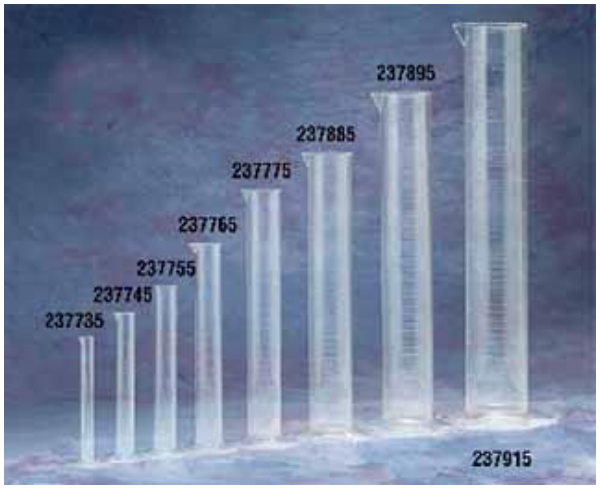
Standard Laboratory Glassware & equipments

Labware

Types of glass

High thermal borosilicate

- Can take long periods of high temperatures
- Scratches easily
- Acceptable for chemistry work
- Examples: Pyrex, Kimax



Labware

Types of glass

Aluminosilicate

- Can withstand heat as long as not in contact with acids or alkalis
- Resists scratching
- Acceptable for chemistry work
- Examples: centrifuge tubes, thermometers

Labware

- Types of glass
  - Soda lime – not suitable for lab use

- Types of plastic resins
  - Polystyrene
    - Clear, rigid
    - Can withstand temperatures to ٧٠ C
    - Examples: many disposables

Types of plastic resins

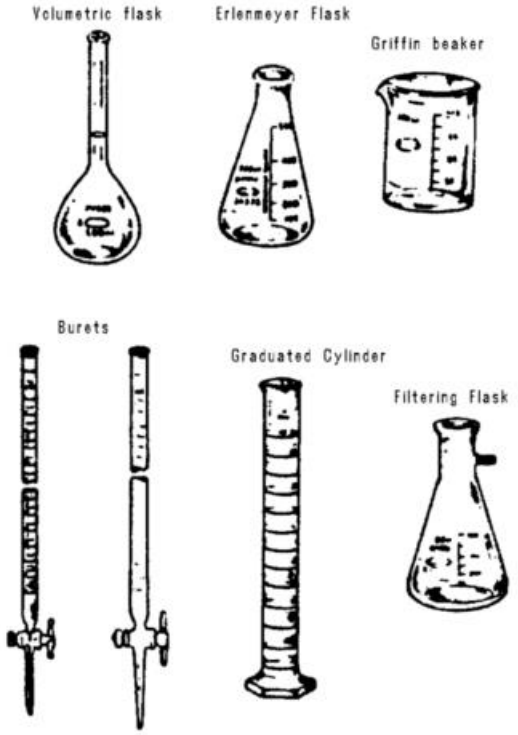
Polyethylene

- Translucent in appearance
- Two types
  - One type can withstand temperatures up to ٨٠ C, and is flexible, i.e., reagent wash bottles
  - Other can withstand temperatures up to ١٢٠ C and is rigid, i.e., droppers

- Types of plastic resins
  - Polyvinyl chloride
    - Translucent in appearance, but rigid
    - Withstands temperatures to ١٣٥ C

Types of glassware

- Beakers
- Flasks
  - Volumetric
  - Erlenmeyer
  - Graduated cylinders
  - Reagent bottles
  - Test tubes



Cleaning of Lab Glassware

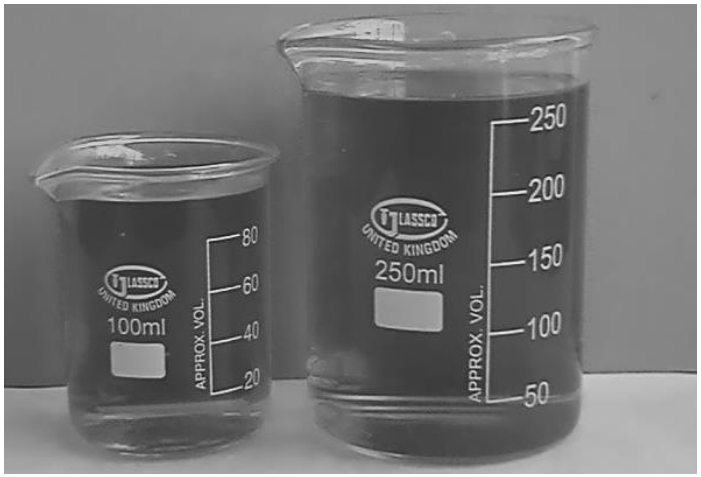
- Majority of time can simply presoak, dishwash, and thoroughly rinse with tap and finally distilled/deionized water

- *Chemically clean* glassware is required for certain chemistry procedures (enzymes, iron, heavy metals, etc.)

- ***'dichromate acid' or 'acid dichromate'***

BEAKERS

Beaker, Low Form with graduation and spout.
DIN ١٢٣٣١, ISO ٣٨١٩



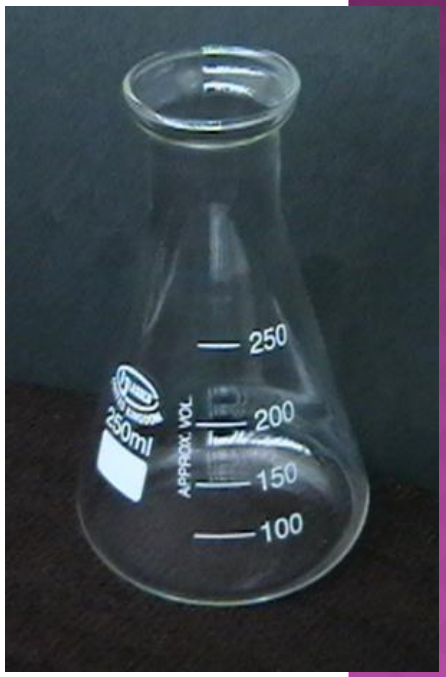
Cat. No.	Capacity ml	Dia. mm	Height. mm
٢٢٩,٢٠٢,٠١	٥	٢٢	٣٠
٢٢٩,٢٠٢,٠٢	١٠	٢٦	٣٥
٢٢٩,٢٠٢,٠٣	٢٥	٣٤	٥٠
٢٢٩,٢٠٢,٠٤	٥٠	٤٢	٦٠
٢٢٩,٢٠٢,٠٥	١٠٠	٥٠	٧٠
٢٢٩,٢٠٢,٠٦	١٥٠	٦٠	٨٠
٢٢٩,٢٠٢,٠٧	٢٥٠	٧٠	٩٥
٢٢٩,٢٠٢,٠٨	٤٠٠	٨٠	١١٠
٢٢٩,٢٠٢,٠٩	٦٠٠	٩٠	١٢٥
٢٢٩,٢٠٢,١٠	١٠٠٠	١٠٥	١٤٥
٢٢٩,٢٠٢,١١	٢٠٠٠	١٣٢	١٨٥

ERLENMEYER FLASK

Erlenmeyer Flask, Narrow Neck with graduation

DIN ١٢٣٨٠, ISO ١٧٧٣

Cat. No	Capacity ml	Dia. mm	D١. mm	H. mm
٢٣١,٢٠٢,٠١	٢٥	٤٢	٢٢	٧٥
٢٣١,٢٠٢,٠٢	٥٠	٥١	٢٢	٩٠
٢٣١,٢٠٢,٠٣	١٠٠	٦٤	٢٢	١٠٥
٢٣١,٢٠٢,٠٤	٢٥٠	٨٥	٣٤	١٤٥
٢٣١,٢٠٢,٠٥	٥٠٠	١٠٥	٣٤	١٨٠
٢٣١,٢٠٢,٠٦	١٠٠٠	١٣١	٤٢	٢٢٠
٢٣١,٢٠٢,٠٧	٢٠٠٠	١٦٦	٥٠	٢٨٠
٢٣١,٢٠٢,٠٨	٣٠٠٠	١٨٧	٥١	٣١٠
٢٣١,٢٠٢,٠٩	٥٠٠٠	٢٢٠	٥١	٣٦٥



ERLENMEYER FLASK

Erlenmeyer Flask, Wide Neck with graduation

DIN ١٢٣٨٥

Cat.No	Capacity ml	Diam. mm	D١. mm	H. mm
٢٣٢,٢٠٢,٠٣	١٠٠	٦٤	٣٤	١٠٥
٢٣٢,٢٠٢,٠٥	٢٥٠	٨٥	٥٠	١٤٠
٢٣٢,٢٠٢,٠٧	٥٠٠	١٠٥	٥٠	١٧٥

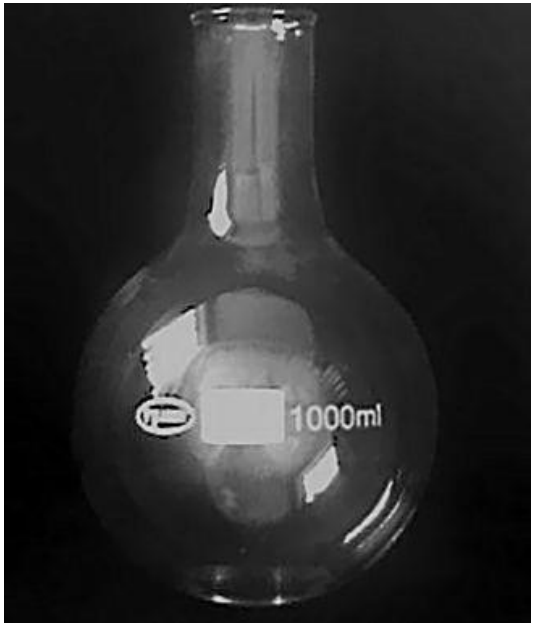
ERLENMEYER FLASK

Erlenmeyer Flask, with B٢٤ Socket, DIN ١٢٣٨٧

Cat. No	Capacity ml	Diameter mm	Socket Size	Height mm
٠٧١,٢٠٢,١٣	١٠٠	١٠٥	٢٤/٢٩	٦٤
٠٧١,٢٠٢,١٩	٢٥٠	١٤٠	٢٤/٢٩	٨٥
٠٧١,٢٠٢,٢٢A	٥٠٠	١٧٥	٢٤/٢٩	١٠٥
٠٧١,٢٠٢,٢٥	١٠٠٠	٢٢٠	٢٤/٢٩	١٣١

