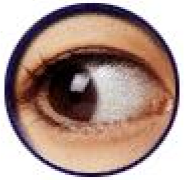


Setup of Accredited Laboratory for Drinking Water Quality Analysis

Dr. Rakesh Kumar

NABL Lead Assessor and retired from Indian Institute of Toxicology Research
Lucknow-226001
Email: rkchitranshi@rediffmail.com

Pass/Fail

A

85%

F

B

C+

93%

Assessment, Scoring, and Evaluation

S

A-

67%

D

GRADES

Unsatisfactory

C

Definitions

- **Assessment** -- *The process of measuring something with the purpose of assigning a numerical value.*
- **Scoring** -- *The procedure of assigning a numerical value to assessment task.*
- **Evaluation** -- *The process of determining the worth of something in relation to established benchmarks using assessment information.*

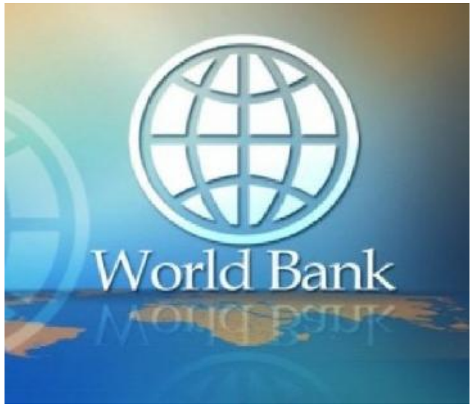
The liberalization of economies and the globalization of markets have intensified international competition. This has brought particular challenges to companies in developing countries.

Developing countries need to have a credible conformity assessment infra structure to certify that their products conform to international standards.

Testing laboratories are an essential component of this infra structure.

Testing Labs in developing countries face major problems in

- In measurement
- Product certificates.



WTO recognized this as a Technical Barrier to trade and established the TBT Agreement.

The test result can only be mutually acceptable if there is a mechanism where by the user has confidence in the technical competence of laboratories and soundness of their measurements.

Global Conformity Assessment System for testing i.e. ISO/IEC-17025 :

Guide Book as a tool in assisting developing countries to achieve international accreditation of their testing laboratories and consequent acceptance of their products in other countries , thus enabling them to over come a major technical barrier to trade and to fully exploit their competitive strength in the global market.

Role of Accredited Test Laboratories in Testing & Calibration Programmes

Accreditation

Definition: Procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks - ISO/IEC Guide 2 : 1996.

Key points:

- ☞ Checks conformity to all clauses of ISO/IEC 17025 (which include all ISO 9001 elements).
- ☞ Assures the client that the procedures and test results are technically valid.
- ☞ Recognizes the technical competence of laboratory staff.
- ☞ Endorses the quality management system.

Some Benefits of Laboratory Accreditation

- ⇨ Provides formal recognition to competent laboratories and ensures that they perform their work in accordance with international criteria.
- ⇨ Minimises the risk of unreliable results which, in turn, reduces the risk for manufacturers or suppliers to produce or supply a faulty product.
- ⇨ Minimises the chances of retesting and hence reduces chances of additional financial burden and time delays.

Some Benefits of Laboratory Accreditation

- Enhances Customer confidence and Satisfaction.
- International acceptability of test results. Based on mutual evaluation and acceptance of other country's laboratory accreditation systems, international agreements called Mutual Recognition Arrangements (MRA) have been established for realizing the ideal of having products "tested once and accepted everywhere". Such agreements are crucial in enabling test data by an accredited laboratory to be accepted in overseas markets and facilitate trade.

Competence

- Raise standard to meet international standards
- Operation
  - ISO/IEC 17025 – testing and cal labs
  - ISO 15189 – medical testing labs
  - ISO/IEC 17043 – proficiency testing providers
  - ISO Guide 34 – reference material producers
  - ISO/IEC 17020 – inspection bodies
  - ISO/IEC 17021 – management system CBs
  - ISO/IEC Guide 65 – Product CBs

About NABL

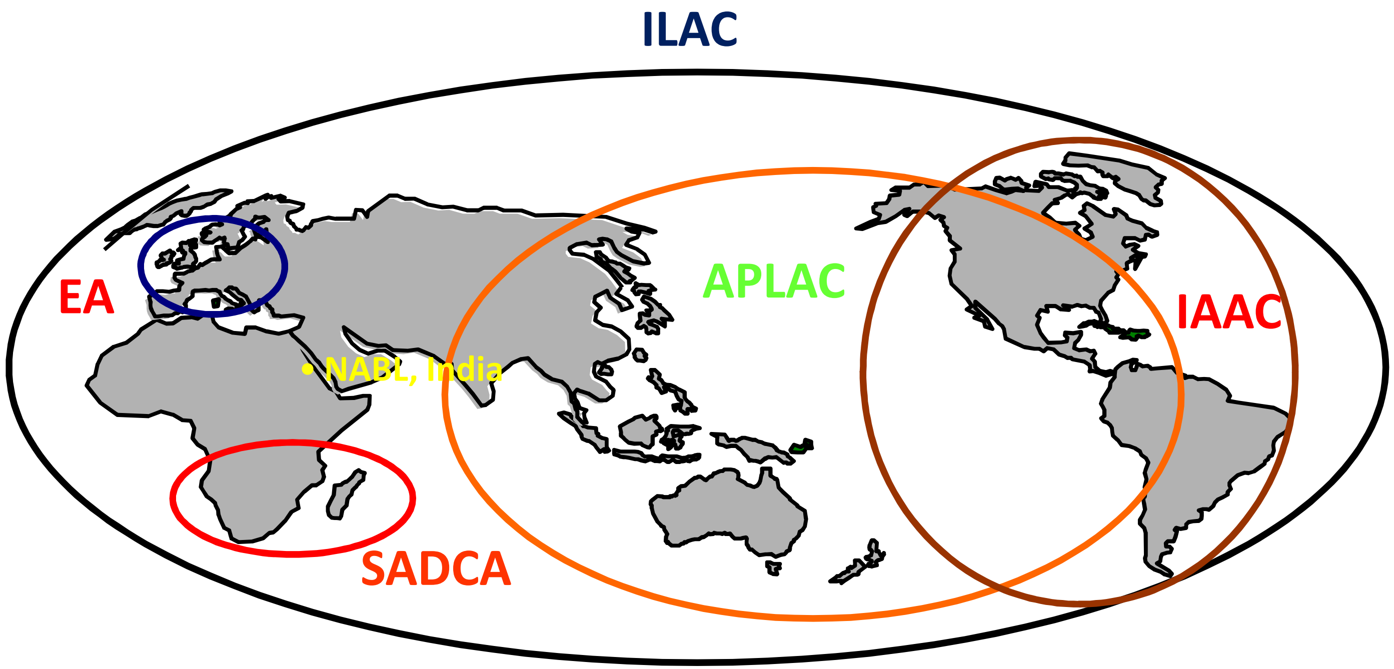
- ☞ NABL provides laboratory accreditation services to laboratories that are performing tests and calibrations in accordance with ISO/ IEC 17025: 1999 (General requirements for the competence of Testing and Calibration Laboratories).

- ☞ NABL has established its accreditation system in accordance with ISO IEC Guide 58, which is followed internationally.

Calibration and testing laboratory accreditation systems -- General requirements for operation and recognition

- ☞ NABL is signatory to APLAC Mutual Recognition Arrangement & ILAC Mutual Recognition Arrangement since October 2000 & November 2000 respectively.

