onto **light magnesium oxide** / light kaolin to keep dry.

Solution C: use **inert diluent** (starch, lactose) to absorb the liquefied mixture.

Solution D: convert to a **different dosage form** (e.g., ointment of menthol + camphor).

Worked method — Camphor + Menthol Eutectic (100 g)

1. Weigh **50 g camphor** + **50 g menthol**.
2. Triturate in **glass mortar** (NOT porcelain — camphor reacts) with gentle strokes.
3. Within minutes the mix **melts to a clear liquid**.
4. To keep as powder, adsorb liquid onto **50 g light MgO** + 25 g starch by geometric levigation.
5. Pass through sieve #44, package in wide-mouth amber jar.

Viva pearl

"Why can't camphor + menthol be packed together as a dry powder?" — Because they form a eutectic that liquefies at room temperature. Standard answer; full marks guaranteed.

§ 3.7 TABLETS — DEFINITION & TYPES

1 Tablets — The Workhorse Dose

Definition

A ***tablet*** is a solid dosage form prepared by compression or moulding of a medicinal substance(s) with or without suitable excipients. Tablets are the ***most prescribed*** dosage form worldwide — cheap, stable, dose-accurate, easy to transport.

Tablet type	Release site	How made	Notes / Example
Compressed	Oral, swallow	Powder granulate compress	Most common; paracetamol 500 mg.
Moulded (tablet triturates)	Sublingual	Wet mould, dry in tray	Disperses fast; nitroglycerin.
Sublingual	Under tongue	Compress or mould	Avoids first-pass; ondansetron.
Buccal	Cheek pouch	Compress + mucoadhesive	Slow buccal absorption; fentanyl.
Chewable	Oral, chewed	Compress with mannitol	Pediatric; antacids.
Dispersible	Oral, in water	Compress + strong disintegrant	For dysphagic patients.
Effervescent	Oral, in water	Compress acid + carbonate	Vitamin C, aspirin.
Enteric-coated	Small intestine	Compress + polymer coat	Protects from gastric acid; omeprazole.
Sugar-coated	Oral, swallow	Compress + syrup coat	Masks bitter taste; old technique.
Film-coated	Oral, swallow	Compress + polymer film	Modern, fast; paracetamol.
Controlled-release	Slow GI release	Compress + matrix/coat	Once daily; metformin SR.

Mnemonic

C-M-S-B-C-D-E-E-S-F-C — Compressed, Moulded, Sublingual, Buccal, Chewable, Dispersible, Effervescent, Enteric-coated, Sugar-coated, Film-coated, Controlled-release. Eleven types, one letter each.

§ 3.8 PILLS vs TABLETS

2 Pills vs Tablets — Hand-Rolled History

Definition

A *pill* is the historical hand-rolled, moulded spherical or ovoid mass of drug + binders. Pills pre-date compressed tablets — today they are largely obsolete, replaced by tablets and capsules. The closest modern analogue is the moulded tablet (tablet triturate).

Pill — old form

Shape: round / oval / spherical, 60–250 mg.

Composition: drug + *plant powders* (liquorice, marshmallow) as binder.

Made by: rolling on a pill tile + cutter, or by *pill machine* (brass plates with calibrated holes).

Coated with: silver leaf, sugar, or gelatin to mask taste.

Drying: 24–48 h on trays.

Status: rare today; mostly historical & homeopathic.

Tablet — modern form

Shape: disc, oval, caplet, scored, often 100–1000 mg.

Composition: drug + 6–8 functional *excipients* (diluent, binder, disintegrant…).

Made by: granulation + *tablet press* (single-punch or rotary).

Coated with: film, sugar, enteric polymer for taste / protection / sustained release.

Drying: granules dried before compression.

Status: dominant dosage form — ~80% of oral prescriptions.

Moulded tablets (tablet triturates) — the bridge

Tablet triturates are small, disc-shaped tablets (~30–100 mg) made by *moulding a moist mass* rather than compression.

Procedure: triturate drug + lactose + sucrose 5% (binder) + alcohol (granulating fluid) press into *mould plate (cavity)* dry in oven eject.

Use: potent drugs requiring small dose with rapid dispersion — *nitroglycerin*, homoeopathic remedies, sublingual preparations.

Key contrast

Pills = hand-rolled , tablets = machine-pressed . Both deliver a unit dose, but tablets are 100x faster, cheaper, and more uniform.

§ 3.9 TABLET EXCIPIENTS

4 Six Pillars of a Tablet

Definition

An **excipient** is any non-active ingredient in a tablet. Without excipients the API cannot be compressed, disintegrated, swallowed, or recognised by the patient. Six functional classes cover nearly every tablet formulation.

Class	Role	Common examples	Typical %	Note
Diluent (filler)	Bulk the tablet	Lactose, MCC, dicalcium phosphate, starch	20–80%	Lactose = most common
Binder	Holds particles	PVP, starch paste, HPMC, ethylcellulose	2–10%	Dry/wet binding
Disintegrant	Breaks tablet in GI	Starch, croscarmellose, SSG, crospovidone	2–8%	Superdisintegrants ≤ 5%
Lubricant	Stops punch sticking	Magnesium stearate, stearic acid, talc	0.5–2%	Hydrophobic slows dissolution
Glidant	Improves powder flow	Colloidal silicon dioxide (Aerosil)	0.1–1%	Reduces caking
Colouring & Flavouring	Patient acceptance	FD&C; dyes, titanium dioxide, fruit flavours	≤ 1%	ID + compliance

Choice rule — Hydrophilic vs hydrophobic

If dissolution matters *minimise Mg stearate*, use SLS.
If sticking matters *increase Mg stearate* but watch dissolution.
If taste is bitter coat, don't load flavour.
If dose is potent (<1 mg) use *diluent first*, then titrate.

Common mistakes

Over-lubrication *slow disintegration*.
Sticking usually *insufficient binder* or moisture.
Capping too dry granules, *re-wet slightly*.
Lamination over-compression; reduce force.

Six pillars, one mnemonic

D-B-D-L-G-C — Diluent, Binder, Disintegrant, Lubricant, Glidant, Colour/Flavour. Without all six categories, a tablet rarely compresses cleanly.

§ 3.10 GRANULATION & COMPRESSION

Wet vs Dry Granulation + Compression

Definition

Most APIs cannot be compressed directly — powders don't flow, don't bind, and segregate. **Granulation** converts fine powder into free-flowing, compressible granules either by adding a liquid binder (**wet granulation**) or by compacting under high pressure (**dry granulation**).

Wet granulation (the workhorse)

Steps: weigh mix **bind** (binder solution) granulate sieve dry mill blend lubricant compress.

Binders: PVP K30 (2–5%), HPMC, starch paste 5–10%.

Equipment: sigma-blade mixer, fluid-bed dryer, oscillating granulator.

Best for: heat-stable, water-tolerant APIs.

Pros: better flow, dust-free, content-uniform.

Cons: heat exposure, extra step, solvent cost.

Dry granulation

Steps: weigh mix compact (**roller compactor**) mill slugs blend lubricant compress.

No heat, no water — ideal for moisture-sensitive drugs.

Best for: aspirin, effervescent blends, hygroscopic APIs.

Pros: no drying step; fewer stages.

Cons: higher equipment cost; ribbon density control.

Compression — what happens inside the press

Single-punch press: 1 die, 2 punches, 60–100 tablets/min — lab scale.

Rotary press: 6–60 stations, 10,000–100,000 tablets/hr — production.

Force: typically 1–5 tonnes for a 10 mm round tablet.

Tablet press controls: weight (die fill), hardness (compression force), thickness (punch depth), friability.

Critical tests after compression: weight variation, hardness, friability, disintegration, dissolution, assay.

Compression pearl

Two granules enter the die as powder — one tablet leaves with 5–15% porosity. Too low porosity = slow dissolution; too high = capping, soft tablet.

§ 3.11 TABLET COATINGS

6 Sugar / Film / Enteric / Sustained

Definition

Coating adds a ***functional or cosmetic layer*** to a compressed tablet core. Each type solves a specific problem — taste, stability, gastric protection, or sustained release.

Coating	Why apply	Polymer	Notes
Sugar coating	Mask taste, swallow ease	Sucrose syrup (60–70%)	Old; 30–50% weight gain; slow process.
Film coating	Taste mask, appearance, swallow	HPMC, HPMCP, ethylcellulose	Modern, thin (3–5% wt); fast; common.
Enteric coating	Avoid gastric acid / protect gastric mucosa	Cellulose acetate phthalate, HPMC-AS, Eudragit	Dissolves at pH ≥ 6 (duodenum); PPI, aspirin EC.
Sustained / controlled release	Slow release over hours	Eudragit RS/RL, ethylcellulose, HPMC matrix	12–24 h; once-daily dosing; matrix vs reservoir.
Compression coating	Layered release	Tablet-in-tablet press	Two-step compression; immediate + sustained layer.

Viva question

"Why is film coating preferred over sugar coating in modern pharma?" — Less weight gain (3–5% vs 30–50%), faster process, more robust, supports logos/printing, and doesn't insulate the tablet against the environment. Synthetic teaching data — authentic dosage-form content only.

§ 3.12 CAPSULES — HARD vs SOFT

1 Capsules — Shell + Powder

Definition

A **capsule** is a solid dosage form in which the drug is enclosed within a two-piece hard shell or a one-piece soft gelatin shell. Capsules hide the taste, deliver the dose intact to the GI tract, and are the fastest-growing oral dosage form after tablets.

Hard gelatin capsules (HGC)

Shell: two pieces — **body** (longer) + **cap** (shorter), made of gelatin + water.
Fill: dry powder, granules, pellets, mini-tablets.
Made by: dipping stainless mould pins into gelatin melt, drying, stripping, joining.
Fill machine: powder fed into body by dosator (volumetric or tamping).
Sealing: body + cap telescoped; band-sealed if needed.
Moisture: 12–15% w/w water in shell; keeps shell flexible.

Soft gelatin capsules (SGC)

Shell: one piece, hermetically sealed, plasticised gelatin.
Fill: liquid or semi-solid (oil, PEG, suspension).
Shapes: round, oval, oblong, tube (**pearl**).
Made by: rotary die process — two gelatin ribbons fused around fill.
Plasticiser: glycerol, sorbitol — keeps shell soft & elastic.
Moisture: 6–8% w/w; lower than hard.