ROUND BOTTOM FLASK

Flask Round Bottom narrow neck, with beaded rim,
DIN ١٢٣٤٧, ISO ١٧٧٣



Cat. No	Capacity ml	Diam. mm	D١. mm	Height mm
٢٣٣,٢٠٢,٠١	٥٠	٥١	٢٦	٩٥
٢٣٣,٢٠٢,٠٢	١٠٠	٦٤	٢٦	١١٠
٢٣٣,٢٠٢,٠٣	٢٥٠	٨٥	٣٤	١٤٤
٢٣٣,٢٠٢,٠٤	٥٠٠	١٠٥	٣٤	١٧٥
٢٣٣,٢٠٢,٠٥	١٠٠٠	١٣١	٤٢	٢٠٠
٢٣٣,٢٠٢,٠٦	٢٠٠٠	١٦٦	٤٢	٢٦٠
٢٣٣,٢٠٢,٠٧	٣٠٠٠	١٨٥	٥٠	٢٦٠
٢٣٣,٢٠٢,٠٨	٥٠٠٠	٢٢٣	٥٠	٣٠٥
٢٣٣,٢٠٢,٠٩	١٠٠٠٠	٢٧٩	٦٥	٤٢٠
٢٣٣,٢٠٢,١٠	٢٠٠٠٠	٣٤٥	٧٦	٥١٥

ROUND BOTTOM FLASK

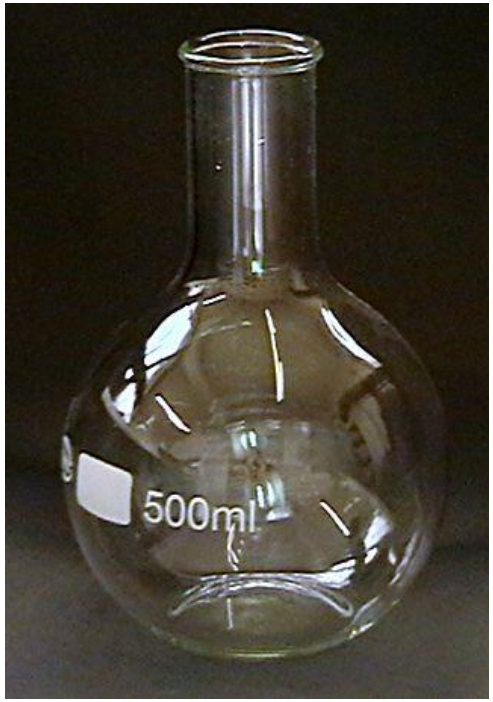
Flask Round Bottom with B٢٤ Socket, DIN ١٢٣٤٨

(٢ or ٣ neck flasks can be made on request)

Cat. No	Capacity ml	Socket Size	Dia. mm	Overall Height mm
٠٥٧,٢٠٢,١٣	١٠٠	٢٤/٢٩	٦٤	١١٥
٠٥٧,٢٠٢,٢٢	٢٥٠	٢٤/٢٩	٨٥	١٤٥
٠٥٧,٢٠٢,٢٦	٥٠٠	٢٤/٢٩	١٠٥	١٧٥
٠٥٧,٢٠٢,٣٠	١٠٠٠	٢٤/٢٩	١٣١	٢١٠
٠٥٧,٢٠٢,٣٣	٢٠٠٠	٢٤/٢٩	١٦٦	٢٦٠

FLAT BOTTOM FLASK

Flask Flat Bottom, narrow neck, with beaded rim
DIN ١٢٣٤٧, ISO ١٧٧٣

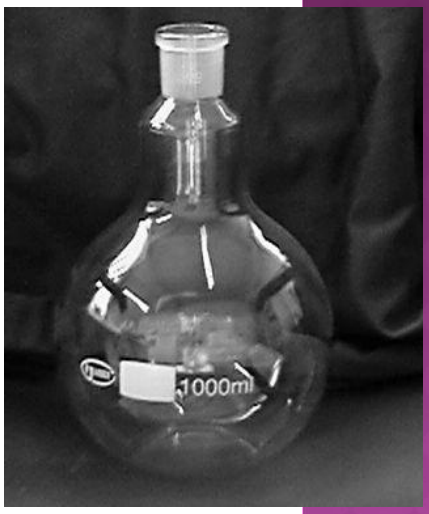


Cat. No.	Capacity ml	Diam. mm	D١. mm	Height. mm
٢٣٥,٢٠٢,٠١	٥٠	٥١	٢٢	١٠٠
٢٣٥,٢٠٢,٠٢	١٠٠	٦٤	٢٢	١١٠
٢٣٥,٢٠٢,٠٣	٢٥٠	٨٥	٣٥	١٤٠
٢٣٥,٢٠٢,٠٤	٥٠٠	١٠٥	٣٤	١٧١
٢٣٥,٢٠٢,٠٥	١٠٠٠	١٣١	٤٢	٢٠٠
٢٣٥,٢٠٢,٠٦	٢٠٠٠	١٦٦	٤٢	٢٥٠
٢٣٥,٢٠٢,٠٧	٣٠٠٠	١٨٥	٥٠	٢٥٠
٢٣٥,٢٠٢,٠٨	٥٠٠٠	٢٢٣	٥٠	٢٩٠
٢٣٥,٢٠٢,٠٩	١٠٠٠٠	٢٨٠	٦٥	٤٠٠

FLAT BOTTOM FLASK

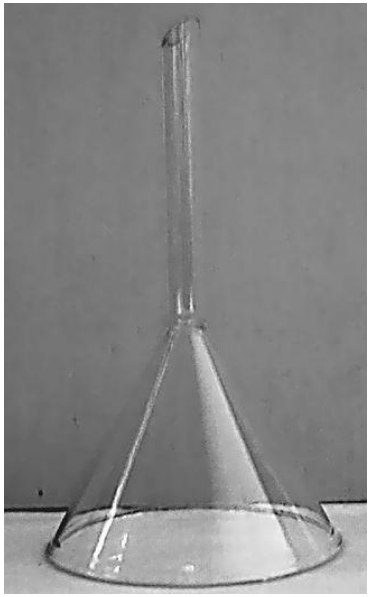
Flask Flat Bottom, with B٢٤ Socket, DIN ١٢٣٤٨
(٢ or ٣ neck flasks can be made on request)

Cat. No.	Capacity ml	Socket Size	Approx. Overall Height	Dia. mm
٠٥٨,٢٠٢,٠٤	١٠٠	٢٤/٢٩	١١٠	٥٠
٠٥٨,٢٠٢,١٢	٢٥٠	٢٤/٢٩	١٤٠	٨٥
٠٥٨,٢٠٢,١٦	٥٠٠	٢٤/٢٩	١٧٠	١٠٥
٠٥٨,٢٠٢,١٩	١٠٠٠	٢٤/٢٩	٢٠٠	١٣١



FILTER FUNNEL

٦٠ Degree Angle with Stem



Cat. No	Diameter mm
٢٣٨,٢٠٢,٠٥	٥٠
٢٣٨,٢٠٢,١٠	٨٠
٢٣٨,٢٠٢,١١	١٠٠
٢٣٨,٢٠٢,١٢	١٢٥
٢٣٨,٢٠٢,١٣	١٥٠

DESICCATOR

Desiccators with plain lid, Die Pressed Neutral Glass with Porcelain Perforated Plate.

Cat. No.	I.D. mm
٢٤٩,٢٠٢,٠١	١٥٠
٢٤٩,٢٠٢,٠٣	٢٥٠

Desiccators with vaccuum lid, Die pressed Neutral Glass with Porcelain Perforated plate and Glass Key Stopcock

Cat. No.	I.D. mm
٢٥٠,٢٠٢,٠١	١٥٠
٢٥٠,٢٠٢,٠٣	٢٥٠

MILLIPORE TYPE FILTER APPARATUS

Millipore Type, Membrane Filter Holder Assembly, with Membrane Support, Funnel, Flask and Clamp, Standard Joint Fittings

Cat. No.	Membrane Dia. mm	Funnel Cap. ml	Flask Cap. ml
٢٥٨,٢٠٢,٠٣	٤٧	٣٠٠	١٠٠٠

SEPERATING FUNNEL WITH GLASS KEY STOPCOCK

Separating Funnels, with Glass Key Stopcock & Polyethylene Stopper, Conical Shape. (Pear shaped funnels can be made on request)

Cat. No.	Capacity ml	N/S
١۴٧,٢٠٢,٠٣	١٠٠	١٩/٢۶
١۴٧,٢٠٢,٠۴	٢۵٠	١٩/٢۶
١۴٧,٢٠٢,٠۵	۵٠٠	٢٩/٣٢
١۴٧,٢٠٢,٠۶	١٠٠٠	٢٩/٣٢
١۴٧,٢٠٢,٠٧	٢٠٠٠	٢٩/٣٢

- ***Other sizes not shown here can be made on request***

SEPERATING FUNNEL WITH PTFE KEY STOPCOCK

Separating Funnels, with PTFE Key Stopcock & Polyethylene Stopper, Conical Shaped.
(Pear shaped funnels can be made on request.)

Cat. No.	Capacity ml	N/S
١۴٨,٢٠٢,٠٣	١٠٠	١٩/٢۶
١۴٨,٢٠٢,٠۴	٢۵٠	١٩/٢۶
١۴٨,٢٠٢,٠۵	۵٠٠	٢٩/٣٢
١۴٨,٢٠٢,٠۶	١٠٠٠	٢٩/٣٢
١۴٨,٢٠٢,٠٧	٢٠٠٠	٢٩/٣٢

- ***Other sizes not shown here can be made on request***

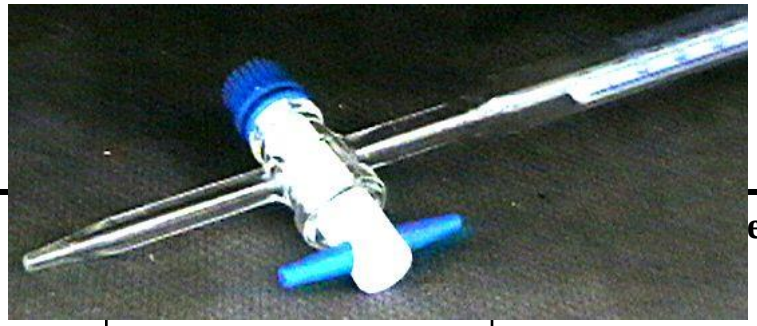
BURETTE WITH GLASS KEY STOPCOCK

Burette with Straight Bore Glass Key Stopcock, Schellbach Stripe, Accuracy as per class AS DIN١٢٧٠٠, ISO ٣٨٥. Certificates are available on request.