The International Picture



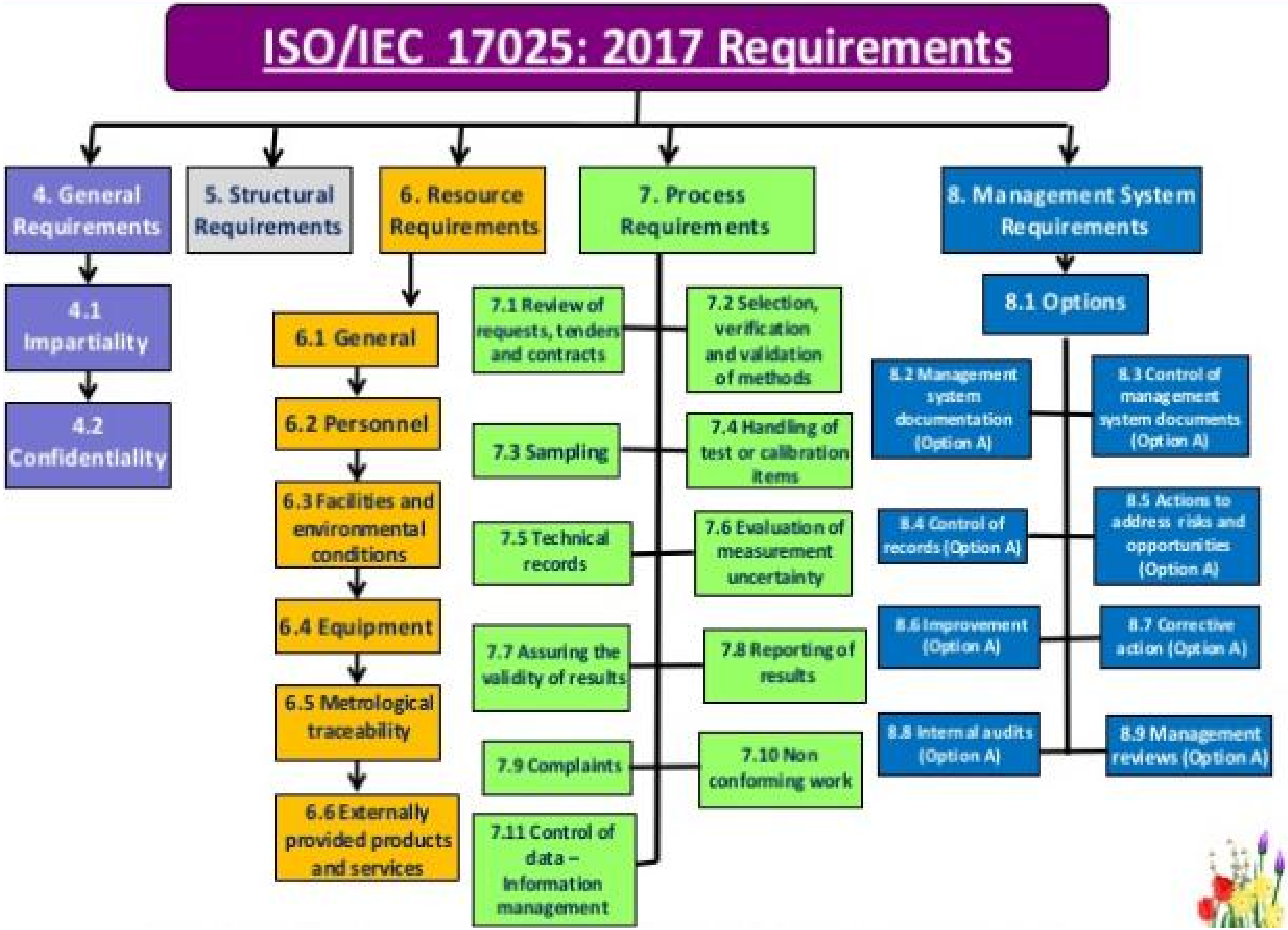
EA European co-operation for Accreditation
APLAC Asia Pacific Laboratory Accreditation Cooperation
ILAC International Laboratory Accreditation Cooperation
SADCA Southern African Development Cooperation for Accreditation
IAAC Inter-American Accreditation Cooperation
Unaffiliated Bodies – Peer evaluated ABs who are not geographically located in one of the established regions