HPMC vegetable capsules — the modern alternative

HPMC (hydroxypropyl methylcellulose) shells replace gelatin for vegetarian / vegan / halal / kosher compliance.
Also tolerate **low humidity** better than gelatin (no brittle shells in dry climates).
Disintegration: similar to HGC (~5 min in gastric fluid).
Used widely in nutraceuticals and for moisture-sensitive APIs.
Other plant alternatives: pullulan (starch), tapioca starch.

Body-cap lock

The cap overlaps the body by ~6 mm. Pulling them apart is easy deliberately, but they stay together in transit — a tamper-evident design. Band-sealed capsules are mandatory for highly potent or hygroscopic fills.

§ 3.13 CAPSULE SIZES 000 5

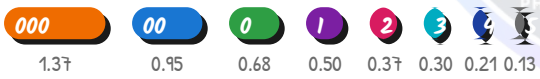
2 Capsule Sizes & Fills

Definition

Standard hard gelatin capsules come in 8 sizes; the largest is **000 (~1.37 mL)** and the smallest is **5 (~0.13 mL)**. Sizes are based on internal volume (mL) so the larger the size, the more powder fits.

Size	Volume (mL)	Length (mm)	Typical fill	Use
000	1.37	26.1	1.0–1.5 g	Largest — veterinary, large doses
00	0.95	23.4	0.6–0.9 g	Most common
0	0.68	21.7	0.4–0.6 g	Common — OTC drugs
1	0.50	19.4	0.3–0.4 g	Common
2	0.37	18.0	0.2–0.3 g	Common
3	0.30	15.9	0.15–0.2 g	Small doses
4	0.21	14.3	0.10–0.15 g	Pediatric
5	0.13	11.1	0.05–0.10 g	Smallest — homeopathic

Visual scale — relative capsule size



Excipients commonly used inside hard gelatin capsules

Diluent: lactose, MCC, dicalcium phosphate — build the bulk.
Lubricant: Mg stearate (0.5–1%) — helps powder slide into body.
Glidant: colloidal SiO (0.1–1%) — improves flow.
Disintegrant: croscarmellose, SSG — release contents quickly.
Wetting agent: SLS — for hydrophobic APIs.
Special: pellets of coated drug for modified release.

Sizing rule

Pick the smallest capsule that holds the dose — patient acceptance is highest with small capsules. Density 0.6–0.8 g/mL is typical for powders.

§ 3.14 CAPSULE STORAGE & MANUFACTURE

3 Storage, Defects & Manufacture

Definition

Gelatin shells contain 12–15% moisture and are **very sensitive to humidity**. Hard gelatin capsules must be stored at 15–25 °C, RH ≤ 60% — too dry and they become brittle, too humid and they soften / stick together.

Storage requirements

Temperature: 15–25 °C (cool, room temp).
Humidity: **45–60% RH** — never above 75%.
Container: **airtight** HDPE bottle + **induction seal** + desiccant (silica gel).
Protection: away from sunlight + heat.
HPMC shells: tolerate drier storage (down to 20% RH) without brittleness.

Common defects

Brittle shell: too low humidity.
Soft / sticky: too high humidity.
Splitting: poor body–cap fit; cold storage.
Discoloration: light or aldehyde-crosslinking.
Content leakage: pinholes from rough handling.
Poor fill uniformity: bad powder flow.

Manufacture flow — hard gelatin capsules

1. **Shell-making** — stainless moulds dipped in gelatin melt (40–45 °C), dried, stripped.
2. **Body printing** (optional) and **orientation**.
3. **Filling** — dosator fills body with powder (volumetric or tamping).
4. **Joining** — cap telescoped onto body by vacuum or mechanical means.
5. **Inspection** — visual (empty/filled), weight check, leak test.
6. **Polishing** — brusher removes surface powder.
7. **Packaging** — HDPE bottle + induction seal + desiccant + leaflet.

Quality tests for filled capsules

Weight variation, content uniformity, disintegration (<30 min IP), dissolution, microbial limits, moisture content of shell, and visual inspection for defects.

§ 3.15 POWDERS · TABLETS · CAPSULES

7 Powders vs Tablets vs Capsules

Definition

The three principal solid dosage forms differ in manufacture, dose accuracy, stability and patient acceptance. The table below summarises the contrast at a glance.

Feature	Powders	Tablets	Capsules
Definition	Loose dry mixture of solids	Compressed / moulded unit dose	Drug in gelatin / HPMC shell
Dose accuracy	Moderate (depends on scoop)	High (machine-controlled)	High (volumetric dosator)
Dose flexibility	Very high (titratable)	Fixed (or scored)	Fixed
Masking taste	Hard	Easy (coating)	Very easy (enclosed)
Suitable for potent drugs	Poor (uniformity)	Excellent	Excellent
Cost (manufacture)	Lowest	Moderate (machine, excipients)	Higher (capsule shell cost)
Stability / humidity	Efflorescent / hygroscopic issue	Very stable	Sensitive (gelatin shell)
Patient convenience	Less (scoop / water)	Most (pocket, portable)	Easy (no swallowing problem)
Examples	ORS, tooth powder, Seidlitz	Paracetamol, aspirin, metformin	Tetracycline, amoxicillin, omeprazole

When to choose what

Choose powder for variable dose, topicals, bulk. Tablet for mass-market, cheap, stable unit dose. Capsule for taste-masking, oily fills, or rapid formulation development.

§ EXAM HIGH-YIELD POINTS

8 Exam-Ready Points

Exam hook	Authentic recall
1. Official powder classification	Simple, Compound, Dusting, Effervescent, Efflorescent, Hygroscopic, Eutectic.
2. Geometric dilution	Mix potent drug with equal amount of diluent, then double the diluent each step — ensures uniformity.
3. ORS — WHO formula	NaCl 2.6 g + KCl 1.5 g + trisodium citrate 2.9 g + glucose 13.5 g per L; osmolarity 245 mOsm/L.
4. Seidlitz powder	Two-paper effervescent — acid (tartaric + bicarb) + base (Rochelle salt + bicarb); mix at dose.
5. Camphor + menthol eutectic	Forms liquid at RT when triturated — remedy: adsorb on light MgO or dispense as separate powders.
6. Tablets vs pills	Pills = hand-rolled; tablets = machine-compressed; moulded tablets bridge the two.
7. Six tablet excipients	Diluent, Binder, Disintegrant, Lubricant, Glidant, Colour/Flavour (D-B-D-L-G-C).
8. Wet vs dry granulation	Wet = binder solution + drying — best for stable APIs. Dry = roller compaction — for moisture-sensitive.
9. Compression force	1–5 tonnes for a 10 mm round tablet; controls hardness, friability, disintegration.
10. Capsule sizes	8 sizes 000 5; volume 1.37 mL 0.13 mL. Choose smallest capsule that fits the dose.
11. Hard vs soft gelatin	Hard = 2 pieces (body + cap), dry fill. Soft = 1 piece, hermetically sealed, liquid fill.
12. Capsule storage	15–25 °C, RH 45–60%, airtight HDPE bottle + desiccant. Gelatin brittle below 35% RH.

Predict the question

Most likely exam Qs: (1) classify powders with examples, (2) discuss advantages/disadvantages of powders, (3) describe ORS composition + role of glucose, (4) explain eutectic + how to overcome, (5) compare tablets vs capsules, (6) explain wet granulation step-by-step.

§ REVISE SMART REVISION

9 One-Page Revision Map

Powders — the 6 classes

S-*Simple* (ORS)
D-*Dusting* (talc)
E1-*Effervescent* (Seidlitz)
E2-*Efflorescent* (citric acid)
H-*Hygroscopic* (NHCl)
E3-*Eutectic* (camphor + menthol)
Method: *trituration, levigation, sifting*.
Mix rule: *geometric dilution*.

Tablets — the recipe

Types: *11* — compressed, moulded, SL, buccal, chewable, dispersible, effervescent, EC, SC, FC, CR.
Excipients: *D-B-D-L-G-C*.
Granulation: *wet* (binder + dry) or *dry* (roll-compact).
Compression: 1–5 t force, *5–15%* porosity.
Coatings: sugar, film, enteric, sustained.

Capsules — the shell

Hard = *body + cap*, dry fill, 12–15% water.
Soft = *1 piece*, liquid fill, rotary die.
HPMC = *vegetarian* shell, low RH tolerance.
Sizes: *000 5*, 1.37 0.13 mL.
Storage: 15–25 °C, RH 45–60%.

Cross-cutting facts

Powder Granule Tablet = same API in 3 forms.
Eutectic = *melt below either MP*.
Geometric dilution = *uniform mix of potent drug*.
Compression force = *hardness / friability trade-off*.
Enteric coat = *pH ≥ 6 only*.
Gelatin brittle below *35% RH*.

30-second recall

Three forms — Powder, Tablet, Capsule . Powders = titratable, tablets = mass-market, capsules = taste-mask + oily fill. Granulation + compression turns powder into tablet. Gelatin shell turns powder into capsule.

§ CHECK SELF-CHECK + SUMMARY

Five questions — answer before you turn the page

Q1. Name the six official classes of pharmaceutical powders and one example for each.

Q2. State the composition of WHO-ORS (per L) and the role of glucose in it.

Q3. Why are camphor and menthol stored separately rather than as a single powder?

Q4. List the six functional excipient classes in a tablet (D-B-D-L-G-C).

Q5. Why are hard gelatin capsules stored below 60% RH and not below 35% RH?

Answers (cover, then recall)

A1. Simple (ORS), Dusting (talc), Effervescent (Seidlitz), Efflorescent (citric acid), Hygroscopic (NH_4Cl), Eutectic (camphor + menthol).

A2. NaCl 2.6 g + KCl 1.5 g + trisodium citrate 2.9 g + glucose 13.5 g. Glucose drives Na / water co-absorption via SGLT-1.

A3. They form a eutectic that liquefies at room temperature; separately they stay crystalline.

A4. Diluent, Binder, Disintegrant, Lubricant, Glidant, Colour/Flavour.

A5. Above 60% RH the shell softens and sticks; below 35% RH the gelatin loses water and becomes brittle.