Cat. No.	Capacity ml	Sub. Div. ml	Tolerance +- ml
١١٠,٢٠٢,٠١A	١٠	٠,٠٥	٠,٠٢٠
١١٠,٢٠٢,٠١	١٠	٠,١٠	٠,٠٥٠
١١٠,٢٠٢,٠٢	٢٥	٠,٠٥	٠,٠٢٠
١١٠,٢٠٢,٠٢A	٢٥	٠,١٠	٠,٠٥٠
١١٠,٢٠٢,٠٣A	٥٠	٠,١٠	٠,٠٥٠
١١٠,٢٠٢,٠٤A	١٠٠	٠,٢٠	١,١٠٠

BURETTE WITH PTFE KEY STOPCOCK

Burette with Straight Bore PTFE Key Stopcock, Schellbach Stripe, Accuracy as per class AS DIN١٢٧٠٠, ISO ٣٨٥. Certificates are available on request.



Cat. No.	Capacity ml		e
١١٤,٢٠٢,٠١A	١٠	٠,٠٥	٠,٠٢٠
١١٤,٢٠٢,٠١	١٠	٠,١٠	٠,٠٥٠
١١٤,٢٠٢,٠٢	٢٥	٠,٠٥	٠,٠٢٠
١١٤,٢٠٢,٠٢A	٢٥	٠,١٠	٠,٠٥٠
١١٤,٢٠٢,٠٣A	٥٠	٠,١٠	٠,٠٥٠
١١٤,٢٠٢,٠٤A	١٠٠	٠,٢٠	١,١٠٠

Buret – essentially an elaborate pipet mounted on a stand used in titration procedures

BULB PIPETTE

Bulb Pipettes, with one mark, Accuracy as per class AS DIN ١٢٦٩١, ISO ٦٤٨,
Certificates are available on request.

Cat. No	Capacity ml	Tolerance +- ml	Colour Code
١٢٣,٢٠٢,٠١	١	٠,٠٠٦	Blue
١٢٣,٢٠٢,٠٢	٢	٠,٠١٠	Orange
١٢٣,٢٠٢,٠٣	٥	٠,٠١٥	White
١٢٣,٢٠٢,٠٤	١٠	٠,٠٢٠	Red
١٢٣,٢٠٢,٠٥	٢٠	٠,٠٣٠	Yellow
١٢٣,٢٠٢,٠٦	٢٥	٠,٠٣٠	Blue
١٢٣,٢٠٢,٠٧	٥٠	٠,٠٥٠	Red
١٢٣,٢٠٢,٠٨	١٠٠	٠,٠٨٠	Yellow

GRADUATED PIPETTE

Graduated Pipette Class AS DIN ١٢٦٩٧, ISO ٨٣٥.

Certificates are available on request.

Cat. No	Capacity ml	Tolerance +-ml	Colour Code
١٢٥,٢٠٢,٠١	١,٠	٠,٠٠٦	Yellow
١٢٥,٢٠٢,٠٢	٢,٠	٠,٠١٠	Black
١٢٥,٢٠٢,٠٣	٥,٠	٠,٠٣٠	Red
١٢٥,٢٠٢,٠٤	١٠	٠,٠٥٠	Orange
١٢٥,٢٠٢,٠٥	٢٠	٠,١٠٠	Yellow
١٢٥,٢٠٢,٠٦	٢٥	٠,١٠٠	White

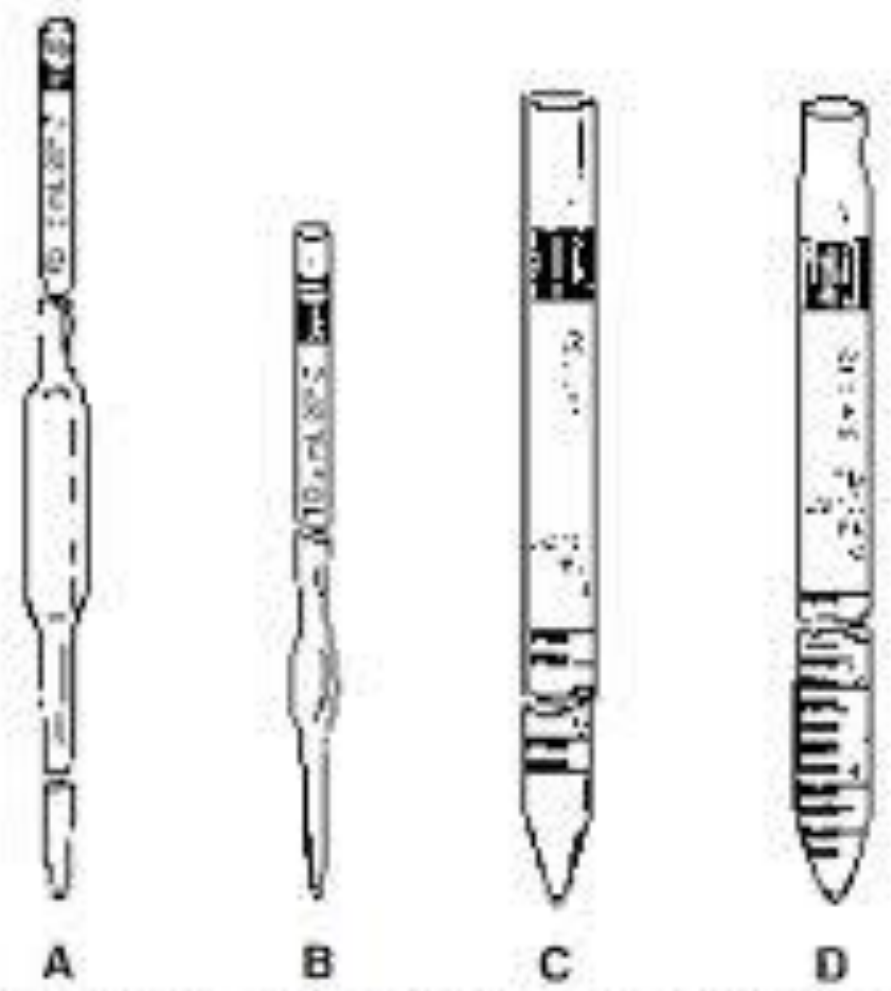


Figure 1-1 Pipettes. **A,** Volumetric (transfer). **B,** Ostwald-Folin (transfer). **C,** Mohr (measuring). **D,** Serological (graduated to the tip).

Pipets

- Types

Volumetric –

Volumetric pipets are TD, the most accurate and used to prepare Standard solutions, Calibrators and Quality Control specimens

Ostwald-Folin

Serologic

- TD = to deliver
- TC = to contain

Mohr

Transfer

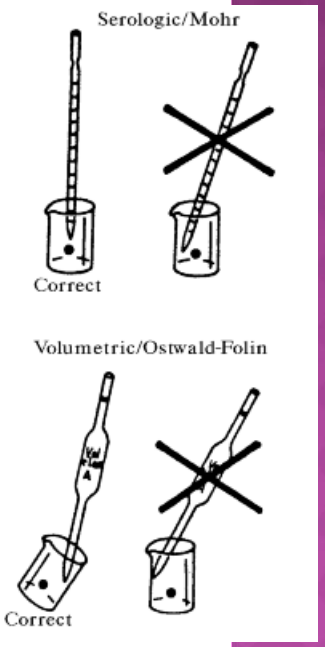
Automatic and semi-automatic

Laboratory Vessels and Pipets

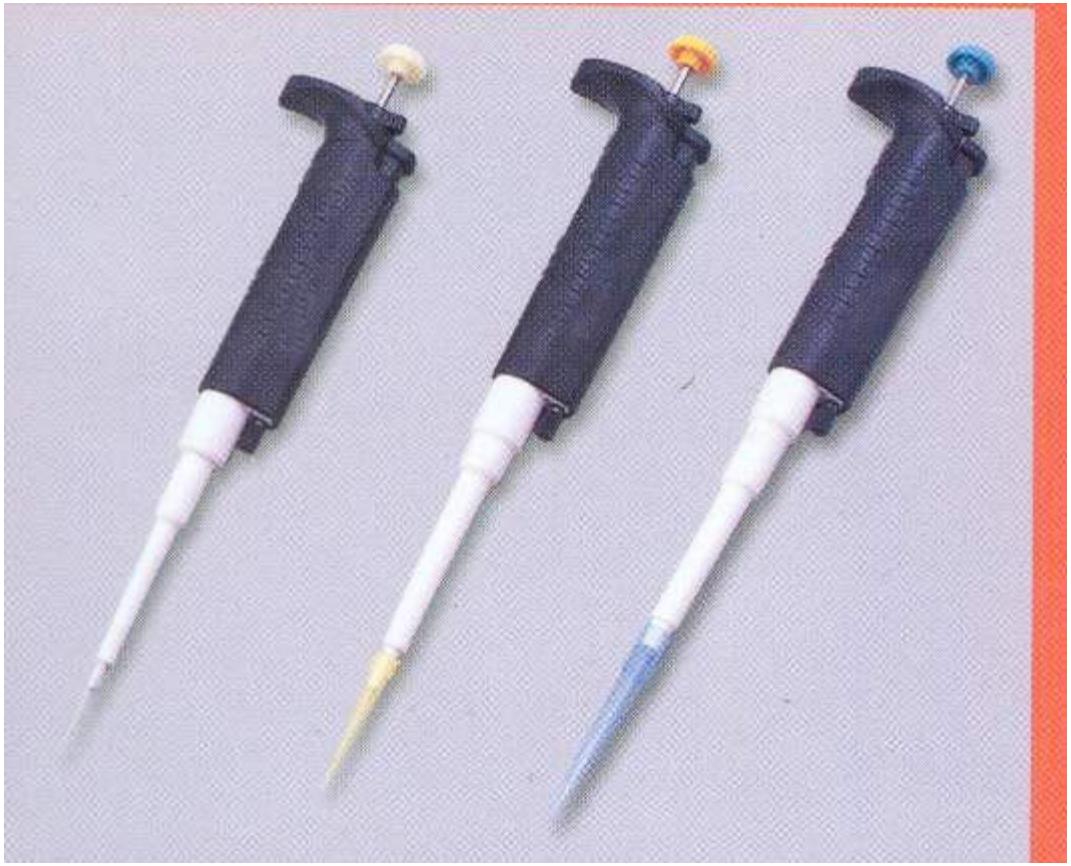
- Volumetric flasks : The line indicates the level that contains an exact volume
- Erlenmeyer flasks : Hold variable volumes
- Graduated cylinders : Hold variable volumes

- Pipet rules
  - TC = needs to be blown out
  - TD = let drain along the side of the receiving vessel
  - Read pipets from the bottom of the meniscus
  - Hold pipets straight up and down
  - Use suction bulbs to aspirate fluids into pipets
  - NEVER MOUTH PIPET !!!
  - Place dirty pipets in soapy water with tips up

- Proper use
  - Use correct pipet for the job
  - Examine the pipet before use for cleanliness, chips, etc.
  - **NEVER** pipet by mouth
  - Draw the solution slightly above the mark



Correct and incorrect pipet positions



VOLUMETRIC FLASK

Volumetric Flask with one graduation mark and Polyethylene Stopper.