ISO/IEC Guide 25:1990

ISO/IEC 17025:1999

ISO/IEC 17025:2005

ISO/IEC 17025:2017

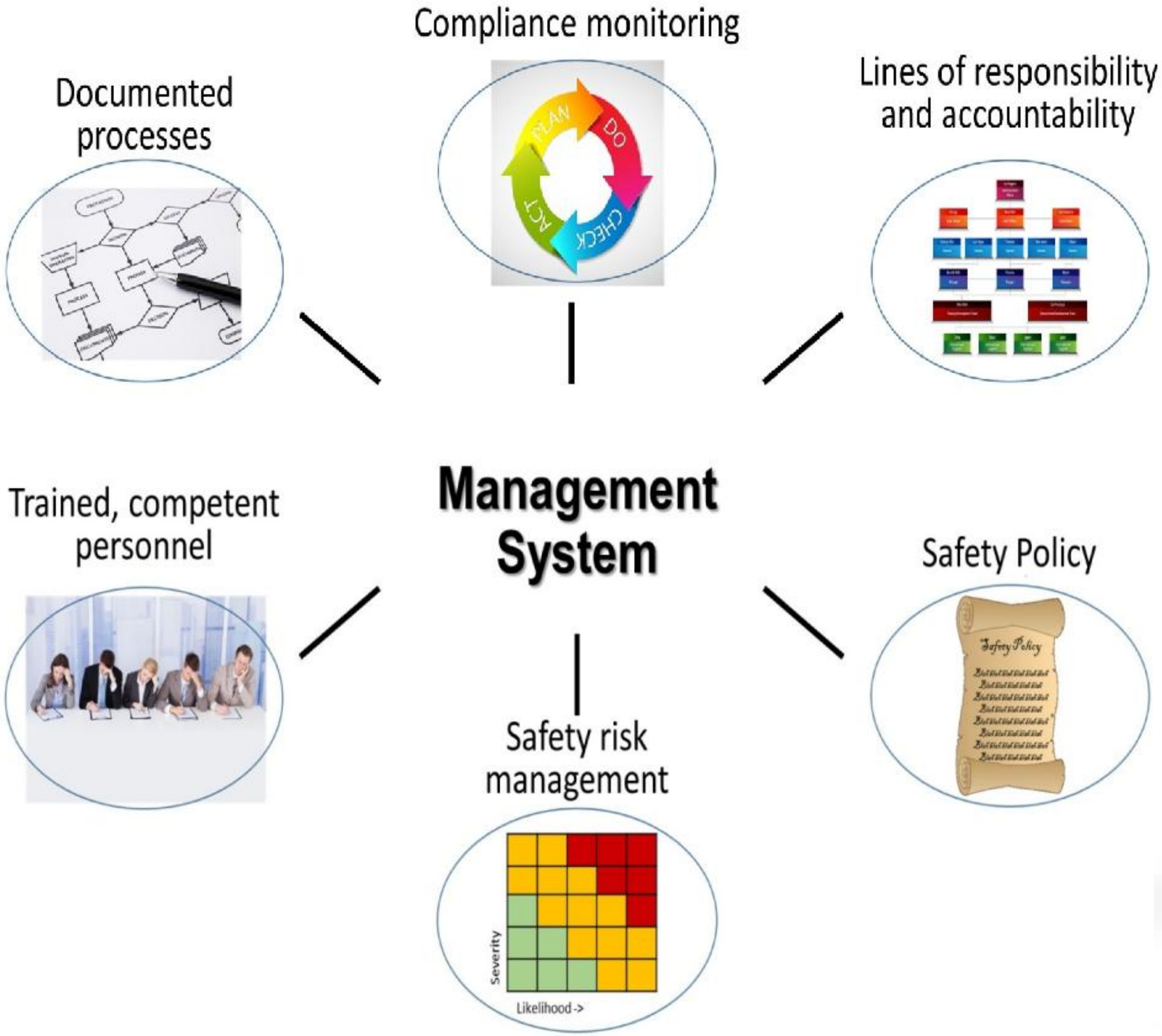

ISO/IEC 17025: 2017 Requirements
4. General Requirements
4.1 Impartiality
4.2 Confidentiality
5. Structural Requirements
6. Resource Requirements
6.1 General
6.2 Personnel
6.3 Facilities and environmental conditions
6.4 Equipment
6.5 Metrological traceability
6.6 Externally provided products and services
7. Process Requirements
7.1 Review of requests, tenders and contracts
7.2 Selection, verification and validation of methods
7.3 Sampling
7.4 Handling of test or calibration items
7.5 Technical records
7.6 Evaluation of measurement uncertainty
7.7 Assuring the validity of results
7.8 Reporting of results
7.9 Complaints
7.10 Non conforming work
7.11 Control of data – Information management
8. Management System Requirements
8.1 Options
8.2 Management system documentation (Option A)
8.3 Control of management system documents (Option A)
8.4 Control of records (Option A)
8.5 Actions to address risks and opportunities (Option A)
8.6 Improvement (Option A)
8.7 Corrective action (Option A)
8.8 Internal audits (Option A)
8.9 Management reviews (Option A)

ISO / IEC 17025 : 2017

Contents of ISO / IEC 17025 : 2017

1. Scope
2. Normative References
3. Terms and Definitions
4. General Requirements
5. Structural Requirements
6. Resources Requirements
7. Process Requirements
8. Management System Requirements

Management System Requirement

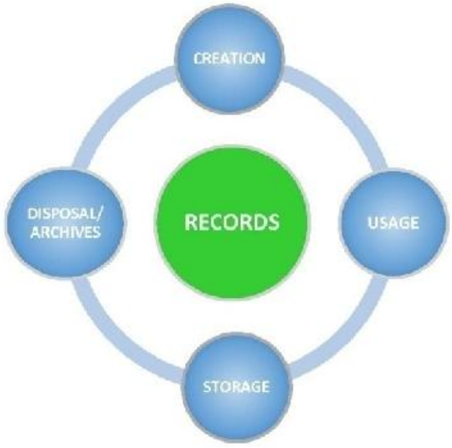


Management System Documentation (Option A)

System acknowledged and implemented all levels

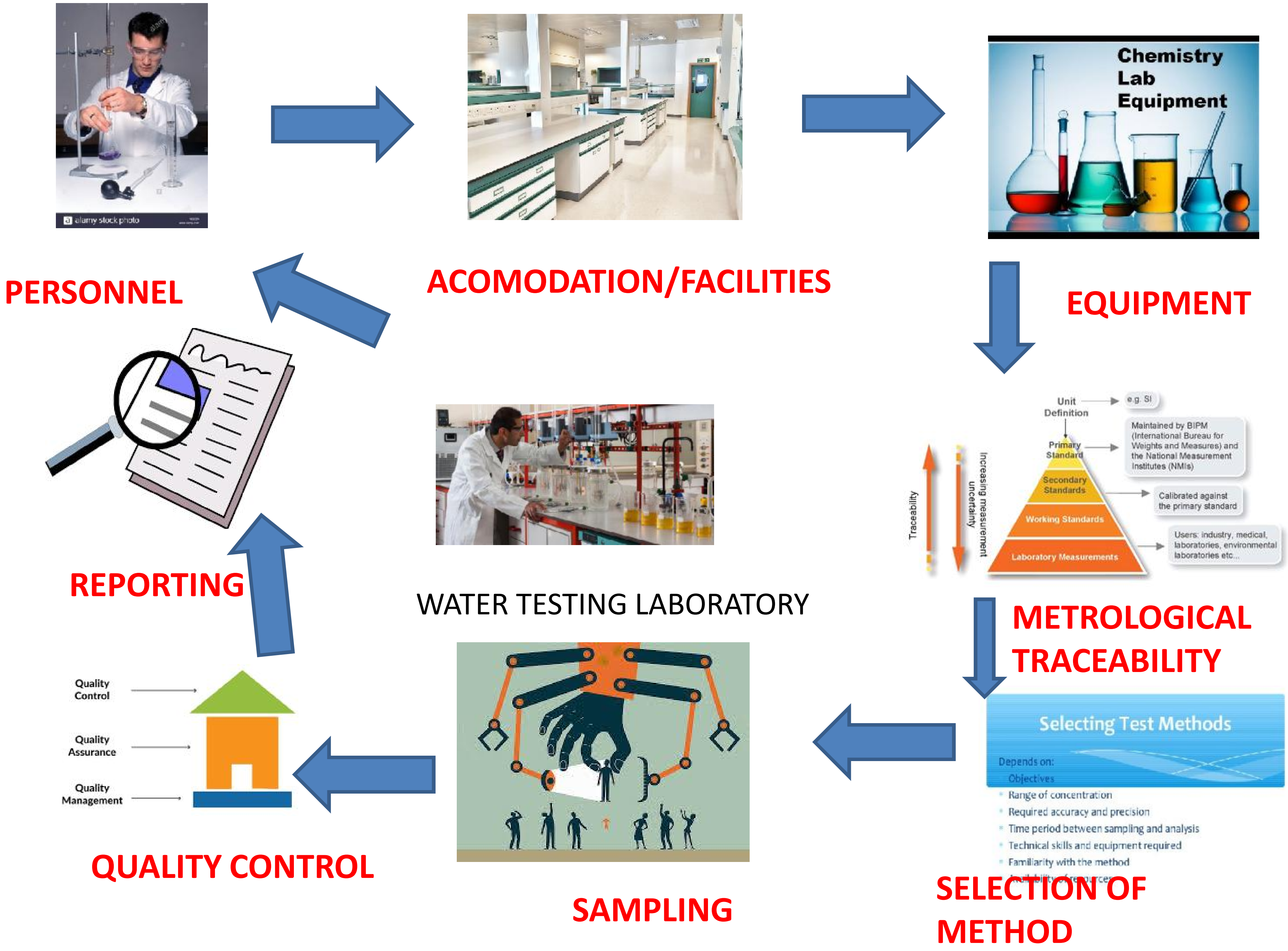
- Level 1 Quality Manual
- Level 2 Quality Assurance Procedures
- Level 3 Standard Operating Procedures for Tests, Equipment’s and Calibration
- Level 4 Forms & Formats, Records

Control of Records



Establish and retain legible
records to demonstrate fulfilment
of the requirements in this document (NEW)

Technical records .