Unit III in one line

Unit 3 covers the three major solid dosage forms — powders (flexible, simple), tablets (precise, mass-market), capsules (taste-masking, easy swallow) — their classification, excipients, manufacture and storage rules that govern every solid oral medicine.

§ PINPOINTS MUST REMEMBER

10 Pinpoints — Must Remember

Hook	Recall in one line
Six powder classes	Simple, Dusting, Effervescent, Efflorescent, Hygroscopic, Eutectic
Geometric dilution	Equal-step doubling: 1:1 1:2 1:4 final bulk
ORS composition	NaCl 2.6 + KCl 1.5 + trisodium citrate 2.9 + glucose 13.5 g/L
Seidlitz	Acid paper + base paper — mixed only at the moment of dose
Eutectic	Liquefies below either MP; adsorb onto light MgO
Tablet excipients	Diluent, Binder, Disintegrant, Lubricant, Glidant, Colour/Flavour
Wet granulation	Mix bind with solution sieve dry mill compress
Compression force	1–5 t for 10 mm round; controls hardness & porosity 5–15%
Capsule sizes	000 5; volumes 1.37 0.13 mL; pick smallest that fits
Capsule storage	15–25 °C, RH 45–60%, airtight HDPE + desiccant

3 exam predictions

1. Classify powders with two examples each. 2. Why is glucose mandatory in ORS — explain SGLT-1 mechanism. 3. Explain eutectic with camphor + menthol and the remedies used in pharmacy.

Mnemonic — SD·E·H·E

Say `Simple-Dusting-Effervescent-Efflorescent-Hygroscopic-Eutectic` once. Then recall D-B-D-L-G-C for tablet excipients and 000 5 for capsule sizes. The whole unit collapses to six lines.

§ UNIT OVERVIEW

3 Unit-IV at a Glance

4.1 Monophasic – Internal

- **Aromatic waters** – rose, cinnamon, chloroform water (IP)
- **Syrups** – 66.7% w/w sugar; simple, invert
- **Elixirs** – hydroalcoholic, less viscous than syrups
- **Linctus** – viscous cough preparations

4.2 Monophasic – External

- **Liniments** – skin application (not broken)
- **Lotions** – aqueous, no friction (calamine IP)
- **Throat paints** – viscous glycerol-base
- **Gargles, mouthwashes** – oral rinse

4.3 Body-cavity dosage

- **Enemas** – rectal solutions (evacuant, retention)
- **Eye/ear/nasal drops** – sterile vs non-sterile
- **Tinctures** – alcoholic/hydroalcoholic

4.4 Suspensions

- **Deflocculated** vs **flocculated**
- **Zeta potential**, Schulze-Hardy rule
- Excipients – wetting, dispersing, thickening, flocculating

4.5 Emulsions

- **o/w vs w/o** – HLB scale
- **Bancroft rule** – phase of higher proportion is dispersion medium
- Identification: dye, dilution, conductivity, fluorescence

4.6 Stability & tests

- Suspensions: **caking, sedimentation volume**
- Emulsions: **cracking, creaming, inversion**
- Worked examples: calamine, cod-liver-oil emulsion, ORS-related math

Definition

Liquid dosage forms are classified by phase count: **monophasic** (single phase – true solutions like syrups and tinctures) and **biphasic** (two phases – suspensions of solid in liquid, emulsions of oil in water or water in oil). Unit IV follows PCI BP102T by walking through the **16 monophasic preparations** (internal + external + body-cavity), then takes the **two biphasic systems** in depth – suspensions and emulsions – with their physical chemistry, excipients, methods and stability tests.

§ MONO AROMATIC WATERS

1 Aromatic Waters (Aquae Aromaticae)

Definition

Aromatic waters (also called **medicated waters** or **aquae aromaticae**) are **clear, saturated aqueous solutions** of volatile oils or other aromatic substances, used as **flavouring agents** and occasionally for mild therapeutic action. They are the simplest monophasic liquid dosage form – essentially water carrying a small amount of dissolved volatile solute.

Key features & official examples

Parameter	Description
Form	Clear, aqueous, single-phase solution
Solute	Volatile oils (e.g., cinnamon, rose, peppermint) or volatile principles
Conc.	Saturated or near-saturated at 15–25 °C
Flavour	Pleasant, aromatic – masks taste of co-administered API
Use	Vehicle for oral mixtures, mouthwashes, nasal sprays
Stability	Volatile – store airtight, cool, dark, full containers

Method – Hydrodistillation (IP standard)

Procedure

1. **Triturate** the aromatic drug (e.g., cinnamon bark, rose petals) with a small quantity of **purified water** (about 1:1).
2. Allow to stand for **15 minutes** so the cellular structure swells and ruptures – releases volatile oils.
3. Transfer to a **clean copper still** (or appropriate still) with the remaining water.
4. **Distil**; collect the distillate. The first portion (about 1/10th) is usually re-distilled.
5. If necessary, **filter** the distillate through a wet filter paper to remove suspended globules of oil.
6. Store in **airtight, amber bottles** away from light to prevent loss of volatiles.

Official aromatic waters (IP / BP)

Preparation	Composition / Use
Concentrated Cinnamon Water (IP)	1 in 40 (v/v of cinnamon oil); diluted for use
Concentrated Peppermint Water (IP)	1 in 50 (v/v peppermint oil); carminative vehicle
Concentrated Dill Water (IP)	0.1% v/v dill oil – infant colic remedy
Rose Water (IP/BP)	Steam distillate of rose petals; cosmetic & flavour use
Strong Rose Water	Saturated distillate from 4 kg petals per 5 L distillate (BP)
Chloroform Water (IP)	0.25% v/v chloroform – used as a preservative in aqueous mixtures

§ MONO SYRUPS

2 Syrups (Sirupi)

Definition

Syrups are **concentrated, sweet, viscous aqueous preparations** containing **sucrose or other sugars** (or sugar substitutes). Sucrose concentration is critical: **66.7% w/w** (= **85% w/v**, density ~1.32 g/mL) provides a **self-preserving** system by reducing water activity below the threshold needed for microbial growth.

Simple Syrup (IP/BP)

Recipe (IP)

Sucrose ..... **66.7 g**
Purified water (q.s.) ..... **100 g**
Boiling – dissolve sucrose in water with the aid of heat; skim surface scum.
When cooled, add sufficient **boiled purified water** to produce 100 g.
Final product: **66.7% w/w sucrose** (= 85% w/v), density 1.32 g/mL, self-preserving.

Why 66.7% w/w?

Microbial preservation logic

At **66.7% w/w**, the water activity (a_w) falls to roughly **0.86** – below the lower limit for bacterial and most yeast/mould growth (~0.91).
This is the **saturation concentration** of sucrose: a tiny excess would re-crystallise on storage.
Below 66.7% w/w, the syrup is **not self-preserving** and requires a chemical preservative (e.g., benzoic acid 0.1–0.2%, methyl paraben 0.1%).
Above 66.7%, **sucrose crystallises out** – syrup becomes gritty and unstable.

Medicated & non-medicated syrups

Type	Composition / Use
Simple Syrup (IP/BP)	66.7% w/w sucrose – vehicle
Syrup BP (B.P.)	66.7% w/w sucrose; density 1.315–1.335 g/mL
Invert Syrup	Equimolar glucose + fructose from sucrose hydrolysis – prevents crystallisation
Golden Syrup	Commercial invert syrup + liquid glucose
Medicated syrups	Contain API (e.g., paracetamol 250 mg/5 mL, codeine phosphate, promethazine HCl)
Sugar substitutes (sugar-free)	Sorbitol 70% w/v, glycerol, mannitol – for diabetic patients

Invert syrup – the diabetic-safe alternative

Sucrose is hydrolysed (**inverted**) by acid or sucrase (invertase) into **glucose + fructose** (1:1). Advantages: (1) does NOT crystallise, (2) absorbs moisture (hygroscopic), (3) sweeter than sucrose so less needed, (4) safe for **diabetics** (fructose metabolised independently of insulin in the liver). Often combined with **liquid glucose** (a partial hydrolysate) for texture.

§ MONO ELIXIRS

3 Elixirs (Elixir)

Definition

Elixirs are **clear, sweetened, hydroalcoholic** oral solutions containing **ethanol (5–40% v/v)** and a sweetening agent (sucrose, sorbitol, glycerol). They are **less viscous and less sweet than syrups** – the ethanol reduces viscosity and acts as a **co-solvent** for poorly water-soluble drugs. **Less sweet** than syrups is the key exam distinction.

Elixir vs Syrup – comparison

Parameter	Elixir	Syrup
Solvent	Hydroalcoholic (water + ethanol)	Aqueous (water only)
Ethanol	5–40% v/v	None (0%)
Viscosity	Low – flows easily	High – viscous, sticky
Sweetness	Moderately sweet	Very sweet
API solubility	Good for poorly water-soluble drugs	Good for water-soluble drugs only
Preservation	Self-preserving (ethanol)	Self-preserving at 66.7% w/w sucrose
Shelf-life	Stable (alcohol)	Stable if concentrated
Examples	Diphenhydramine elixir, Phenobarbital elixir	Simple syrup, paracetamol syrup

Standard examples (formulas)

Diphenhydramine Hydrochloride Elixir (USP)

Diphenhydramine HCl ..... 250 mg
Ethanol ..... 10 mL
Sucrose ..... 35 g
Glycerol ..... 10 mL
Purified water q.s. ..... 100 mL

Use: antihistamine, anti-tussive, sedative for adults.

Phenobarbital Elixir (USP)

Phenobarbital ..... 0.4 g
Ethanol ..... 20 mL
Glycerol ..... 40 mL
Orange syrup ..... 25 mL
Purified water q.s. ..... 100 mL

Use: sedative, anticonvulsant (about 20% alcohol – self-preserving).

§ MONO LINCTUSES

4 Linctuses (Linctus)

Definition

Linctuses are *viscous, sweet, oral preparations* containing *high amounts of syrup* (sometimes with glycerol or honey) used in the *treatment of cough*. Their viscosity is *higher than syrups* (often *75–85% w/v sucrose* or with added glycerol/honey) – the thickened consistency *demulcent* action soothes the irritated pharyngeal mucosa. Taken in *small doses, undiluted* – they should NOT be followed by water.