ISO ١٠٤٢, DIN ١٢٦٦٤, Class A. Certificates are available on request.

Cat. No.	Capacity ml	Tolerance +-ml	N/S
١٢٩,٢٠٢,٠١	٥	٠,٠٢٥	١٠/١٩
١٢٩,٢٠٢,٠٢	١٠	٠,٠٢٥	١٠/١٩
١٢٩,٢٠٢,٠٢A	٢٠	٠,٠٤٠	١٠/١٩
١٢٩,٢٠٢,٠٣	٢٥	٠,٠٤٠	١٠/١٩
١٢٩,٢٠٢,٠٤	٥٠	٠,٠٦٠	١٢/٢١
١٢٩,٢٠٢,٠٥	١٠٠	٠,١٠٠	١٤/٢٣
١٢٩,٢٠٢,٠٦	٢٠٠	٠,١٥٠	١٤/٢٣
١٢٩,٢٠٢,٠٧	٢٥٠	٠,١٥٠	١٤/٢٣
١٢٩,٢٠٢,٠٨	٥٠٠	٠,٢٥٠	١٩/٢٦
١٢٩,٢٠٢,٠٩	١٠٠٠	٠,٤٠٠	٢٤/٢٩
١٢٩,٢٠٢,١٠	٢٠٠٠	٠,٦٠٠	٢٩/٣٢

MEASURING CYLINDER SPOUTED

Measuring Cylinders, with Spout & Hexagonal Base, Class AS, DIN ١٢٦٨٠.

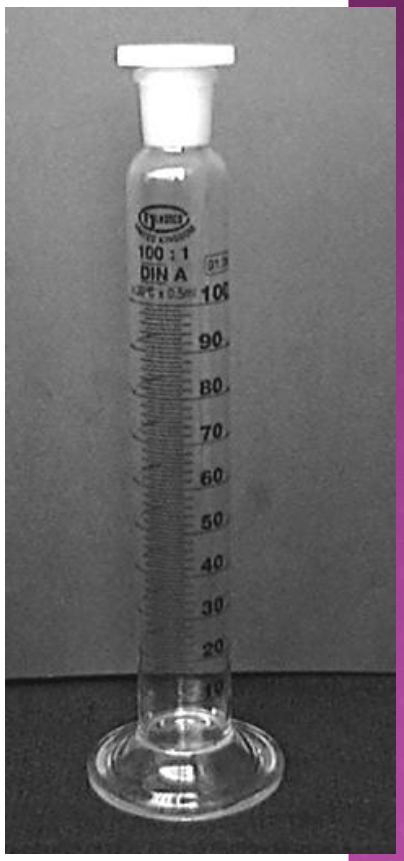
Certificates are available on request.

Cat. No.	Capacity ml	Sub. Div. ml	Tolerance +-ml
١٣٩,٢٠٢,٠١A	١٠	٠,٢	٠,١٠
١٣٩,٢٠٢,٠٢A	٢٥	٠,٥	٠,٢٥
١٣٩,٢٠٢,٠٣A	٥٠	١,٠	٠,٥٠
١٣٩,٢٠٢,٠٤A	١٠٠	١,٠	٠,٥٠
١٣٩,٢٠٢,٠٥A	٢٥٠	٢,٠	١,٠٠
١٣٩,٢٠٢,٠٦A	٥٠٠	٥,٠	٢,٥٠
١٣٩,٢٠٢,٠٧A	١٠٠٠	١٠,٠	٥,٠٠
١٣٩,٢٠٢,٠٩	٢٠٠٠	٢٠,٠	١٠,٠٠

MEASURING CYLINDER STOPPERED

Measuring Cylinders, with Interchangeable Polyethylene Stopper & Hexagonal Base, Class AS, DIN ١٢٦٨٥, ISO ٤٧٨٨. Certificates available on request.

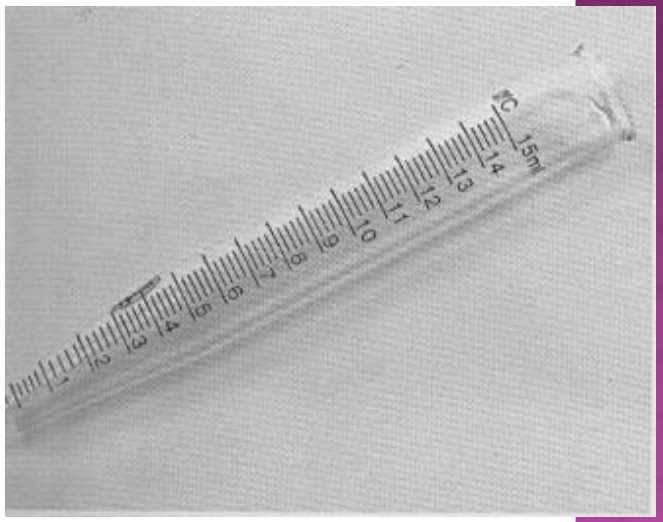
Cat. No.	Capacity ml	Sub. Div. ml	Tolerance +-ml
١٤١,٢٠٢,٠١A	٥	٠,١	٠,٠٥
١٤١,٢٠٢,٠٢A	١٠	٠,٢	٠,١٠
١٤١,٢٠٢,٠٣A	٢٥	٠,٥	٠,٢٥
١٤١,٢٠٢,٠٤A	٥٠	١,٠	٠,٥٠
١٤١,٢٠٢,٠٥A	١٠٠	١,٠	٠,٥٠
١٤١,٢٠٢,٠٦A	٢٥٠	٢,٠	١,٠٠
١٤١,٢٠٢,٠٧A	٥٠٠	٥,٠	٢,٥٠
١٤١,٢٠٢,٠٨A	١٠٠٠	١٠,٠	٥,٠٠
١٤١,٢٠٢,٠٩A	٢٠٠٠	٢٠,٠	١٠,٠٠



CENTRIFUGE TUBES

Centrifuge Tube, Conical Bottom, Graduated

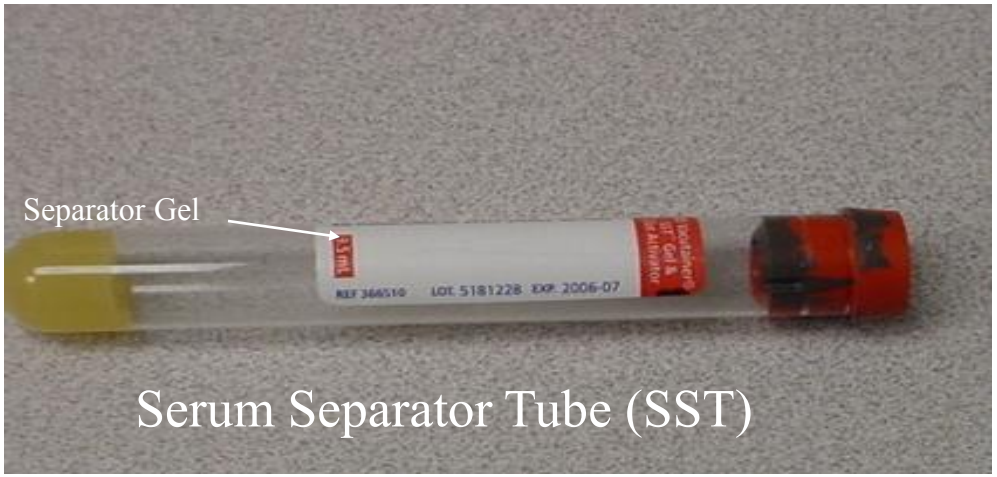
Cat. No	Capacity	Height x O.D. mm
٠٨٨,٢٠٢,٠٢	١٠	١١٠ x ١٥
٠٨٨,٢٠٢,٠٣	١٥	١٢٠ x ١٧

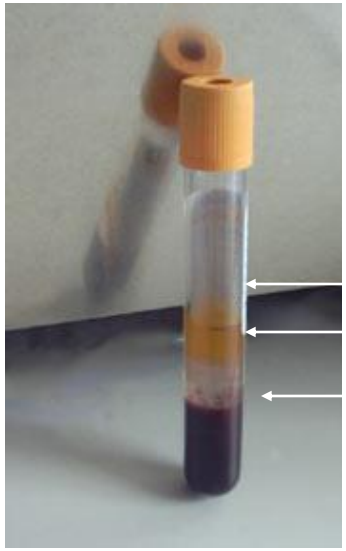


COLLECTION TUBES

- The most widely used tubes for blood collection are evacuated tubes (Vacutainers)
  - Negative pressure facilitates collection
  - Easy to use
  - Sterile
  - Universally used colour-coded rubber stoppers to denote tube type.
  - Tubes can contain various anticoagulants for the collection of whole blood or plasma.
  - Tubes can have additives for specific tests (glucose, metals)

COLLECTION TUBES (VACUTAINERS)

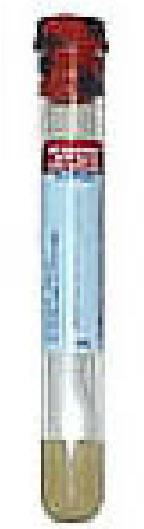




- Collection tubes / Additives
  - Red None
  - Red / Black None – Gel separator
  - Lavender EDTA anticoagulant
  - Orange Thrombin promotes clotting
  - Blue Sodium citrate anticoagulant
  - Gray Sodium fluoride / Potassium oxalate
  - Green Heparin anticoagulant
- Collection order (to avoid contamination / interference)
  - ١ Sterile specimens – Blood Cultures (yellow)
  - ٢ Blue
  - ٣ Gold / Red / Orange
  - ٤ Green
  - ٥ Lavender
  - ٦ Gray

Specimen processing

- Serum separators –
  - Gel barrier
  - Plastic tube device



COLLECTION TUBES

- Red-top tubes contain no anticoagulants or preservatives
- Red-top tubes are used for collecting serum
  - ١٠-١٥ minutes is required to allow blood to clot before centrifuging
  - Used for blood bank specimens, some chemistries

COLLECTION TUBES

- Gold (and “tiger”) top tubes contain a gel that forms a physical barrier between the serum and cells after centrifugation
- No other additives are present
- Gel barrier may affect some lab tests

COLLECTION TUBES

- Used for Glucose measurement.
- After blood collection, glucose concentration decreases significantly because of cellular metabolism
- Gray-top tubes contain either:
  - Sodium fluoride and potassium oxalate, or
  - Sodium iodoacetate
- Both preservatives stabilize glucose in plasma by inhibiting enzymes of the glycolytic pathway
  - NaF/oxalate inhibits enolase
  - Iodoacetate inhibits glucose-٣-phosphate dehydrogenase

COLLECTION TUBES

Green-top tubes contain either the Na, K, or lithium (Li) salt of heparin. Most widely used anticoagulant for chemistry tests.