PERSONNEL
ACOMODATION/FACILITIES
Chemistry Lab Equipment
EQUIPMENT
Unit Definition
e.g. SI
Primary Standard
Maintained by BIPM (International Bureau for Weights and Measures) and the National Measurement Institutes (NMIs)
Secondary Standards
Calibrated against the primary standard
Working Standards
Laboratory Measurements
Users: industry, medical, laboratories, environmental laboratories etc...
Traceability
Increasing measurement uncertainty
METROLOGICAL TRACEABILITY
Selecting Test Methods
Depends on:
Objectives
Range of concentration
Required accuracy and precision
Time period between sampling and analysis
Technical skills and equipment required
Familiarity with the method
SELECTION OF METHOD
SAMPLING
Quality Control
Quality Assurance
Quality Management
QUALITY CONTROL
REPORTING
WATER TESTING LABORATORY

1.PERSONNEL

- Sufficient in number
- Qualified
- Trained
- Competent
- Responsible for authorized work only

2. ACCMOODATION and FACILITIES

- Suitable for different activities
- Well Separated rooms for Equipment, Wet Lab,
  Hot Zone and Storage room
- Maintenance of Environmental conditions(temperature
  and Humidity).
- Entry is restricted
- Use PPE in Laboratory
- Good Housekeeping

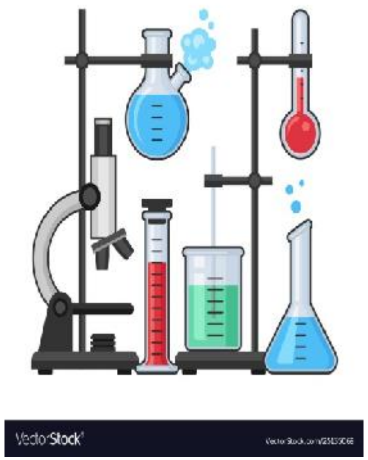
Lab should ensure environmental condition ,lighting, energy sources etc to get correct results



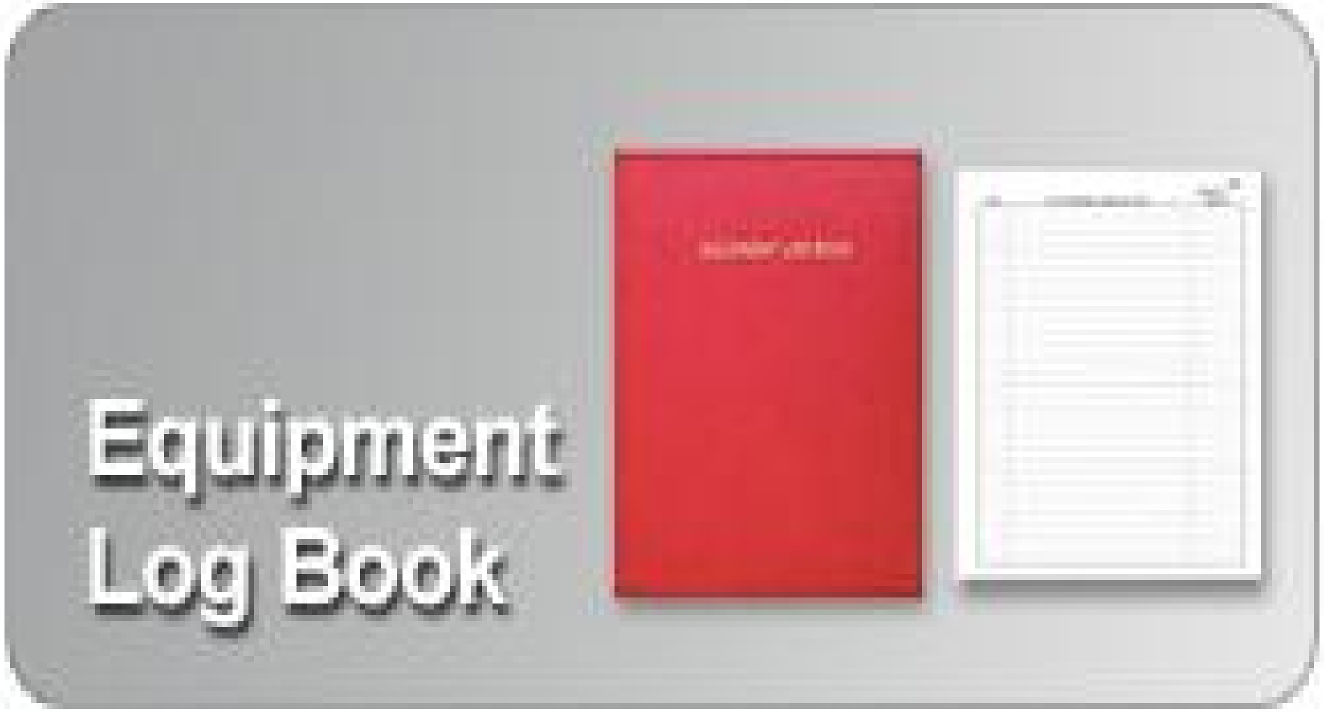



3. EQUIPMENT

- ➢ Includes all apparatus, equipment ,software, reagents, glassware, chemicals and Reference standards
- ➢All Equipment must be calibrated and calibration status must be maintained by doing intermediate checks.
- ➢All Equipment must have UID and log books
- ➢ All equipment must have maintenance plan.
- ➢Equipment are operated by authorized personnel only.



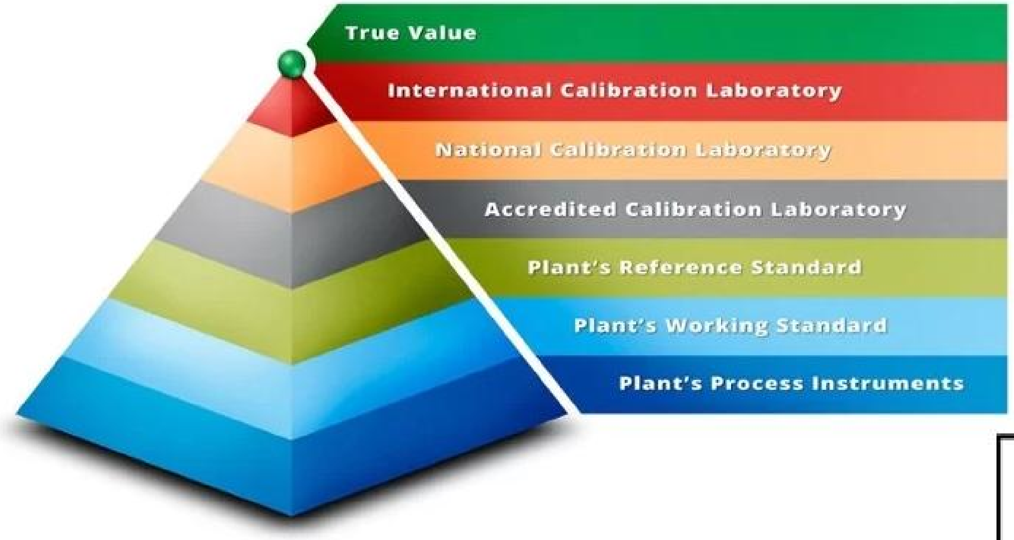
Unique identification of each equipment.