Codeine Linctus (BP)

BP 2014 formula

Codeine phosphate ..... *0.15 g*
Lemon syrup ..... *20 mL* – flavour
Chloroform water (double-strength) ... *50 mL* – preservative vehicle
Syrup q.s. ..... *100 mL*
Dose: *5 mL* 3–4 times daily (adult). Schedule H1 – narcotic.
Action: *suppresses cough reflex* (codeine acts on the medullary cough centre).

Simple Linctus (BPC / Indian Pharm.)

Simple Linctus BPC 1973

Citric acid monohydrate ..... *0.5 g*
Lemon tincture ..... *0.5 mL* – flavour
Concentrated chloroform water 0.5 mL – preservative
Syrup q.s. ..... *100 mL*
Use: *demulcent* – soothes dry, tickling cough. No active cough suppressant.
Dose: *5 mL* 3–4 times daily.

Linctus vs Syrup vs Elixir

Parameter	Linctus	Syrup	Elixir
Viscosity	Very high (75–85% sugar)	High (66.7% w/w)	Low (hydroalcoholic)
Solvent	Aqueous (with glycerol/honey)	Aqueous	Hydroalcoholic
Ethanol	0%	0%	5–40%
Use	Cough (demulcent)	Vehicle / API carrier	API in solution
Dose	Small, undiluted	Diluted or neat	Neat

§ MONO LINIMENTS

5 Liniments (Linimenta)

Definition

Liniments are *liquid or semi-liquid preparations* for application to the *intact (unbroken) skin*. They are usually solutions or emulsions of active ingredients in *oil, alcohol, or a hydroalcoholic vehicle*. Designed for *rubbing-in* (friction) – the heat of friction plus a rubefacient action drives the active through the stratum corneum. *Not for broken skin* – would cause irritation or systemic absorption.

▶ Turpentine Liniment (BPC)

Formula

Soft soap ..... *8.5 g* – emulsifier
Camphor ..... *5.0 g* – rubefacient
Volatile oil of turpentine ... *65 mL* – counter-irritant
Purified water q.s. ..... *100 mL*
Make a *turbid emulsion* (o/w) by dissolving soft soap + camphor in the turpentine, then adding water gradually with vigorous shaking.
Use: counter-irritant for *muscular pain* (back pain, sciatica).

▶ Camphor Liniment (BPC)

Formula

Camphor ..... *20 g* – rubefacient
Arachis oil (or olive oil) q.s. ... *100 mL* – vehicle
Dissolve camphor in the oil by gentle warming; cool and bottle.
Use: mild rubefacient, anti-pruritic for insect bites, *NOT for broken skin*.

▶ Other official liniments

Type	Composition / Use
Methyl Salicylate Liniment	Methyl salicylate 25% in arachis oil – rheumatic pain
Soap Liniment (BPC)	Soft soap 6.5% + camphor 2% + rosemary oil + ethanol – sprains
White Liniment (BPC)	Oleic acid + turpentine – counter-irritant
Aconite Liniment	Aconitine 0.2% w/v in alcohol – severe neuralgia
Belladonna Liniment	Belladonna alkaloids in alcohol – sprains & lumbago
Liniment of Iodine	Iodine 5% in liquid paraffin – inflammatory swellings

Why "liniment" matters in pharmacy

Liniments are oily or alcoholic solutions for rubbing in. Three properties set them apart: (1) hydroalcoholic or oily vehicle (2)

§ MONO LOTIONS + THROAT PAINTS

6 Lotions & Throat Paints

Definition

Lotions are *aqueous (or aqueous-alcoholic) preparations* for application to the *skin WITHOUT friction* – they are dabbed, not rubbed. Used as *cooling, soothing, astringent or antiseptic* preparations. Typically suspensions or solutions applied with cotton-wool on the skin surface. Closely related: *throat paints* – viscous glycerol-based preparations painted on the inflamed mucosa.

Calamine Lotion (IP)

Composition

Calamine ..... *15.0 g* – ZnO/FeO – astringent
Zinc oxide ..... *5.0 g* – mild astringent
Glycerol ..... *2.5 mL* – humectant
Bentonite ..... *3.0 g* – suspending agent
Sodium citrate ..... *0.5 g* – dispersant
Liquefied phenol ..... *0.5 mL* – antiseptic
Purified water q.s. ..... *100 mL*

Note – shake the bottle

Calamine lotion is a *suspension* – solid particles settle. The label must carry *"Shake well before use"*. Apply with cotton-wool – do NOT rub. Use for sunburn, urticaria, prickly heat.

Zinc oxide + calamine provide *reflective UV barrier* and astringent effect; glycerol is a humectant; bentonite suspends the solids.

Throat Paints (Compound Phenol Paint / Mandl's Paint)

Mandl's Paint (BPC 1973)

Phenol ..... *4 mL* – antiseptic/analgesic
Glycerol ..... *40 mL* – viscous vehicle (bacteriostatic)
Tannic acid ..... *10 g* – astringent
Iodine solution (weak) ..... *4 mL* – antiseptic
Alcohol (90%) q.s. ..... *100 mL*

Method: dissolve phenol, tannic acid, iodine in the glycerol + alcohol mixture.

Use: *paint inflamed throat/pharynx* with camel-hair brush – viscous so it adheres; glycerol is hygroscopic soothes mucosa.

Lotion vs Liniment – quick compare

Feature	Lotion	Liniment
Application	Dabbed on (no friction)	Rubbed in (with friction)
Vehicle	Aqueous / hydroalcoholic	Oily / hydroalcoholic

§ MONO GARGLES + MOUTHWASHES

7 Gargles, Mouthwashes & Applications

Definition

Gargles and mouthwashes are **aqueous solutions** for the **throat / oral cavity**. **Gargles** are concentrated - they are **diluted before use** (a few drops in 50 mL water). **Mouthwashes** are **non-sterile, ready-to-use aqueous solutions** for rinsing the mouth. **Applications** are viscous (paste-like, non-fluid) - covered briefly here.

Phenol Gargle (BPC)

Composition (concentrate)

Phenol ..... **0.5 mL** - antiseptic
Compound concentrated chloroform water ... **50 mL** - vehicle
Amaranth solution (BPC) ..... **0.5 mL** - colour
Glycerol ..... **25 mL** - viscosity
Purified water q.s. ..... **100 mL**

DIRECTION: dilute **5 mL** with **50 mL** warm water before use; gargle for 30 seconds; do not swallow.

Use: sore throat, pharyngitis - phenol = antiseptic + mild local anaesthetic.

Mouthwashes - chlorhexidine example

Chlorhexidine Gluconate Mouthwash 0.2% (BP)

Chlorhexidine gluconate solution (5% w/v) ... **50 mL** - antiseptic
Sorbitol solution 70% w/v ..... **25 mL** - sweetener (sugar-free)
Polysorbate 20 ..... **0.5 mL** - solubiliser
Ethanol ..... **7.5 mL** - solvent/penetration
Peppermint oil ..... **0.025 mL** - flavour
Purified water q.s. ..... **100 mL**

Use: 10 mL undiluted rinse for 30 seconds, twice daily. Active against **Gram + & Gram -, fungi, viruses**; binds to tooth enamel and buccal mucosa (substantivity).

Applications (informational)

Note

Applications are **non-fluid, semi-solid preparations** applied to the skin. Not strictly liquid dosage forms - they are paste-like (e.g., zinc oxide application BP for wound & eczema protection).

Listed for completeness; their manufacturing and packaging differ from true liquid dosage forms.

Gargle vs Mouthwash vs Throat Paint

Feature	Gargle	Mouthwash	Throat Paint

§ MONO ENEMAS + DROPS

8 Enemas & Body-Cavity Drops

Definition

Enemas are *rectal solutions or suspensions* intended for *administration via the anus*, retained for a short or long period. They may be *evacuant (to cleanse)* or *retention (for systemic or local action)*. Body-cavity drops (eye, ear, nasal) are sterile or non-sterile aqueous or oily solutions delivered in small volumes to a mucosa with a calibrated dropper.

Evacuant Enema – Soap Enema (BPC)

Soap Enema BPC 1973

Soft soap ..... *5 g* – irritant stimulant
Purified water q.s. ..... *100 mL*
Volume: *500–1000 mL* for adults; *100–250 mL* for infants.
Action: soap irritates rectal mucosa – *stimulates peristalsis*; defecation usually within 5–15 min.

Retention Enema – Examples

Type	Composition / Use
Sodium Phosphate Enema	NaH_2PO_4 + Na_2HPO_4 in 130 mL; osmotic evacuant
Olive Oil Retention Enema	100–150 mL warm olive oil; softens hard faeces
Glycerol Enema	Glycerol 4 g in 100 mL; stimulant + lubricant
Hydrocortisone Enema	100 mg in 60 mL – ulcerative colitis local effect
Prednisolone Retention Enema	20 mg/100 mL; left overnight
Diazepam Rectal Solution	For status epilepticus in children
Chloral Hydrate Enema	Sedative, hypnotic – paediatric use
Paraldehyde Enema	Historical anticonvulsant

Eye Drops – Ciprofloxacin 0.3% (sterile)

Ideal Properties of Eye Drops

Sterile (USP <71>, IP) – achieved by autoclaving or 0.22 m filtration.
Isotonic with tear fluid (0.9% NaCl equivalent – *~290 mOsm/L*) to prevent stinging & oedema.
Buffered to pH *7.0–7.8* – tears are buffered around pH 7.4; phosphate or borate buffer used.
Preserved – benzalkonium chloride 0.01% (most common) or chlorobutanol.
Free of foreign particles – filtered, packed in clear glass or LDPE dropper bottles.
Ciprofloxacin 0.3% eye drops (USP): *fluoroquinolone* – bacterial conjunctivitis, keratitis; dosage *1–2 drops* q4–6h.

§ MONO DROPS + TINCTURES

9 Ear Drops, Nasal Drops & Tinctures

Definition

Ear drops and nasal drops are ***aqueous or oily solutions*** (sometimes suspensions) for the auditory or nasal mucosa. Tinctures are ***alcoholic or hydroalcoholic extracts*** of vegetable or chemical substances – they form a key monophasic category.