- Should not be used for Na, K or Li measurement
- Can effect the size and integrity of cellular blood components and not recommended for hematology studies

Heparin accelerates the action of antithrombin III, which inhibits thrombin, so blood does not clot (plasma)

The advantage of plasma is that no time is wasted waiting for the specimen to clot

COLLECTION TUBES

- Lavender-top tubes contain the K salt of ethylenediaminetetraacetic acid (EDTA), which chelates calcium (essential for clot formation) and inhibits coagulation
- Used for hematology, and some chemistries
- Cannot be used for K or Ca tests

COLLECTION TUBES

- Blue-top tubes contain sodium citrate, which chelates calcium and inhibits coagulation
- Used for coagulation studies because it is easily reversible.

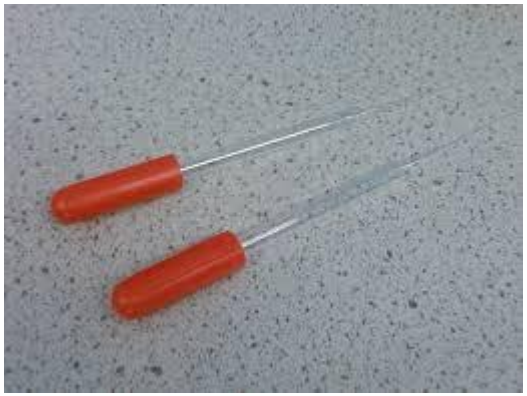
COLLECTION TUBES

- Brown and Royal Blue top tubes are specially cleaned for trace metal studies
  - Brown-top tubes are used for lead (Pb) analysis
  - Royal blue-top tubes are used for other trace element studies (acid washed)

MORTAR AND PESTLE

SPATULA

PASTEUR PIPETTE



PLATIC PISSETTE

LABORATORY DISPENSER

General Laboratory Equipment:

BALANCES

- Type chosen dependent on volume/weight needed and degree of accuracy required.

Double Pan Classic, single beam with equal arm length, pan on each end Counter weights on one side, desired substance on other side	
Single Pan Most common in lab Arms of unequal length, pan is on shorter arm Has restoring force on other side to bring weight back to null position	
Double-/Triple-beam Forms of unequal-arm balance Single pan on short arm, long arm has ٢-٣ parallel beams with different weights attached	

BALANCES (CON'T)

Electronic single-pan balance

The load causes the beam to tilt downward

A null detector senses the position of the beam and indicates when it has deviated from equilibrium point

An electromagnetic force is applied to return the balance to its null position

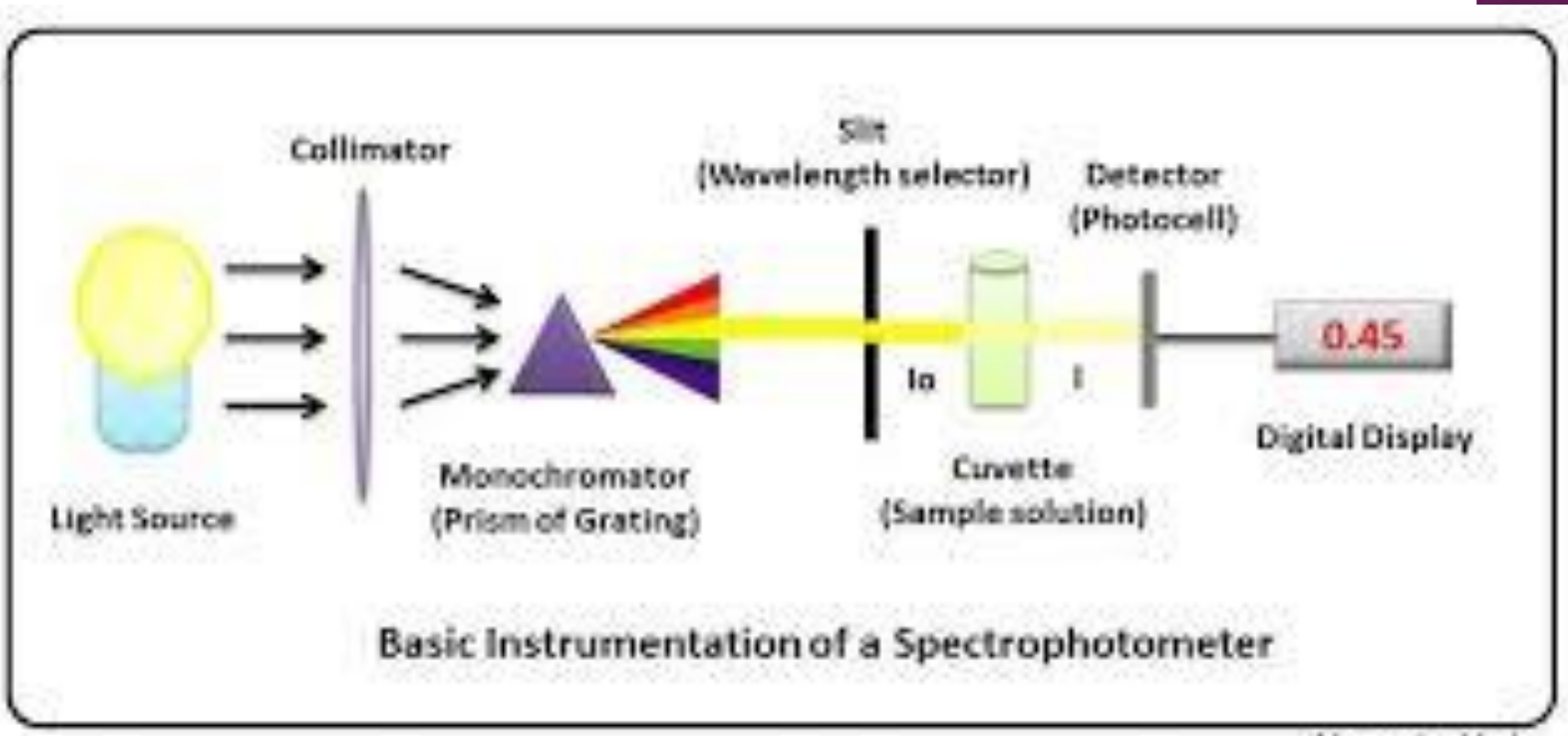
Restoring force is proportional to weight on pan, is applied through a solenoid or torque motor

The current required to produce the force is displayed digitally by liquid crystals in a form equivalent to mass on balance

BALANCES: HOW TO USE

- Balance must be located in a vibration-free area, including air currents
- Balance must be kept clean
- Periodically calibrated with known weights
- Use plastic weigh boats or paper to weigh chemicals

S


Collimator
Slit
(Wavelength selector)
Detector
(Photocell)
0.45
Io
I
Digital Display
Light Source
Monochromator
(Prism of Grating)
Cuvette
(Sample solution)
Basic Instrumentation of a Spectrophotometer

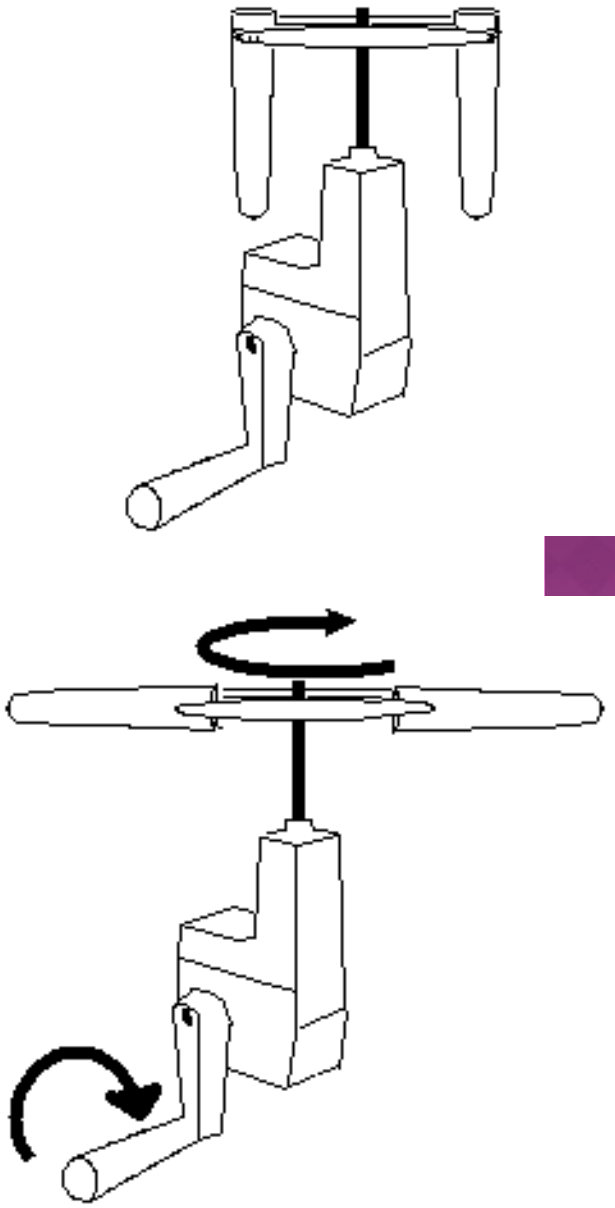
General Laboratory Equipment: Centrifuge

- Purpose
  - Separating solids from a liquid suspension by means of centrifugal force
- Types
  - Benchtop
  - Swing-bucket
  - Fixed-head or fixed-angle
  - Ultracentrifuge
- Maintenance
  - Interior and exterior cleaning
  - Verification of accuracy of timers and speeds

CENTRIFUGE SAFETY

CENTRIFUGE

A mechanical device that uses the principle of centrifugal force to separate materials of different densities.