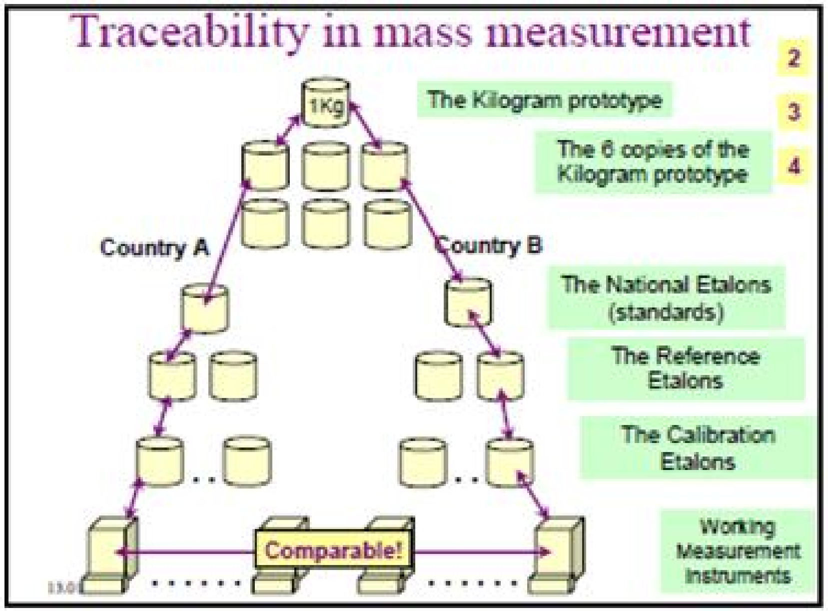


Log Books of Equipment

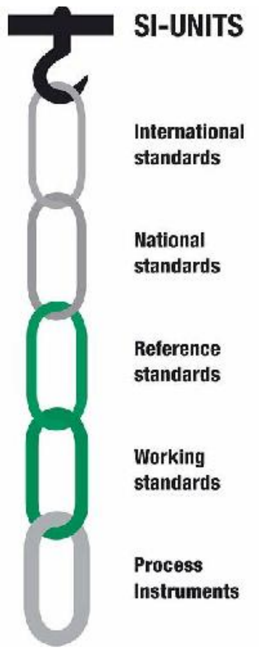
4.Metrological Traceability

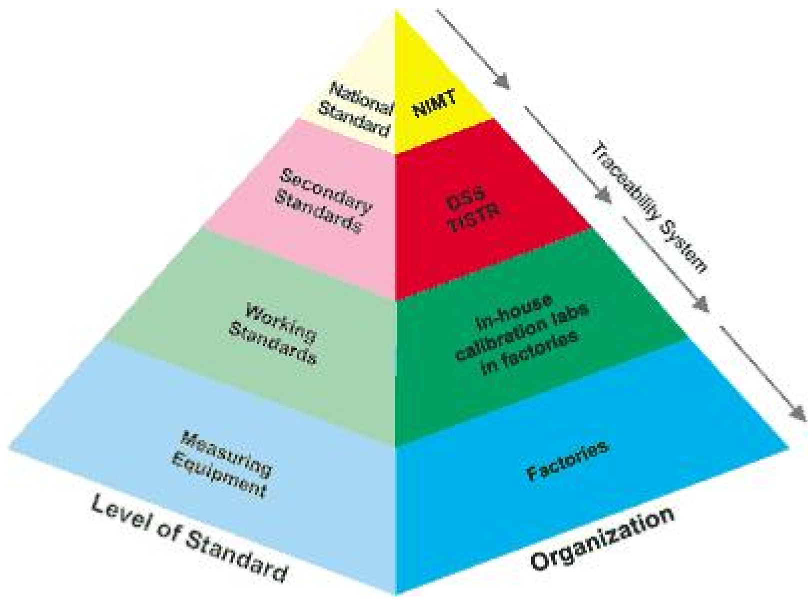
These requirements have been made clearer, with simplified text.





1:The laboratory must maintain metrological traceability of its measurement results by a documented unbroken chain of calibrations, each contributing to the measurement uncertainty, linking them to an appropriate reference.





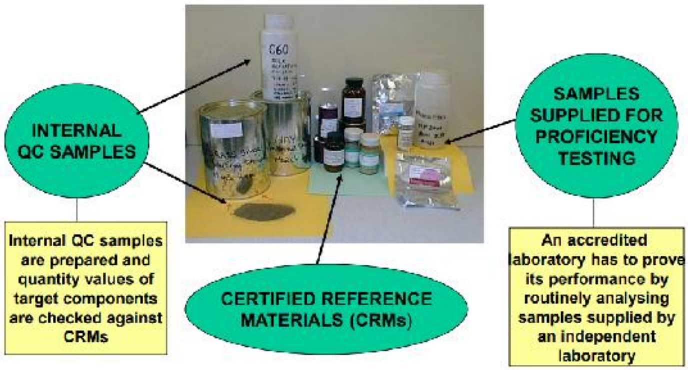
2:Measurement results are to be traceable to SI units through either:

a) calibration by a competent laboratory;

b) certified values of certified reference materials from a competent producer with stated traceability to SI units;

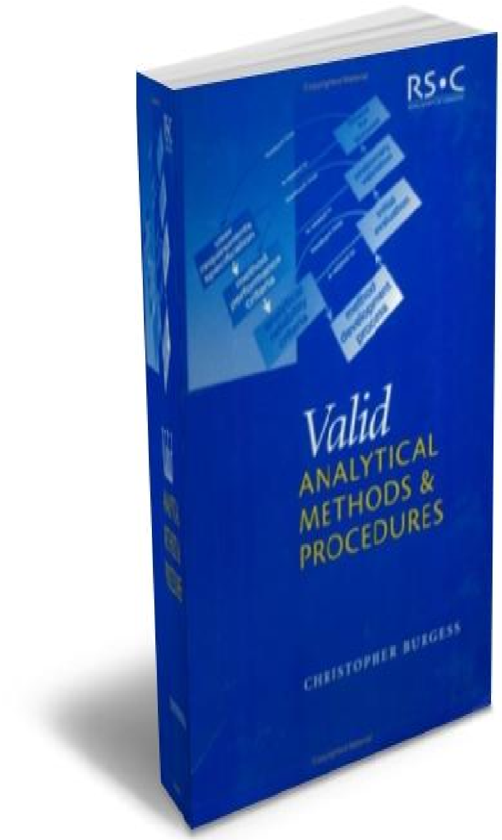
c) direct realisation of the SI units.

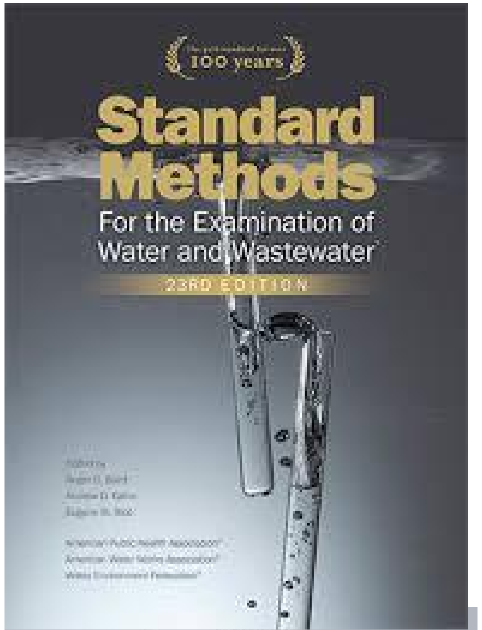
Clarity provided that traceability to SI may be achieved through the use of certified reference materials.