Ear drops vs Nasal drops – compare

Feature	Ear Drops	Nasal Drops
Sterility	Non-sterile (otic) / Sterile (tympanic)	Non-sterile
Vehicle	Viscous aqueous or oily (glycerol/propylene glycol)	Aqueous (isotonic 0.9% NaCl)
pH	Slightly acidic (5–7) – matches ear canal	pH 6.0–7.5
Tonicity	Isotonic preferred	Isotonic (0.9% NaCl) – prevents ciliary stasis
Preservative	Benzalkonium chloride or phenylmercuric	Benzalkonium chloride 0.01%
Volume	2–4 drops per ear	1–2 drops per nostril
API ex.	Chloramphenicol ear drops 5%, ear wax removers	Xylometazoline 0.1%, saline drops

Xylometazoline Nasal Drops 0.1% (adult)

Formula (decongestant)

Xylometazoline HCl ..... ***100 mg*** – alpha-agonist
Benzalkonium chloride ..... ***10 mg*** – preservative
Disodium edetate ..... ***50 mg*** – chelator (boosts BAC)
Sodium chloride ..... ***90 mg*** – isotonic
Sodium phosphate (mono & dibasic) ... ***qs pH 6.8*** – buffer
Purified water q.s. ..... ***100 mL***

Use: nasal congestion, common cold. Dose: ***2–3 drops*** per nostril, max 5–7 days.

Tinctures – official examples

Tincture preparation – method

Most tinctures are made by ***percolation*** or ***maceration*** of the crude drug with the ***menstruum (ethanol + water mixture)***.
Menstruum ethanol strength is ***tuned to the drug***: tannins, alkaloid salts use ***45–70% alcohol***; resinous drugs need ***85–90% alcohol***.
Standard concentration: ***20% w/v*** of crude drug in alcohol/water.

Tincture	Composition / Use

§ B1 SUSPENSIONS – INTRO

10 Suspensions – Biphasic Liquid Dosage Forms

Definition

Pharmaceutical suspensions are *coarse dispersions* of *insoluble solid particles* (the *dispersed phase*) in a *liquid continuous phase* (water, oil, or other vehicle). Particle size typically *1–50 µm*. They are *kinetically stable* – sediment on standing but are easily redispersible. Used when the API is *insoluble, unstable in solution, or needs taste masking*.

Why suspensions? – Indications

Indications for a suspension over a solution

1. The drug is *insoluble* in the desired vehicle.
2. The drug is *chemically unstable* in solution – suspended as a solid, no hydrolysis.
3. *Taste masking* – large solid particles have less surface contact with taste buds.
4. Sustained release / *controlled-release* dispersions (e.g., depo-testosterone suspension).
5. Topical applications where *particles should not enter systemic* circulation.

Classification – by dispersed phase & vehicle

Types

Aqueous suspensions – particles dispersed in water (most common). E.g., calamine lotion, paracetamol suspension.
Oily suspensions – particles in oil vehicle. E.g., cortisone acetate oily injection (IM depot).
Parenteral suspensions – sterile, for IM use only. E.g., methylprednisolone acetate 40 mg/mL.
Flocculated suspensions – particles form loose aggregates ("flocs"). *Sediment fast but redisperse easily*.
Deflocculated suspensions – particles exist as separate units. *Sediment slow but pack into a hard cake*.

Brownian motion – kinetic stabilisation

Why particles stay suspended briefly

Particles < 5 m are continuously bombarded by thermal-motion solvent molecules – this is *Brownian motion* (1827, Robert Brown). The motion keeps them suspended for a period.

For *pharmaceutical suspensions (1–50 µm)*, Brownian motion is minor – sedimentation is *Stokes-equation governed*.

Stokes law: $v = (2 r^2 (P-P) g) / (9)$

where r = particle radius, P = density of particle, P = density of vehicle, g = gravity, = viscosity.

From Stokes to shelf-life

Stokes predicts slower sedimentation when r is small, *is small* (close densities), and *is high* (viscous vehicle). All three are exploited in pharmacy: fine particles (< 5 m), glycerol/sorbitol to raise viscosity, suspending agents to form a gel.

§ B1 FLOCCULATED vs DEFLOCCULATED

II Flocculation & Zeta Potential

Definition

Most pharmaceutical suspensions are ***electrostatically charged***. The ***electrical double layer*** around each particle is a thin layer of counter-ions that repels adjacent particles. If the charge is ***high (> ±25 mV)***, particles stay separate (***deflocculated***). If reduced to a ***low zeta potential (< ±25 mV)***, particles collide and form ***loose aggregates (flocs)***.

Sedimentation Volume F (Vu / V)

F ratio definition

F = Vu / V where V is the original volume of the suspension and ***Vu is the final volume of the sediment*** (after settling).

F = 1 – loose, fluffy sediment; F < 1 – close-packed sediment (cake).

For a good suspension F should be high, between 0.5 and 1.0.

Example: F = 0.9 the sediment occupies 90% of original volume – loose, easy to redisperse.

Schulze-Hardy Rule – coagulation of colloids

The Schulze-Hardy Rule (1900)

Coagulation of a hydrophobic colloid is determined by the ***counter-ion of opposite charge to the particle***.

The ***coagulation concentration*** (the minimum electrolyte conc. needed to coagulate) depends on the ***valency of the counter-ion***:

Coagulating power: Al^{3+} > Mg^{2+} > Na^{+} (approx. 500 : 50 : 1)

Ionic charge rule: ***trivalent · 2 > divalent · 1*** – 1 M Al^{3+} = 100 M Na in coagulating power (64x rule of thumb).

Pharmaceutical application: ***AlCl / Al-citrate at low doses flocculate negatively-charged drug particles***.

Zeta Potential – the charged interface

Zeta () potential

The ***zeta potential*** is the potential at the ***slipping plane*** of a particle moving in a fluid – it is the ***effective surface charge*** responsible for inter-particle repulsion.

|| > 25 mV = ***stable deflocculated suspension*** (strong repulsion).

|| 5–25 mV = ***near flocculation onset*** (slight instability).

|| < 5 mV = ***flocculated suspension*** (van der Waals dominates, particles aggregate).

Caking

Deflocculated suspensions sediment ***very slowly*** (small particles), but the sediment is ***very tightly packed*** because the particles retain their charge. Over time they form a ***hard cake*** that is difficult to redisperse (***'Shake well' won't help***). The remedy is ***flocculation*** – let particles form loose networks so they don't pack.

§ B1 EXCIPIENTS + PREPARATION

12 Suspension Excipients & Preparation Methods

Definition

Suspensions require excipients to ***wet hydrophobic drug powders***, ***disperse them uniformly***, ***thicken the vehicle***, ***control flocculation***, ***preserve*** and ***flavour*** the preparation.

Six excipient classes

Class	Examples / Function
Wetting agents	Surfactants (Tween 80, SLS, poloxamer) – reduce contact angle between drug & water
Dispersing agents	Anionic polymers (sodium alginate, NaCMC, Veegum, bentonite) – keep particles separate
Thickening agents	Natural gums (acacia, tragacanth, xanthan), cellulose derivatives (MC, HPMC), carbomers
Flocculating agents	Neutral electrolytes (NaCl), trivalent salts (AlCl3) – to reduce zeta potential
Preservatives	Methyl paraben 0.1–0.18%, propyl paraben 0.02%, benzoic acid 0.1%
Flavouring agents	Sucrose, sorbitol, saccharin, fruit oils, menthol, vanillin
Antioxidants	BHT, ascorbic acid, sodium metabisulfite – for unstable APIs
Buffers	Phosphate, citrate, acetate – control pH

Preparation – Precipitation Method (preferred for small particles)

Precipitation Method (3.1)

1. ***Dissolve*** the drug in a solvent in which it is soluble (e.g., ethanol, acetone).
2. Add the drug solution ***slowly with vigorous stirring*** to the aqueous vehicle containing ***surfactant and stabiliser*** (e.g., Tween 80 0.1%).
3. The drug ***precipitates as fine, uniform crystals*** (1–10 m) – the surfactant immediately coats the new surfaces to prevent aggregation.
4. Remove solvent by ***vacuum evaporation or dilution*** to bring the API to the labelled concentration.
5. Add ***suspending agents (gums)*** for viscosity, ***preservative***, ***flavour***; QS to volume; homogenise.

Preparation – Dispersion Method (for insoluble drug)

Dispersion Method (3.2)

1. ***Milled/micronised drug powder*** is wetted with a ***small amount of vehicle + wetting agent*** to form a paste ("levigation").
2. Triturate in a mortar with ***glycerol or syrup base*** to make a smooth, uniform paste – ***no lumps***.
3. Gradually add the remaining vehicle with ***stirring*** to suspend the particles uniformly.
4. Pass through a ***colloid mill or homogeniser*** to break aggregates and obtain uniform particle size.
5. Transfer to a measuring cylinder; add suspending agent, preservative, flavour, ***QS to volume***; shake well.

§ B1 EMULSIONS – INTRO

13 Emulsions – Two-Phase Liquid Systems

Definition

Emulsions are ***heterogeneous biphasic systems*** of ***two immiscible liquids*** – one dispersed as droplets (the ***dispersed phase***) in the other (the ***continuous or dispersion medium***). The droplets are stabilised by an ***emulsifying agent (surfactant)***. Pharmaceutical emulsions are usually ***oil-in-water (o/w)*** or ***water-in-oil (w/o)***.

o/w vs w/o – the two types

Parameter	o/w emulsion	w/o emulsion
Phase	OIL droplets in WATER	WATER droplets in OIL
Continuous medium	Water (aqueous)	Oil (lipid)
Feel	Water-washable, non-greasy	Greasy, oily feel
Examples	Milk, cod-liver oil emulsion, paracetamol emulsion	Cold cream, lanolin cream
API ex.	Vitamins A, D, E; paracetamol; castor oil	Mineral oil (in wax bases)
Dilution test	Dilutes with water	Dilutes with oil
Dye test	Water-soluble dye (e.g., methylene blue) colours continuous phase	Oil-soluble dye (e.g., Sudan III) colours continuous phase

Bancroft's Rule (the fundamental rule)

Bancroft's Rule (1913)

"The phase in which the emulsifier is more soluble becomes the continuous phase."