THE CENTRIFUGES OF CONCERN…

… fit the original definition of "….principle of centrifugal force to separate materials of different densities," specifically

HIGH SPEED centrif
aka SUPERSPEED centrif

up to around ٢٢,٠٠٠ rpm

ULTRA centrifuges

ultra = higher. Modern ultras have max speeds ٨٠,٠٠٠ – ١٥٠,٠٠٠ rpm

HIGH SPEED CENTRIFUGE

Beckma

٢٦,٠٠٠ rpm (revolu

٨٢

ULTRACENTRIFUGE

- Beckman OptimaLXP
- ١٠٠,٠٠٠ rpm
- ٨٠٢,٤٠٠ g
- Weight ١٠٢٥ lb

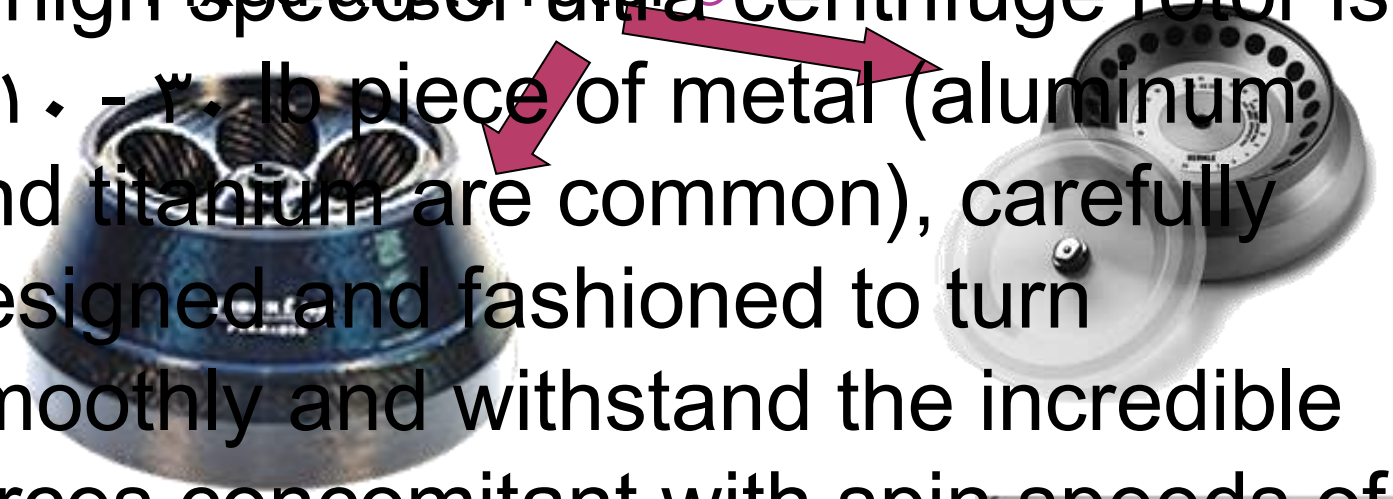
MECHANICAL FAILURE

Is caused by age and by improper use or inadequate care of centrifuge or rotor. Especially the rotor.

ROTORS

A high speed or ultra centrifuge rotor is a ١٠ - ٣٠ lb piece of metal (aluminum and titanium are common), carefully designed and fashioned to turn smoothly and withstand the incredible forces concomitant with spin speeds of ١٥,٠٠٠ - ١٥٠,٠٠٠ rpm.

- Fixed angle rotor
- Swinging bucket rotor



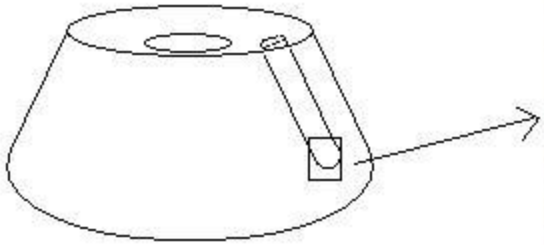
CARE AND ATTENTION

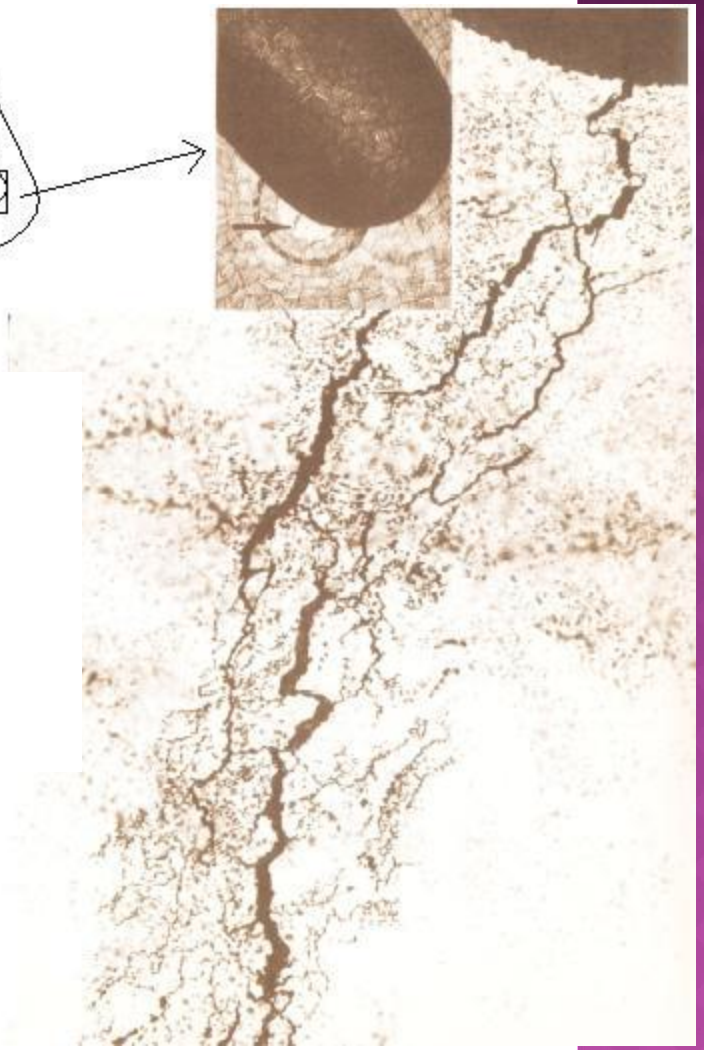
- Safe high-speed spin requires nearly perfectly balanced load.
- Age, use, and misuse contribute to rotor flaws.
- A rotor which comes apart at high speed can be deadly.

TINY FLAWS ARE

…NOT so tiny

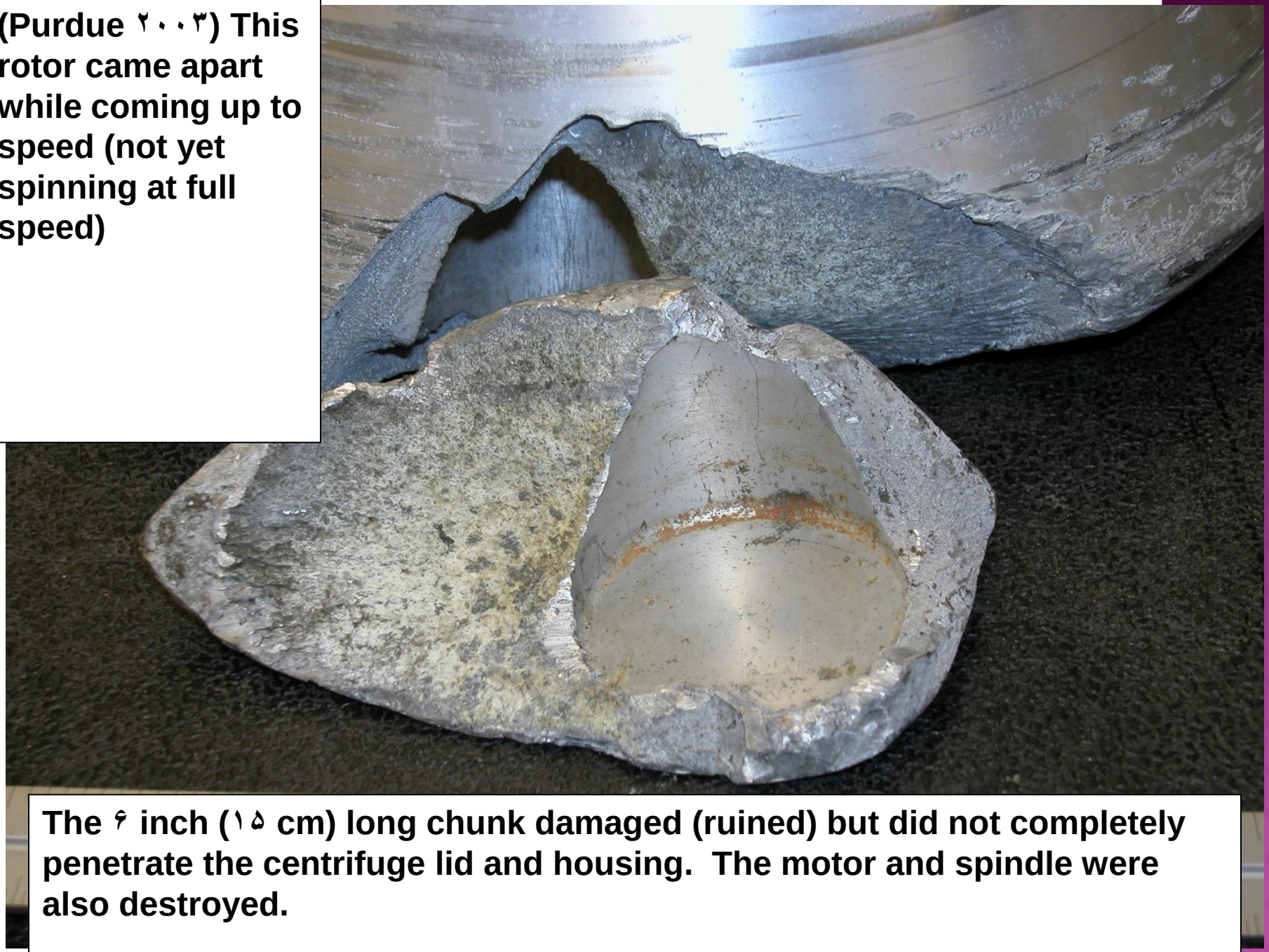
at ٨٠,٠٠٠ rpm





These are micro-fissures and cracks caused by stress and corrosion in the bottom of a tube cavity.