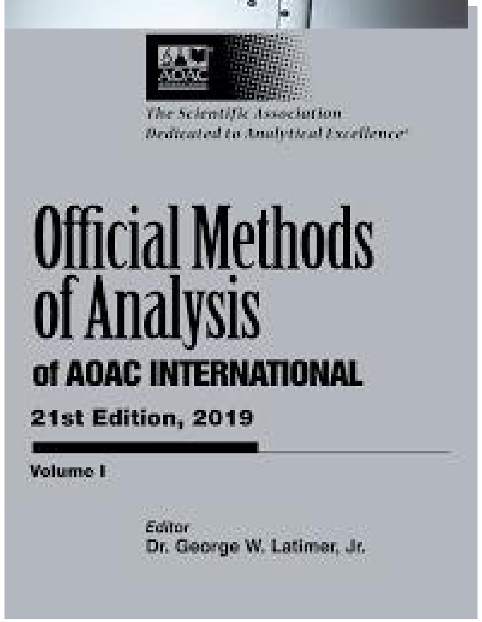


5.SELECTION OF METHOD

Appropriate methods







Method up to date, readily available to personnel

Standard Operating Procedure (SOP)

- A unique identification number of SOP
- Its title.
- Its application and limitations.
- the adaptation and amendment date and amendment number.
- A brief description of its principle.
- Reference to the standard on which the procedure is based, if applicable.
- The name of equipment and chemical and reagents required.
- An unambiguous step-by-step test instruction to be followed by technical staff.
- The precision of the method whenever applicable.
- Detail instructions for handling, transportation and storage and preparation of items (eg Standards), estimation of uncertainty and precaution to be taken.
- Procedure for record of data produced.

Verify method before use

Method Verification

- importing a validated method
- show that laboratory can do it at its site
- demonstrate that laboratory can repeat the method performance

Aspect of a Verification

Be extensive enough to show that the method is fit for the intended use and meets the customer's needs

Method Verification

Standard methods shall be verified for:

1. the equipment

2. the required reference materials/standard, reagents

3. the environmental conditions

4. testing staff member competence to perform the test

5. capability to achieve the method performance

Validation for car driving

Car driving Training

Verification of Car driving

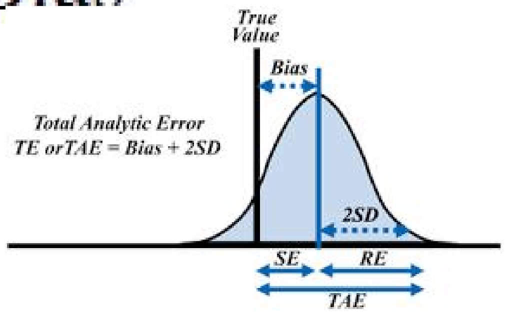
Car driving

Method Verification

To demonstrate you can repeat the method performance, including:

- Detection limits
- Precision

- Bias



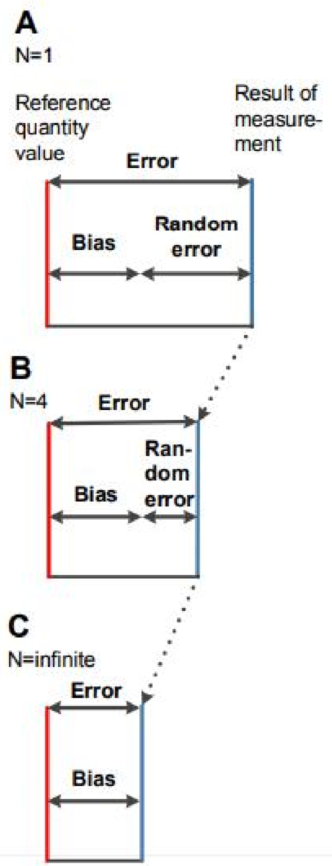
Method Verification – Bias

- To demonstrate the absence of lab bias
- Proficiency tests/interlaboratory comparisons
- Analysis of CRMs

PT Services

Bias

- **Trueness** is the "closeness of agreement between the average of an infinite number of replicate measured quantity values and a reference quantity value". It is quantitatively expressed as ***bias***.



Water

Who am I?

I am tasteless, I am Colourless,

I am shapeless, I am Odourless,

But without me, there's no life.

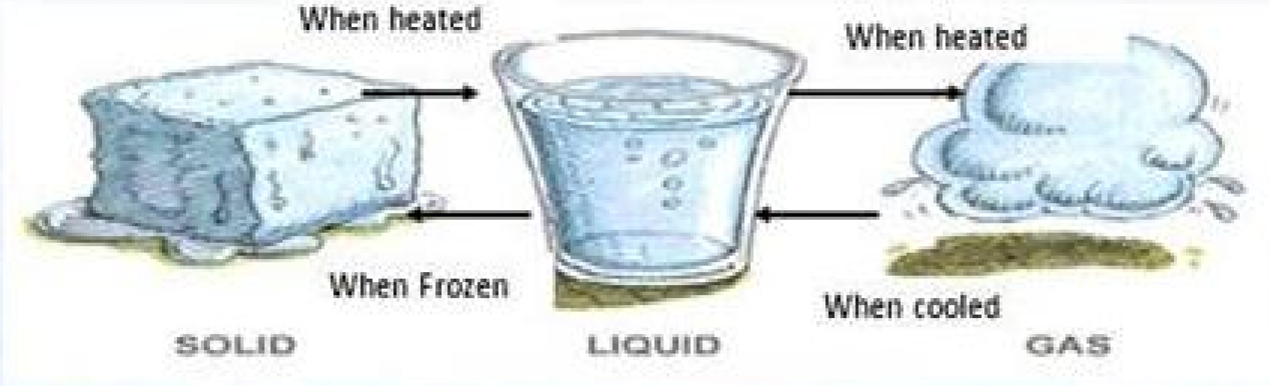
Can you tell me who m I?

Yes! I 'm Water

Introduction to Water

- Water is the most common substance found on the Earth.
- About 3/4th of the Earth is covered with water.
- Water can be found in ponds, rivers, lakes, oceans and seas.

Three Forms of Water



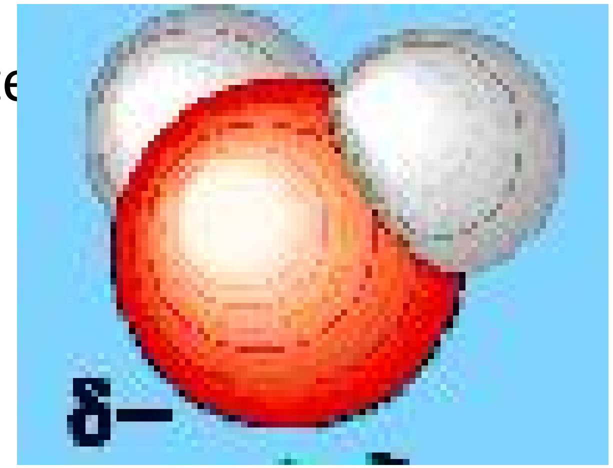
When water is heated, it into **steam** changes or **water** water vapour. This water vapour is a gas, which can be changed into by cooling. When kept in the 'freezer' of a refrigerator, water will change into solid **ice.** If you keep the ice in a warm place, it will change into water.

Properties of Water

- Polar molecule
- Cohesion and adhesion
- High specific heat
- Density – greatest at 4^oC
- Universal solvent of life

Polarity of Water

- In a water molecule two hydrogen atoms form single polar covalent bonds with an oxygen atom. Gives water more structure than other liquids
  - Because oxygen is more electronegative, the region around oxygen has a partial negative charge.
  - The region near the two hydrogen atoms has a partial positive charge.
- A water molecule is a polar molecule with opposite ends of the molecule with opposite charges.



- Water has a variety of unusual properties because of attractions between these polar molecules.
  - The slightly negative regions of one molecule are attracted to the slightly positive regions of nearby molecules, forming a hydrogen bond.
  - Each water molecule can form hydrogen bonds with up to four neighbors.