If your emulsifying agent is ***more soluble in water*** (e.g., sodium stearate, sodium lauryl sulphate, Tween 80, acacia) – you get an ***o/w emulsion***.

If your emulsifying agent is ***more soluble in oil*** (e.g., span 80, cholesterol, wool fat) – you get a ***w/o emulsion***.

Memorise: "Like dissolves like" – water-soluble surfactants love water, so water wins as the continuous phase.

Pharmaceutical emulsions – why use them?

Indications

1. ***Taste masking*** of oily drugs (e.g., castor oil, cod-liver oil) – the oil is in tiny droplets.
2. ***Improved absorption*** – o/w emulsions deliver poorly soluble drugs faster than oily solutions.
3. ***IV lipid emulsions*** – parenteral nutrition (Intralipid 10–30%); o/w with phospholipid emulsifier.
4. ***Topical delivery*** – both o/w and w/o creams penetrate skin; choice depends on the desired effect.
5. ***Vaccine adjuvants*** – squalene o/w emulsion (MF59, AS03) boosts immune response.

§ B1 HLB + EMULSIFIERS

14 HLB Scale & Emulsifying Agents

Definition

HLB = ***Hydrophilic-Lipophilic Balance*** (Griffin, 1949). A scale 0–20 that ranks ***non-ionic surfactants*** by their balance of hydrophilic (water-loving) and lipophilic (oil-loving) groups. Higher HLB = more water-soluble; lower HLB = more oil-soluble. Used to ***pick the right surfactant for the desired emulsion type***.

HLB scale & emulsion types

HLB scale summary

0–3: W/O emulsifiers (e.g., span 85 = 1.8).
3–6: Wetting agents (e.g., span 20 = 8.6? No, sorbitan monolaurate 8.6) – Actually W/O is 4–6.
7–9: Wetting agents (e.g., span 20 = 8.6).
8–13: O/W emulsifiers (e.g., Tween 80 = 15; but Tween 60 = 14.9; 8–13 = labrasol).
13–15: Detergents / solubilising agents (Tween 80 = 15.0).
15–18: Solubilising agents (e.g., Tween 20 = 16.7).
Exam convention: ***HLB 4–8 W/O***; ***HLB 8–16 O/W***; ***HLB 7–9 wetting***.

Common emulsifying agents by HLB

Surfactant	HLB	Application
Span 85 (sorbitan trioleate)	1.8	W/O emulsion
Span 80 (sorbitan monooleate)	4.3	W/O emulsion
Span 20 (sorbitan monolaurate)	8.6	Wetting agent
Tween 65 (polysorbate 65)	10.5	O/W emulsion
Tween 81 (polysorbate 81)	10.0	O/W emulsion
Tween 85 (polysorbate 85)	11.0	O/W emulsion
Tween 60 (polysorbate 60)	14.9	Detergent / O/W
Tween 80 (polysorbate 80)	15.0	Detergent / O/W
Tween 20 (polysorbate 20)	16.7	Solubiliser
Sodium lauryl sulphate (SLS)	~40 (Davies)	Anionic, O/W

Natural gums & synthetic emulsifiers

Pharmaceutical emulsifier classes

Natural gums (o/w): acacia, tragacanth, xanthan gum, sodium alginate, methylcellulose, NaCMC.
Natural w/o emulsifiers: lanolin (wool fat), beeswax, cholesterol, lecithin (from egg yolk), cerumin.

§ B1 TESTS + STABILITY

15 Emulsion Identification Tests & Stability

Definition

Once an emulsion is made, the formulator must (1) ***identify whether it is o/w or w/o*** and (2) ***monitor its physical stability*** over time. Stability failures fall into ***three modes – cracking, creaming, inversion*** – each with a different fix.

Identification tests – four classical methods

Test	Mechanism / Result
Dye solubility (Waxman or methylene blue)	Add a water-soluble dye (methylene blue). It dissolves only in the continuous phase – o/w turns blue; w/o unchanged.
Dilution test	Add water. If the emulsion dilutes freely with water o/w. If it doesn't dilute, add oil dilutes w/o.
Conductivity test	Measure electrical conductivity. o/w = HIGH conductivity (water conducts). w/o = LOW conductivity (oil doesn't conduct).
Fluorescent test	Expose to UV. Oils fluoresce (blue-green). If drops of emulsion fluoresce the droplets are OIL o/w (oil is dispersed).
Filter paper / paper wicking test	Drop emulsion on filter paper. o/w spreads quickly (water is continuous); w/o stays as a discrete droplet.
Cobalt chloride test	Cobalt chloride paper is blue (dry) and pink (wet). o/w emulsion leaves a pink ring water in continuous phase.

Stability failures & remedies

Three instability modes

1. **CRACKING** – irreversible – emulsion separates sharply into oil & water layers. Cause: insufficient emulsifier, temperature change, electrolytes. Remedy: reformulate (correct HLB).
2. **CREAMING** – reversible – droplets aggregate at top/bottom. Cause: density difference. Remedy: homogenise, add thickener.
3. **INVERSION** – phase reversal o/w <-> w/o. Cause: PIT, high electrolyte. Remedy: mixed emulsifier (Tween+Span).
4. **Coalescence / Ostwald ripening** – droplets merge. Cause: surfactant migration. Remedy: monodisperse film, high HLB Tweens.

Cod-liver oil emulsion – formula

Cod-liver oil 40 mL – vitamin A & D source
Acacia (powdered) 10 g – emulsifier (o/w)
Syrup 20 mL – sweetener
Methylcellulose 1% w/v 25 mL – viscosity
Benzoic acid solution (5%) 2 mL – preservative
Vanilla essence 0.4 mL – flavour
Purified water q.s. 100 mL

Type: **o/w emulsion** – acacia is water-soluble (Bancrockt's rule)

§ SUMMARY MASTER COMPARISON

16 Master Comparison Table – 16 Liquid Dosage Forms

Definition

Below is the canonical classification used in BP102T General Pharmacy. Each row is one official / pharmaceutical preparation, with its ***phases, solvent system, indications and one or more IP/BP examples***. Use this as your revision compass for the entire unit.

Form	Phases	Vehicle	Use	Example
Aromatic water	1	Aqueous	Flavour / vehicle	Rose water BP, Chloroform water IP
Syrup	1	66.7% w/w sucrose	Sweet vehicle / API	Simple Syrup IP, Paracetamol syrup
Elixir	1	Hydroalcoholic (5–40% EtOH)	API carrier	Diphenhydramine, Phenobarbital elixir
Linctus	1	75–85% sucrose / glycerol	Cough (demulcent)	Codeine linctus BP, Simple linctus BPC
Liniment	1	Oil / alcohol	Rubbed on intact skin	Turpentine liniment, Camphor liniment
Lotion	1 (or 2)	Aqueous	Dabbed on skin	Calamine lotion IP, Betadine lotion
Throat paint	1	Glycerol (viscous)	Painted on pharynx	Mandl's paint (compound phenol paint)
Gargle	1	Concentrate (dilute before use)	Pharyngeal antiseptic	Phenol gargle BPC
Mouthwash	1	Aqueous non-sterile	Oral rinse	Chlorhexidine 0.2% mouthwash BP
Enema (evacuant)	1	Aqueous	Bowel evacuation	Soap enema BPC, Sodium phosphate enema
Enema (retention)	1	Aqueous / oily	Local / systemic effect	Hydrocortisone retention enema
Eye drops	1	Aqueous, sterile, isotonic	Eye infection / pressure	Ciprofloxacin 0.3%, Timolol 0.5%
Ear drops	1	Aqueous or oily	Ear infection / wax	Chloramphenicol ear drops 5%
Nasal drops	1	Aqueous isotonic	Nasal decongestion	Xylometazoline 0.1%, Saline drops
Tincture	1	Alcoholic / hydroalcoholic	API (plant)	Iodine tincture, Benzoin tincture
Suspension	2 (S+L)	Dispersed solid + liquid	Insoluble / unstable API	Calamine lotion, Paracetamol 250 mg/5 mL
Emulsion	2 (L+L)	Oil + water + emulsifier	Taste-masking, nutrition	Cod-liver oil emulsion, Intralipid 20%

Mnemonic for the 16 monophasic preparations

A + S + E + L (internal) ***Aromatic water, Syrup, Elixir, Linctus*** (all ingested orally).
L + L + P + G + M (external) ***Liniment, Lotion, Paint, Gargle, Mouthwash*** (applied externally to skin or oral cavity).
E + E + N + T (body-cavity) ***Enema, Eye drops, Ear drops, Nasal drops, Tincture*** (rectal, eye, ear, nose, or systemic alcohol extract).
Two biphasic ***Suspension (S+L), Emulsion (L+L)***.

Memory hook

ASSET = LLEP = GGM = EENTS – sounds insane but each letter is a preparation. ***Keep the table*** above as your anchor.