(Purdue ٢٠٠٣) This rotor came apart while coming up to speed (not yet spinning at full speed)



The ٦ inch (١٥ cm) long chunk damaged (ruined) but did not completely penetrate the centrifuge lid and housing. The motor and spindle were also destroyed.

TO REDUCE WEAR AND CHANCE OF FAILURE

- Follow instructions in manual and rotor care guide
- Use only compatible rotors
- Check routinely for rotor damage
- Don't overfill tubes
- Cap tubes
- Balance load carefully
- Check that rotor correctly seated on drive spindle
- Run at ≤ max safe speed

continued……

TO REDUCE WEAR AND CHANCE OF FAILURE, CONTINUED

- Stay right there until full speed is reached.
- Stop the centrifuge if anything seems unusual
- Never open until stopped (never ‘manual brake’)
- Clean rotor gently
- Dry completely
- Store rotor upside down (why?)
- Maintain a careful rotor logbook
- Derate and retire rotors for age/use

(MIT ١٩٩٩) This rotor split in half at ٥٥,٠٠٠ rpm after ٣ h of what was supposed to be a much longer spin.

Grad student report "Rotor was manufactured in ١٩٨٦ and was covered for ١٠,٠٠٠ hours of operation or ٥ years, whichever comes first." No surprise that it flew apart ١٣ years later. <u>Fortunately the centrifuge housing contained it.</u>

(Cornell, ١٩٩٨)

The rotor failure was not contained.

Much other damage done, equipment ruined, chemicals spilled.

Nobody was near, or someone would have been badly hurt or killed.

TO MINIMIZE AEROSOLS AND RISK OF EXPOSURE

Most points on preceding panel, PLUS

SOPs for human or infectious centrifuge samples should address this issue carefully

Know and follow emergency procedures.

Water Specifications

- Tap water is unsuitable for lab use (too many impurities)
- Types of water purification techniques
  - Distillation – removes most organic matter
  - Reverse osmosis
  - Filtration
  - Deionization – ions removed
- Reagent Grades of water
  - Type I Purest – Required for sensitive tests
  - Type II Acceptable for most uses
  - Type III OK for washing glassware
- CAP - QC of water : pH, electrical resistance, bacterial culture

Water filtration system for Automated chemistry analyzer.

SPECIMEN COLLECTION AND PROCESSING

- Medical ethics in specimen collection – ***professionalism and confidentiality at all times***
  - Special collection procedures
    - Fasting specimens: overnight for most tests, ١٢ hours for lipid studies
    - Timed interval specimens
      - Examples include glucose tolerance, therapeutic drug monitoring, and hormone stimulation testing

- **. REAGENTS; Chemical Grades**

  - Reagent preparation in the clinical lab is decreasing - most reagents are obtained from commercial manufacturers
  - **Objective: Identify and differentiate the different degrees of chemical purity.**

  - Common terms that relate to reagent purity:

    - Analytical Grade (purest), also called reagent grade or ACS grades - best choice for lab work.
    - National Formulary (NF) or US Pharmacopeia (USP) – used for drugs, may be OK for lab work
    - Chemical Pure (least pure) – not recommended for lab
    - Technical or commercial grade – never for lab use

REAGENTS; Chemical Grades

- **Primary Standard** : Highly purified solution of known concentration. These standards are used in the clinical lab to "calibrate" / "standardize" instruments in order to measure other solutions of unknown concentration
  - Primary Standards must be ٩٩,٩٨% pure
- **Secondary Standard** : Less pure substance whose concentration was determined by comparison to a Primary Standard
- **Standard Reference Material / Calibrator**
  - The name for biological substances used as 'standards'
  - Most biological standards cannot be ٩٩,٩٨% pure because the chemical processes to achieve this level of purity would destroy the substances.

Controls

- *For our purposes:*
  - ***Defined: substance, whose physical and chemical properties resemble the unknown specimen …***
- A control should have the same appearance and consistency as does the patient samples:
  - If patient sample is ‘serum’; the control should look like and have the same consistency as serum.
  - If the patient sample is ‘urine’, the control is urine, etc.
- ***- Controls are used to verify the accuracy and acceptability of a run.***

Control Solutions vs. Standard Solutions

- A Control specimen is used to monitor Quality Control (QC)
- A Control has known acceptable ranges, established either by the manufacturer *(assayed)* or the hospital lab itself (*un-assayed)*
- It is usually a serum/plasma based solution that is treated just as if it were a patient specimen
- Control specimens must produce results within established ranges in order for the 'run' to be acceptable.

Control Solutions vs. Standard Solutions

- A Standard solution is a highly purified solution that is usually not serum / plasma based
- Standard solutions have set, listed values that are established by the manufacturer
- Standard solutions are used to “calibrate” instruments, that is to “set” instruments to measure correctly at known concentration

Control Solutions vs. Standard Solutions

- Standard solutions are also called " Calibrators" – if they are biological in nature
  - **Consider for example, analytes such as bilirubin.**
  - **These substances do not come in the 'highly purified state, as calcium, glucose, etc.**
  - **A bilirubin standard is biological based, and technically a calibrator rather than the purely defined standard.**
  - **What about the 'hematology standards'? Standard or calibrator?**

Use of Blanks

- Review: Blanks used to eliminate or subtract the effects of reagent or specimen colors that would interfere with accurately measuring an analyte.

  - Water Blank – DI water, used to 'zero' the spectrophotometer. Seen mostly in UV procedures.

  - Reagent Blank – contains all the reagents used in the 'tests'. DI water sometimes used in the place of the amount of patient specimen. Colorimetric procedures.

  - Patient Blank – required by some procedures if patient sample has deep color that would affect results. ***Name ٣ situations that would warrant use of 'patient blank'.***

- General Laboratory Equipment
  - Centrifuge
    - Purpose
    - Types
    - Characteristics
      - Fixed rotor head / swinging bucket
      - Closing – locked closed lid now required

Specimen Collection and Processing

- Medical ethics in specimen collection – ***professionalism and confidentiality at all times***
- Special collection procedures
  - Fasting specimens: overnight for most tests, ١٢ hours for lipid studies
  - Timed interval specimens
    - Examples include glucose tolerance, therapeutic drug monitoring, and hormone stimulation testing
    - In some cases urine collection also required
  - Legal chain of evidence
  - Other special collection procedures

Specimen processing

- Determining specimen acceptability
  - *Other than improper timing, identify things that can affect chemical analysis of clinical specimens.*
- Specimen accessioning

Other / SPECIMEN CONSIDERATIONS

- Specimen collection and processing are critical
- A poor specimen = poor specimen results
- Most lab errors are ***pre-analytical !!!***

- *Common sources of error*

  - Contamination with IV fluids
  - Hemolysis of RBCs contaminates plasma and serum
  - Labeling errors
  - Collection with improper anticoagulants and preservatives
  - Analyzers clogged by clotted specimens

- The slides that follow are from another information source and remain here only for general use, at this time.

CLINICAL BIOCHEMISTRY

STEPS IN THE INVESTIGATION OF A PATIENT

- Patient History
- Physical Examination
- Laboratory Tests
- Imaging Techniques
- Diagnosis
- Therapy
- Evaluation

LABORATORY MEDICINE

- A discipline of medicine that functions to provide diagnostic tests which are utilized by physicians to assess the health of an individual.
  - Must more than just a "service". Dynamic interaction with all hospital departments (Emergency (ER), Intensive Care Unit (ICU), Cardiac Care Unit (CCU) as well as physicians outside of the hospital to maximize health care through:
    - Consultation regarding tests to be requested
    - Education
      - Medical students, residents
      - Medical Technologists
      - Medical Staff
    - Development, Evaluation and Implementation of New Diagnostic Assays
    - Supporting Clinical and Basic Research
    - Interaction with all departments to maintain and/or improve the flow and accuracy of information (i.e test results)
  - Driving force is Patient Care……This must be done effectively and economically
    - Laboratory Medicine Program must operate as a Non-profit business
    - Has a fixed yearly budget to cover staff, equipment and reagents

LABORATORY MEDICINE PROGRAM

CLINICAL CHEMISTRY LABORATORY ORGANIZATION

- Core Lab Facility
  - found at virtually all hospitals
  - operates ٢٤h day ٧ days a week to provide the essential most requested tests
  - Highly automated environment
  - Instruments with Multi-analyte capabilities
- Special Chemistry
  - less frequently ordered tests
  - labour intensive and often manual methods
  - generally non-stat tests (result not required immediately)
- Point of Care Testing (POCT)
  - Instruments located outside of chemistry laboratory such as CCU, ER, ICU or satellite centre (clinic)

CORE LAB

High volume tests (many per day). Often require quick turn-around-time

Many tests where abnormal values are incompatible with life and therefore of critical value to the physician

Electrolytes: sodium (Na), potassium (K), Chloride (Cl)

Blood gases: pO_2, pCO_2, pH, HCO^3, oxygen saturation

Endocrine: Thyroid hormones

- Prolactin
- Testosterone

Lipids: Total Cholesterol, Low Density Lipoprotein Cholesterol (LDLc), High Density Lipoprotein Cholesterol (HDLc), Triglyceride (Fats)

Proteins: Total Protein

- Specific proteins such as Albumin, immunoglobulins,

Glucose

Tumour Markers: Prostate Specific Antigen (PSA)

Vitamins (Vit B^{12}) and minerals (Calcium, (Ca))

Toxicology

- Ethanol, methanol
- Drugs of abuse generally conducted as a screen

CORE LAB INSTRUMENTATION

CORE LAB INSTRUMENTATION

- Bar-coded test tubes are loaded onto to the instrument.
- Menu Driven Test selection
- All pipetting, mixing and measurements are automatic
- Random Access (can perform specific tests on a specific sample)
- Analyzer is interfaced with Laboratory Information System (LIS).
- Once resulted are verified, they can be broadcast (sent out)
- All reagents for specific tests such as control calibrators, buffers come as kits that a loaded directly onto the instruments.
- Instruments constantly monitors amount of consumables on-board and volume of liquid and solid waste generated

Type of analytical techniques found on Multi analyte analyzers

Many are immunoassays based with colorimetric detection

Ion-selective electrodes. Designed with a membrane that is specific for a particular analyte (Na, K, Cl). Change in potential is measured when electrode is placed in sample.