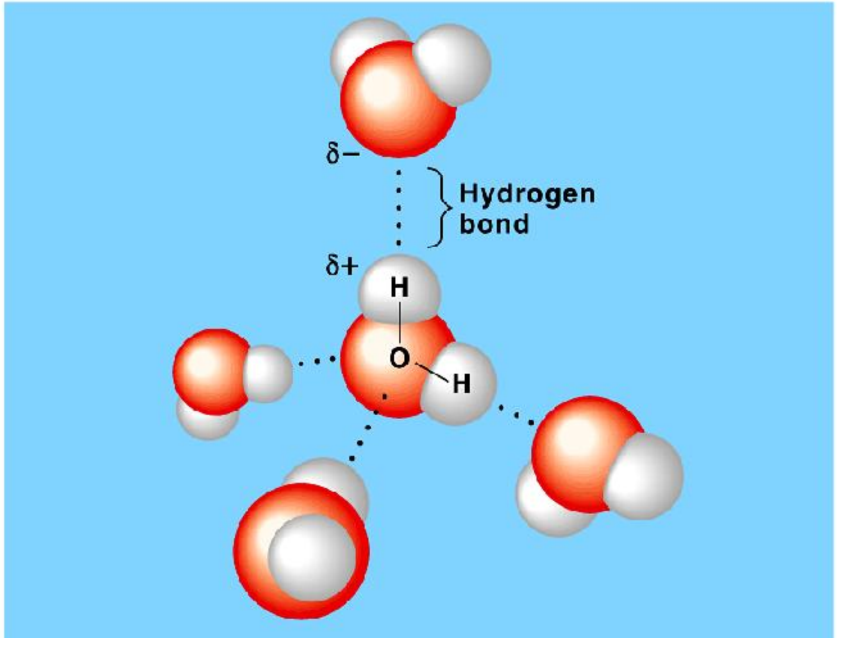


Fig. 3.1

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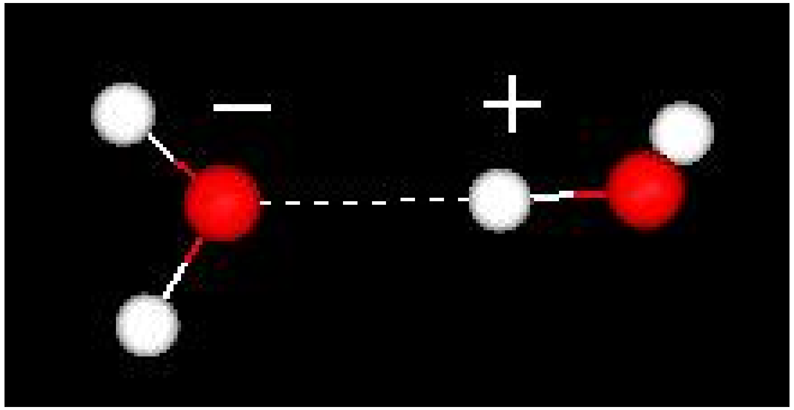
HYDROGEN BONDS

- Hold water molecules together
- Each water molecule can form a maximum of 4 hydrogen bonds
- The hydrogen bonds joining water molecules are weak, about $1/20^{th}$ as strong as covalent bonds.
- They form, break, and reform with great frequency

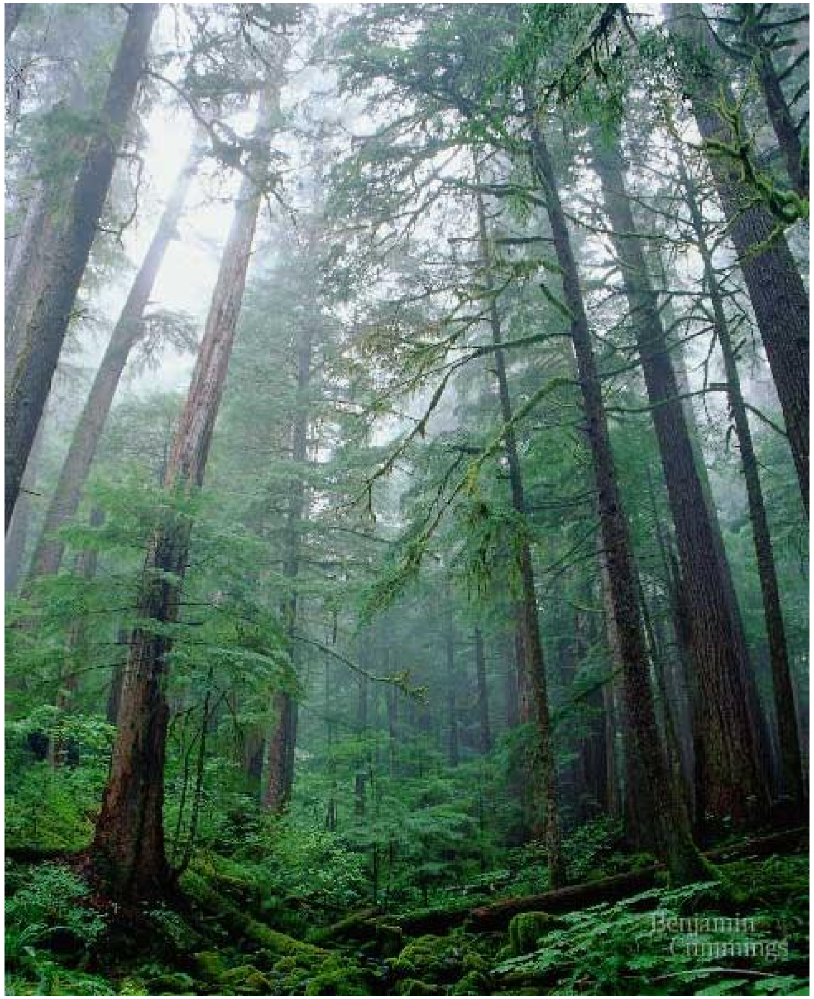
- Extraordinary Properties that are a result of hydrogen bonds.
  - Cohesive behavior
  - Resists changes in temperature
  - High heat of vaporization
  - Expands when it freezes
  - Versatile solvent



Organisms Depend on Cohesion

Hydrogen bonds hold the substance together, a phenomenon called cohesion

- **Cohesion is responsible for the transport of the water column in plants**
- **Cohesion among water molecules plays a key role in the transport of water against gravity in plants**
- **Adhesion, clinging of one substance to another, contributes too, as water adheres to the wall of the vessels.**



- **Surface tension,** a measure of the force necessary to stretch or break the surface of a liquid, is related to cohesion.
  - Water has a greater surface tension than most other liquids because hydrogen bonds among surface water molecules resist stretching or breaking the surface.
  - Water behaves as if covered by an invisible film.
  - Some animals can stand, walk, or run on water without breaking the surface.