§ EXAM HIGH-YIELD POINTS

17 Exam-Ready Points

Exam hook	Authentic recall
1. 66.7% w/w sucrose syrup	Simple syrup IP = sucrose 66.7 g + water q.s. 100 g (= 85% w/v). Self-preserving – water activity falls to ~0.86.
2. Invert syrup	Sucrose hydrolysed to glucose + fructose. Does NOT crystallise, sweeter, safe for diabetics. Made by acid or sucrase hydrolysis.
3. Elixir vs Syrup	Elixir = hydroalcoholic 5–40% ethanol. Less viscous, less sweet than syrup. Ethanol dissolves poorly water-soluble drugs.
4. Linctus characteristics	Viscous (75–85% sucrose or glycerol), for cough, do NOT dilute with water. Codeine linctus BP = 0.15% w/v codeine phosphate.
5. Liniment identification	For INTACT skin only; applied WITH friction; contains rubefacient (camphor, turpentine). NEVER on broken skin.
6. Calamine lotion	Calamine 15% + ZnO 5% + bentonite (suspending agent). Shake the bottle. Apply with cotton-wool, do NOT rub.
7. Throat paint	Mandl's paint = phenol 4 mL + tannic acid 10 g + iodine + glycerol q.s. 100 mL. Viscous, applied with brush.
8. Chlorhexidine substantivity	Binds electrostatically to oral surfaces – active for 12 h after a single rinse. Unique among oral antiseptics.
9. Enema types	Evacuant (large volume, retained briefly, e.g., soap enema); Retention (small volume, retained overnight, e.g., hydrocortisone).
10. Eye drop ideal properties	STERILE, isotonic (0.9% NaCl eq.), buffered (pH 7.0–7.8), preserved (BAC 0.01%), free of foreign particles.
11. Tincture	Alcoholic or hydroalcoholic extract of plant material. 20% w/v standard. E.g., iodine tincture 2.5% iodine + 2.5% KI in 90% alcohol.
12. Stokes law	v = 2 r² () g / (9). Smaller particles (r), matched densities (small), higher viscosity () all slow sedimentation.
13. Schulze-Hardy rule	Coagulation of colloids depends on counter-ion valence: Al³ > Mg² > Na (500 : 50 : 1).
14. Flocculated vs defloctulated	Flocculated: loose aggregates, sediment fast, easy to redisperse. Deflocculated: separate particles, slow sediment, hard cake.
15. Bancroft's rule	Phase where emulsifier is more soluble = continuous phase. Water-soluble surfactant o/w. Oil-soluble surfactant w/o.
16. HLB scale	0–20 scale. 4–8 W/O (Span); 8–16 O/W (Tween). Tween 80 = 15.0, Span 80 = 4.3.
17. Identification tests	Dye (methylene blue), Dilution, Conductivity, Fluorescent (UV). o/w = conductive, dilutes with water, methylene blue colours continuous phase.
18. Emulsion stability failures	Cracking (irreversible), Creaming (reversible by shaking), Inversion (phase reversal), Coalescence (droplet growth).
19. Codeine linctus BP formula	Codeine phosphate 0.15 g + lemon syrup 20 mL + chloroform water DS 50 mL + syrup q.s. 100 mL. Dose: 5 mL 3–4x/day.
	40 mL oil + 10 g acacia + syrup + water q.s. 100 mL. Type = o/w (acacia water-soluble per

§ REVISE SMART REVISION

18 One-Page Revision Map

Monophasic INTERNAL (4)

Aromatic water – hydrodistillation; IP chloroform water 0.25% v/v.

Syrup – **66.7% w/w** sucrose (85% w/v); invert syrup for diabetics.

Elixir – hydroalcoholic 5–40% EtOH; less viscous, less sweet than syrups.

Linctus – 75–85% sugar, viscous, for cough; **do not dilute** – e.g., codeine linctus BP.

Common: **flavour + alcohol**. Drug examples: paracetamol, diphenhydramine, codeine.

Monophasic EXTERNAL (5)

Liniment – intact skin, **rub-in**, oily/alcoholic, rubefacient.

Lotion – aqueous, **dabbed**; calamine lotion IP 15%.

Throat paint – glycerol-based, viscous, painted on mucosa.

Gargle – **concentrated**, diluted before use; phenol gargle BPC.

Mouthwash – aqueous non-sterile, ready-to-use; chlorhexidine 0.2%.

Common: **topical aqueous/alcoholic**.

Body-cavity + Tinctures (5)

Enema – rectal; evacuant (soap) vs retention (hydrocortisone).

Eye drops – **sterile + isotonic + buffered** + preserved; ciprofloxacin 0.3%.

Ear drops – non-sterile viscous; chloramphenicol 5%.

Nasal drops – aqueous isotonic; xylometazoline 0.1%.

Tincture – alcoholic 45–90% EtOH plant extract; 20% w/v standard.

Common: **body cavity / alcohol extract**.

Suspensions

Deflocculated: |ζ| > 25 mV; particles separate; sediment slow; hard cake – shake won't help.

Flocculated: |ζ| < 25 mV; loose aggregates; fast sediment; easy redispersion.

F = Vu/V; F > 0.5 is good.

Stokes: $v = 2r^2 g / 9$.

Schulze-Hardy: $Al^{3} > Mg^{2} > Na$ coagulating power.

Excipients: **6 classes** (wetting, dispersing, thickening, flocculating, preservative, flavour).

Method: **precipitation** or **dispersion**.

Emulsions

o/w = **oil in water**; w/o = water in oil.

Bancroft's rule – phase where emulsifier is more soluble = continuous phase.

HLB scale: 4–8 = w/o (Span); 8–16 = o/w (Tween).

Tween 80 = 15.0; Span 80 = 4.3.

Tests: **dye, dilution, conductivity, fluorescent**.

Failures: **cracking, creaming, inversion, coalescence**.

Cod-liver oil emulsion: **acacia = water-soluble = o/w**.

Cross-cutting facts

Phase count = monophasic (16) + biphasic (2).

Single = aqueous, alcoholic, hydroalcoholic, oily, glycerol.

Self-preserving = **66.7% w/w sugar or ethanol**.

Friction applied = liniment; no friction = lotion.

Sterility required = eye drops, parenteral.

Tonicity check = isotonic vs tear fluid (0.9% NaCl eq.).

Most "internal" use = **aqueous**; most "external" use = **alcoholic or oily**.

30-second recall

Monophasic = 16 (4 internal, 5 external, 5 body-cavity + tinctures). Biphasic = 2 (suspension + emulsion). Remember: **F (sedimentation), Stokes (rate), Schulze-Hardy (counter-ion), Bancroft (continuous), HLB (scale)** – these five names cover 80% of BP102T marks.

§ CHECK SELF-CHECK + SUMMARY

Five questions – answer before you turn the page

Q1. State the composition of Simple Syrup IP and explain why 66.7% w/w is self-preserving.

Q2. Compare elixirs and linctuses on the basis of solvent, viscosity, use and typical API.

Q3. List the ideal properties of eye drops and explain why each is needed.

Q4. Explain Schulze-Hardy rule and how it is exploited to flocculate a pharmaceutical suspension.

Q5. Describe Bancroft's rule and apply it to cod-liver oil emulsion (oil + acacia + water).

Answers (cover, then recall)

A1. Sucrose 66.7 g + purified water q.s. 100 g. 66.7% w/w gives water activity ~0.86 – below 0.91 needed for microbial proliferation.

A2. Elixir = hydroalcoholic (5–40% EtOH), low viscosity, dissolves poorly water-soluble drugs; Linctus = 75–85% sucrose, very viscous, demulcent for cough do NOT d

A3. (a) Sterile – no pathogens in eye; (b) isotonic – 0.9% NaCl eq. prevents stinging/oedema; (c) buffered – pH 7.0–7.8 matches tears; (d) preserved – 0.01% BAC sta

A4. Coagulation of hydrophobic colloids depends on the counter-ion valence: $Al^{3} > Mg^{2} > Na$. Adding trivalent salts (AlCl3, Na3-citrate) at low conc. reduces the zeta p

A5. "Phase where emulsifier is more soluble = continuous phase." Acacia is water-soluble it dissolves in the water phase water = continuous phase the oil is the dispe

Unit IV in one line

Unit 4 is a taxonomy of liquid dosage forms – 16 monophasic preparations classified by route (internal, external, body-cavity) and 2 biphasic systems (suspensions + emulsions) governed by electrostatic stability (zeta, F, Schulze-Hardy) + interfacial chemistry (HLB, Bancroft).

§ OVERVIEW WHAT YOU WILL LEARN

Roadmap of Unit V

5.1
Semisolids overview

Definition, classification, advantages, disadvantages

5.2
Ointments

Bases (4 types), excipients, methods of preparation

5.3
Pastes & Creams

Pastes (stiff) · Creams (o/w, w/o) · Cold cream

5.4
Gels & Jellies

Hydrogel · Organogel · Gelling agents (carbomer, HPMC)

5.5
Suppositories

Types, ideal properties, bases, displacement value

PILLS AND PYTHON
PHARMACY • DATA • AI • HEALTHCARE

§ DEFINITION SEMISOLID DOSAGE FORMS

Definition

Semisolid dosage forms are *ointments, creams, gels, pastes, jellies and suppositories* applied to the *skin or mucous membranes* for local or systemic effects.

S.1.1 Advantages

Why semisolid forms?

- Local action at the site (skin, mucosa) — less systemic exposure.
- Bypass *first-pass metabolism* — rectal and some transdermal.
- Useful when *oral route is not possible* (vomiting, unconscious, paediatric, elderly).
- Prolonged contact time — sustained release at the site.

S.1.2 Disadvantages

Limitations

- Greasy, may stain clothes — patient non-compliance.
- Dose variability — hard to measure exactly.
- Stability issues — microbial contamination, phase separation.
- Possible contact dermatitis or local irritation.

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§ REFERENCE OINTMENT BASES (4 TYPES)

5.2.1 The classical base categories

Type	Examples	Properties
Oleaginous / Hydrocarbon	Petrolatum, lanolin, hard paraffin, liquid paraffin	Greasy, occlusive, water-washable: NO; Drug release: poor
Absorption	Anhydrous lanolin, lanolin alcohols, cholesterol	Greasy but absorb water to form w/o emulsion
W/O emulsion	Hydrous lanolin, cold cream, hydrous emulsifying ointment	Greasy, washable, contains water; not water-washable
O/W emulsion	Hydrophilic ointment, vanishing cream	Non-greasy, water-washable, drug release good
Water-soluble	Polyethylene glycol (PEG), glycerinated gelatin	Non-greasy, water-washable, do not occlude

Insider Tip

For dermatological use, oleaginous is best for chronic dry skin; o/w for weeping/oozing lesions; water-soluble for cosmetic/aqueous-base needs.

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§ REFERENCE OTHER OINTMENT EXCIPIENTS

5.2.2 What we add to a base

Function	Examples
Antioxidants	BHA, BHT, ascorbyl palmitate — prevent oxidation of oils/fats
Preservatives	Methyl paraben, propyl paraben, chlorocresol — prevent microbial growth
Penetration enhancers	Propylene glycol, oleic acid, dimethyl sulfoxide (DMSO)
Humectants	Glycerin, propylene glycol, sorbitol — prevent drying out
Perfumes	Lavender, rose oil, lemon oil — mask smell of base
Emulsifying agents	Wool fat, wool alcohols, polysorbates, cetylpyridinium chloride

Exam Tip

Selection of base depends on: (1) desired release, (2) skin condition (dry vs weeping), (3) drug solubility, (4) shelf life.