SPECIAL CHEMISTRY LABORATORY

- Generally lower volume tests
- Not available on auto-analyzer
  - Because the demand is not there
  - The test is not easily automated (extraction steps)
- Instruments are usually batch analyzers. Either research instruments or diagnostic instruments that perform 1 specific test on multiple samples.
- More training involved with test protocols and instrumentation than Core Lab instrumentation. Longer time required to reach competency
- Only larger centres have Special Chemistry Lab because
  - Requires the volume of specimens to justify the test
  - High cost of equipment to relative few specific tests

SPECIAL CHEMISTRY INSTRUMENTATION AND ANALYTICAL METHODS

Just about any analytical technique can be found in a Special Chem Lab

- Electrophoresis
  - Used to separate serum proteins into ٥ distinct bands
  - Used to separate Lipoproteins into ۴ distinct bands
  - Often used to separate isoforms of enzymes
- HPLC
  - Used to measure vitamins and hemoglobin variants
- Infrared Spectroscopy
  - Used to analyze components of Kidney stones
- Radioimmunoassay (RIA)
  - Used less and less but still employed for those analytes present in minute amounts (pmol) in the blood (ie. testosterone)
- GC-MS (Gas chromatography-mass spectroscopy) and/or LC-MS (liquid chromatography- mass spectroscopy.
  - Used for quantitative drug measurement

POINT OF CARE TESTING (POCT)

- Tests are of urgent importance, and results will affect the immediate management of the patient
- Instruments are available that can perform certain tests at remote locations, such as at the bedside on in a clinical care unit
  - Blood glucose
  - Urinalysis
  - Blood gases
  - Electrolytes
  - Cardiac markers (Troponin I & T)
  - Drug screens
- POC are nearly always more expensive, than the same tests performed in the central laboratory
- Many are immunoassay based. Can be qualitative or quantitative

ISSUES FOR POC TESTING

- Who is going to pay for the instrument and reagents
- Who is going to conduct the test
- Who is to perform the necessary quality control, general maintenance and order supplies
- Does the instrument interface with the hospital LIS.
- Are the tests performed on the POCT instrument standardized with the same tests performed using the hospital instrumentation

POC INSTRUMENTATION

tative

WHY ARE LABORATORY TESTS ORDERED

- Diagnosis
- Monitor progression of disease
- Monitor effectiveness of treatment
- Screening population for diseases
- To identify complications of treatment
- For predicting survivability, employability
- To check the accuracy of an unexpected data
- To conduct research
- To prevent malpractice
- For educating residents
- To assess nutritional status and health of an health individual
- Responding to total uncertainty

THE TEST

Measuring an analyte as a Marker to distinguish health and disease

Ideal Marker

- Absolutely specific for a specific disease
- Easily measurable
- Quantity reflective of severity of disease
- Early detection following onset of disease
- Not affected by other biological disturbances

Highly Specific marker:

Troponin I. It is a marker of Myocardial infarction (Heart Attack)

Found predominately in Cardiac Tissue

Released into the blood stream following cell death

Non specific marker: low blood pH (acidosis)

Very important to know but can be caused by a hosts of events

Drugs

Respiratory problems

Renal problems

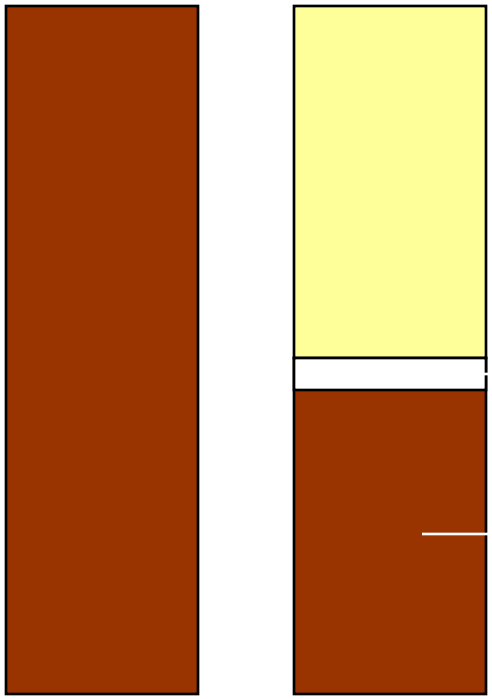
BIOLOGICAL SPECIMENS

"IF YOU SEND IT TO US WE WILL ANALYZE IT"

- Blood
- Urine
- Cerebrospinal Fluid
- Amniotic Fluid
- Duodenal Aspirate
- Gastric Juice
- Gall stone
- Kidney Stone
- Stools
- Saliva
- Synovial Fluid
- Tissue Specimen

- Choice of specimen type depends on
  - Analyte to be measured
  - Ease of collection

BLOOD COMPOSITION



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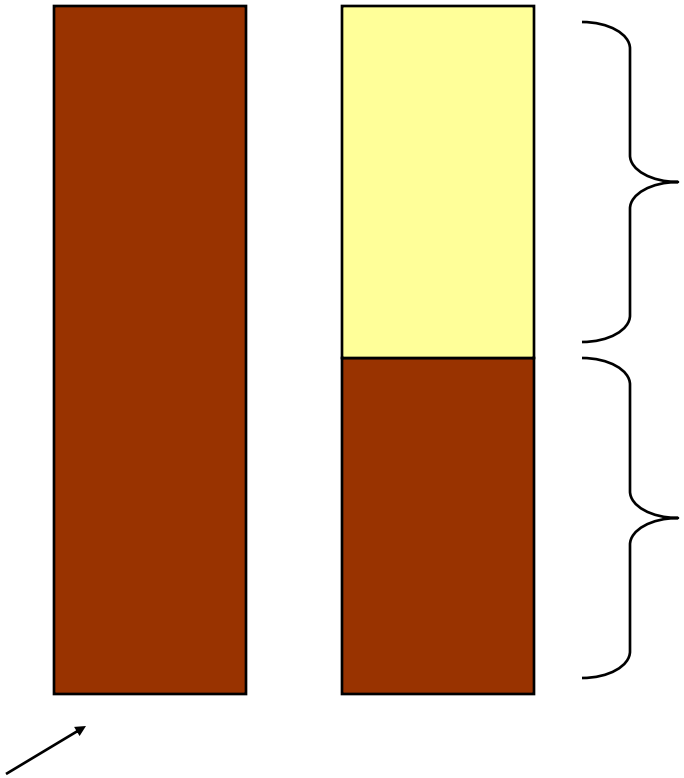

BLOOD ANALYSIS

Collections Method

- Veins
  - Syringe
  - Evacuated tube
- Arteries
- Skin puncture-capillary blood
- Additives
  - Separator gel
- Intravenous lines

Factors affecting choice of Blood Source and Collection Method

- Analyte under investigation
- Patient
  - vascular status
  - ease of collection

BLOOD ANALYSIS

- Testing can be done on whole blood, serum or plasma. Choice depends on a number of factors
- Analyte to be measured
  - Most hematology tests requires whole blood
- Instrumentation used for analysis
  - Most automated instruments are not set up for whole blood analysis
- The way the test was developed.
  - Tests are often only validated on either plasma or serum
- Turn around time
  - Analysis of whole blood is the quickest. No waiting for clot or spinning
  - Plasma requires centrifugation prior to analysis
  - With serum, the blood must clot then you have to centrifuge

BLOOD ANALYSIS IN THE CHEMISTRY

- Since most tests in the chemistry lab involve analytes that are dissolved in the fluid portion of blood, serum or plasma are the specimens of choice.
- Important exceptions include
  - Hemoglobin, Red blood cell (RBC) Folate
  - Blood gases
- Protein electrophoresis was developed based on the analysis of serum. Not done on plasma because of the presence of the protein fibrinogen which distorts the electrophoretic pattern.
- Many tests can use either serum or plasma

TEST RESULTS
VARIATIONS, ERRORS, INTERFERENCES

- Variations
- *Clinical variations* within an individual and between individuals
- *Analytical variations*-no test is perfect. All tests have some degree of variations for repeated measurements of the same sample.
- The final test result is affected by factors that occur
  - Pre-analytically
  - At the time of the test
  - After the test is completed

STEPS IN OBTAINING A LABORATORY TEST

- Test is requested by physician and ordered on the computer. Barcode is generated
- Specimen is collected
- Specimen and order are transported to the lab
- The specimen is accessioned in the lab
- The specimen is processed
- The specimen is analyzed
- The results are reviewed and verified by an technologists
- The results are released to the patient's record

WHY ANALYTICAL RESULTS VARY

Inter-individual Variation

- Age
- Sex
- Race
- Genetics
- Long term health status

Pre-analytical Variation

- Transport
- Exposure to UV light
- Standing time before separation of cells
- Centrifugation time
- Storage conditions

PRE-ANALYTICAL ERRORS

- Collection
  - Was the right tube used?
  - Was venipuncture performed correctly?
  - Was the specimen properly stored?
- Identification
  - Was the blood collected from the correct patient?
  - Was the blood correctly labeled?
    - Patient name, ID, date, time of collection, phlebotomist

SPECIMEN IDENTIFICATION

- One of the common sources of erroneous lab results is misidentified specimens
- The lab is required to have a clear and rational policy for identifying specimens, and handling misidentified specimens

PROLONGED VENOUS STASIS

Blocking the flow of blood with the tourniquet with eventually lead to a sieving effect. Small molecules, water and ions are forced out blood vessels and larger molecules are concentrated

- Increases Total Protein, proteins, iron (Fe), cholesterol, bilirubin
- Decreases potassium

SUPINE VS. SITTING OR STANDING

- Going from lying (supine) to upright reduces total blood volume by about ٧٠٠ ml
- The following may decrease by ٥-١٥% in the supine patient:
  - Total protein
  - Albumin
  - Lipids
  - Iron
  - Calcium
  - Enzymes

SIGNIFICANTLY AFFECTED BY HEMOLYSIS:

- Hemolysis-rupture of red blood cell
  - Can be due to improper collection
  - End result is dumping cellular contents into blood. Mild dilution effect in some analytes
- Significant increase in potassium, magnesium, phosphorous

INTERFERENCES

- Hemolysis
  - The release of hemoglobin into blood can effect the reactions comprising specific tests
  - Causes serum or plasma to be red and can effect tests that are colorimetric
- Lipemia (lots of fats) and proteinemia (lots of protein)
  - Causes serum or plasma to be become turbid. This can effect colorimetric and turbidometric based tests
  - Also can cause a dilution effect. Fats and proteins are large and displace water in plasma. Can give falsely low results especially for Na
- Human Anti Animal Antibodies.
  - Occurs in individual that have been exposed to foreign immunoglobins
  - Can significantly increase or decrease immunoassay based tests since all utilize animal antibodies, particularly mouse. Referred to as Human Anti Mouse Antibodies (HAMA)
  - Tests usually contain reagent to clear HAMA
  - Technicians performs a dilution test to determine if HAMA are present