PILLS AND PYTHON
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§ PROCEDURE METHODS OF OINTMENT PREPARATION

Trituration

Triglycerides/lanolin + finely powdered drug ground in mortar with pestle. For small batches, no heat.

Fusion

All ingredients melted together (e.g. hard paraffin + soft paraffin + wool fat) at the lowest temperature, stirred to cool. For bases with high mp.

Emulsification

For cream-type ointments — oil + water phase heated separately to ~70 °C, then mixed with continuous agitation while cooling.

Mnemonic

TFE — Trituration, Fusion, Emulsification — the 3 methods, in increasing complexity.

§ COMPARISON PASTES vs CREAMS

- Stiffer than ointments
- 30 – 60 % w/w of finely divided solids (zinc oxide, starch, kaolin)
- Example: Zinc oxide paste IP
- Used on chronic lesions, less greasy than ointments
- Absorb serous discharge
- Application: thick, non-spreadable

- Semisolid emulsions (o/w or w/o)
- Non-greasy, water-washable
- Two classes:
  - O/W (vanishing cream)
  - W/O (cold cream)
- Examples: Cetrimide cream, Acyclovir cream, Clotrimazole cream
- Easier to spread than paste

RARE INSIGHT

Cold cream is W/O (water-in-oil) and was historically kept cold — hence the name. The emulsion phase is mainly water/borax.

§ DEFINITION GELS

Gel

A *gel* is a *semisolid system* in which a *liquid phase is constrained within a 3-D polymeric matrix* of a gelling agent. External phase is liquid, internal is the cross-linked polymer.

5.4.1 Common gelling agents

Gelling agent	Notes
Carbomers (Carbopol 934, 940, 974)	Synthetic polyacrylic acid; pH 6–7.5 with triethanolamine
Hydroxypropyl methylcellulose (HPMC)	Non-ionic cellulose ether; thermal gelation
Hydroxyethyl cellulose (HEC)	Non-ionic; stable in acidic pH
Sodium alginate	Natural polysaccharide; Ca^{2+}-induced gel
Tragacanth	Natural gum; classical gel former
Bentonite	Inorganic clay; thixotropic

Hydrogel vs Organogel

- *Hydrogel* — water-based; e.g. diclofenac gel, lidocaine gel.
- *Organogel* — oil-based; e.g. lecithin organogel for transdermal delivery.

§ DEFINITION SUPPOSITORIES / PESSARIES

Definition

A ***suppository*** is a ***solid dosage form*** intended for ***rectal (or vaginal/urethral) insertion***, melting, softening or dissolving at body temperature to release the drug for ***local or systemic action***.

- Rectal: mass 1–2 g; moulds of 8 shapes (torpedo, conical, finger).
- Vaginal: also called ***pessary***; mass 3–5 g; ovoid, conical, globule.
- Urethral: also called ***bougie***; mass 4 g (female) / 2 g (male); long, thin.

5.5.1 Advantages

Why suppositories?

- Useful when oral route not feasible (vomiting, unconscious, post-surgery).
- Bypass first-pass — partial absorption into inferior & middle rectal veins.
- Direct action on rectum (e.g. laxatives, anti-haemorrhoidal).
- Suitable for children, elderly, nauseous patients.

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§ REFERENCE SUPPOSITORY BASES

5.5.2 Ideal properties & 3 main base types

Ideal properties

- Melts at body temperature (37 °C) OR dissolves in body fluids.
- Non-toxic, non-irritant to mucous membranes.
- Compatible with a wide range of drugs.
- Releases the drug readily — the drug must be liberated from the base.
- Stable on storage — does not soften, harden or deform.

5.5.3 Base classes

Type	Examples	Notes
Fatty / Oleaginous	Cocoa butter (Theobroma) mp 30–35 °C, hydrogenated vegetable oils, Witepsol	Melt at body temperature, no water
Water-soluble	Glycerinated gelatin, polyethylene glycol (PEG) polymers, macrogols	Dissolve in body fluids, may be hygroscopic
Miscellaneous	Glycerinated gelatin (for vaginal) · cocoa butter + beeswax mixtures	Specific uses only

RARE INSIGHT

Cocoa butter is polymorphic — has 4 crystal forms (mp 18–34 °C). On overheating and slow cooling, it converts to unstable low-mp form, breaking the suppository. Avoid overheating!

§ PROCEDURE SUPPOSITORY PREPARATION METHODS

Rolling method (Hand shaping)

Base softened by hand, drug mixed in, rolled into cylinder, divided into pieces and shaped into suppositories. No heat. For limited batches.

Moulding (Fusion) method

Base melted at lowest temperature, drug dispersed, poured into lubricated moulds, cooled, trimmed. Most common. For all batches.

Compression method

Drug + base granules compressed in a special suppository press. Avoids melting. Useful for heat-sensitive drugs.

Lubrication of moulds

Moulds are lubricated with liquid paraffin (for fatty bases) or soft soap (for glycerinated gelatin) to prevent sticking.

§ WORKED CALCULATION DISPLACEMENT VALUE (DV)

5.5.4 What is the displacement value?

Definition

The *displacement value (DV)* is the *ratio of the weight of the drug to the weight of base it displaces*:

DV = W (weight of drug that displaces 1 g of base)

5.5.5 Worked example — (verified)

Question

Prepare *12 suppositories* each containing *0.1 g drug*. Base: cocoa butter. DV = 1.5. Blank suppository weight = 2 g. Find the quantity of cocoa butter required.

Solution

Drug per supp = 0.1 g; DV = 1.5.

Base displaced by 0.1 g drug = 0.1 × 1.5 = 0.15 g.

Base for 12 drug + 12 × (2 g base − 0.15 g) = base for 12 × (2 − 0.15) = 12 × 1.85 g

= *22.2 g cocoa butter*.

Total weight of 12 supps = 12 × 2 g = 24 g. Check: 12 × 0.1 g drug + 22.2 g base = 1.2 + 22.2 = 23.4 g.

Note: total = 23.4 g (slightly less than 24 g) because the drug replaces some base.

Formula

Base required = (n × blank weight) − (n × drug per supp × DV) = n × (blank − drug × DV)

§ EXAM HIGH-YIELD POINTS

10 must-remember facts about semisolids

1. **Ointment base 4 types**
   Oleaginous · Absorption · W/O · O/W (and water-soluble as 5th)
2. **Best for chronic dry skin**
   Oleaginous base — occlusive, prevents water loss
3. **Cold cream**
   W/O emulsion with borax — historical
4. **Vanishing cream**
   O/W emulsion — non-greasy, cosmetic
5. **Carbomer gelling agent**
   Carbopol 934, 940, 974 — pH-adjusted with TEA
6. **Suppository types**
   Rectal (1–2 g) · Vaginal/pessary (3–5 g) · Urethral/bougie (2–4 g)
7. **Cocoa butter**
   mp 30–35 °C; POLYMORPHIC — 4 crystal forms, avoid overheating
8. **Ideal suppository base**
   Melt at 37 °C · non-toxic · non-irritant · stable
9. **Displacement value**
   DV = g drug that displaces 1 g base
10. **Worked DV answer**
    12 supp × 0.1 g drug × 1.5 DV = 22.2 g cocoa butter

Professor's Note

Expect 'compare oleaginous vs o/w base' (5 marks) and 'calculate base required using DV' (5 marks) on every exam.

§ REVISION QUICK GLANCE

Five sub-topics in one page

Local/systemic · skin & mucosa · bypass 1st-pass

5 base types · excipients · TFE method

Paste 30–60 % solid · cold cream W/O · vanishing O/W

Carbomer · HPMC · hydrogel vs organogel

Cocoa butter · glycerinated gelatin · DV = 22.2 g / 12

Connection

How the 5 link

Ointment bases carry the drug; *creams & gels* are cosmetic-friendly o/w; *pastes* are stiff; *suppositories* deliver the API through mucosae with bypassed first-pass.

§ SELF-CHECK 5 QUESTIONS

Solve without looking back. 5 marks each.

1. List 4 types of ointment bases with one example each.
2. Differentiate: oleaginous base vs o/w emulsion base.
3. Name 3 gelling agents and the pH at which carbomer gels.
4. A 6-suppository batch needs 0.2 g drug each, DV = 1.0, blank supp = 2.0 g. Calculate base required.
5. State 4 ideal properties of a suppository base.

answers.py

```
A1. Oleaginous (petrolatum) · Absorption (lanolin) · W/O (cold cream) · O/W (vanishing cream) · Water-soluble (PEG). A2. Oleaginous is greasy, occlusive, water-immiscible, no water. O/W is non-greasy, water-washable, contains water in oil-in-water emulsion. A3. Carbomer (pH 6–7.5) · HPMC (neutral) · Tragacanth (neutral). Sodium alginate with Ca²■. A4. Base = 6 × (2.0 − 0.2 × 1.0) = 6 × 1.8 = 10.8 g base. A5. Melts at 37 °C · non-toxic · non-irritant · releases drug · stable on storage · compatible with drugs.
```

Unit V in one line

Unit V teaches you the carrier — from a greasy ointment that hugs the skin, to a suppository that delivers drug through the mucosa.

§ PINPOINTS MUST REMEMBER

10 hooks for last-minute revision

1. **4 base types**
   Oleaginous · Absorption · W/O · O/W (+ water-soluble).
2. **Oleaginous = greasy**
   Best for chronic dry skin; occlusive; not water-washable.
3. **Cold cream is W/O**
   Borax + beeswax + water.
4. **Vanishing cream is O/W**
   Non-greasy, cosmetic.
5. **Carbomer 934 / 940**
   Carbopol range — use TEA to neutralise and gel.
6. **Suppository = 1–2 g rectal**
   Vaginal pessary 3–5 g · Urethral bougie 2 g (male) / 4 g (female).
7. **Cocoa butter mp 30–35 °C**
   POLYMORPHIC — 4 forms; avoid overheating.
8. **Ideal supp. base**
   Melt at 37 °C, non-toxic, non-irritant, releases drug, stable.
9. **DV formula**
   Base = n × (blank weight − drug per supp × DV).
10. **Worked DV**
    12 supp × 0.1 g drug × 1.5 DV 22.2 g base.

Mnemonic

Ointments have FIVE 'C' excipient roles — Carrier, Conditioner, Cosmetic, Chemical-stability, Compatibility.