Fig. 3.3

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Moderates Temperatures on Earth

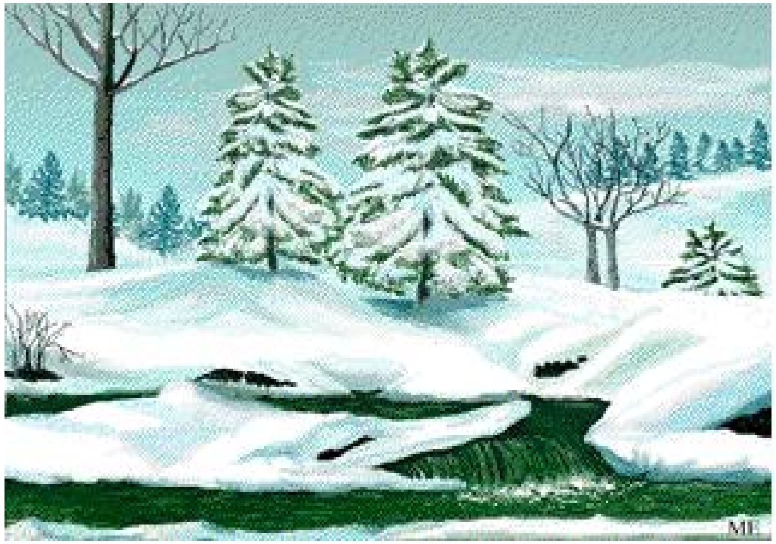
Water stabilizes air temperatures by absorbing heat from warmer air and releasing heat to cooler air.
Water can absorb or release relatively large amounts of heat with only a slight change in its own temperature.

Celsius Scale at Sea Level	
$100^{o}C$	Water boils
$37^{o}C$	Human body temperature
$23^{o}C$	Room temperature
$0^{o}C$	Water freezes

- **What is kinetic energy?**
- **Heat?**
- **Temperature?**
- **Calorie?**
- **What is the difference in cal and Cal?**
- **What is specific heat?**

Density of Water

- Most dense at 4^{o}C
- Contracts until 4^{o}C
- Expands from 4^{o}C to 0^{o}C



The density of water:

1. Prevents water from freezing from the bottom up.
2. Ice forms on the surface first—the freezing of the water releases heat to the water below creating insulation.
3. Makes transition between season less abrupt.

– When water reaches 0°C, water becomes locked into a crystalline lattice with each molecule bonded to to the maximum of four partners.

– As ice starts to melt, some of the hydrogen bonds break and some water molecules can slip closer together than they can while in the ice state.

– Ice is about 10% less dense than water at 4°C.

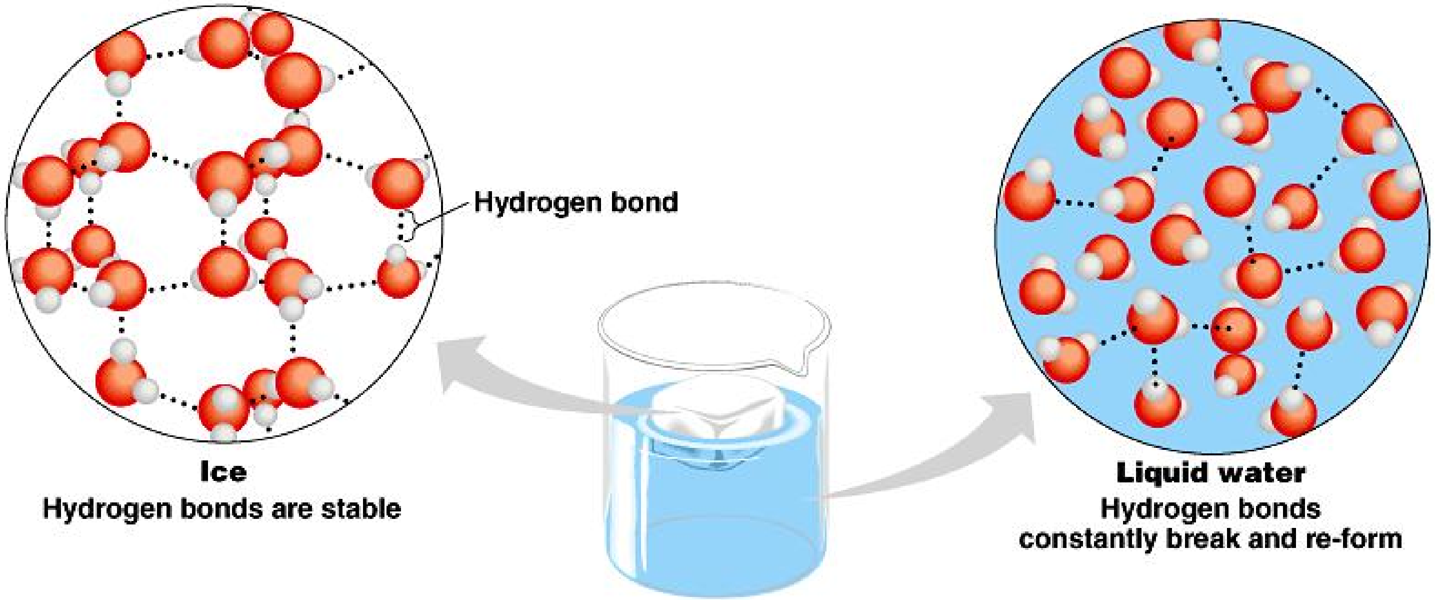


Fig. 3.5

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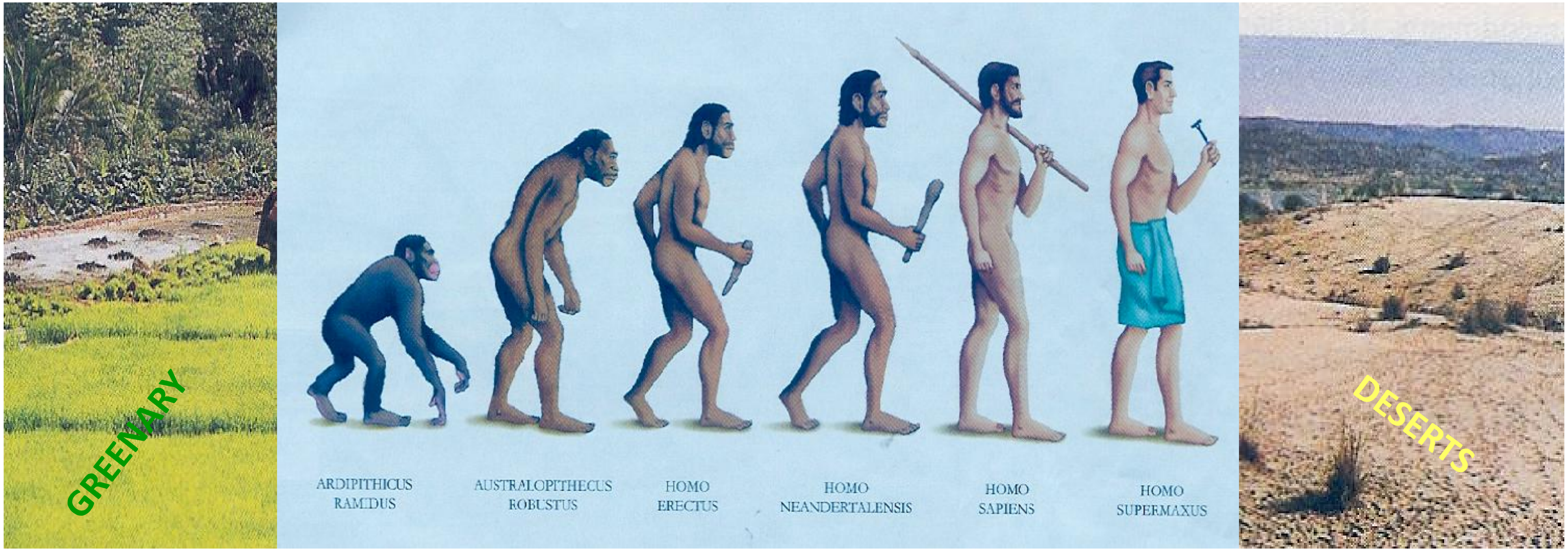
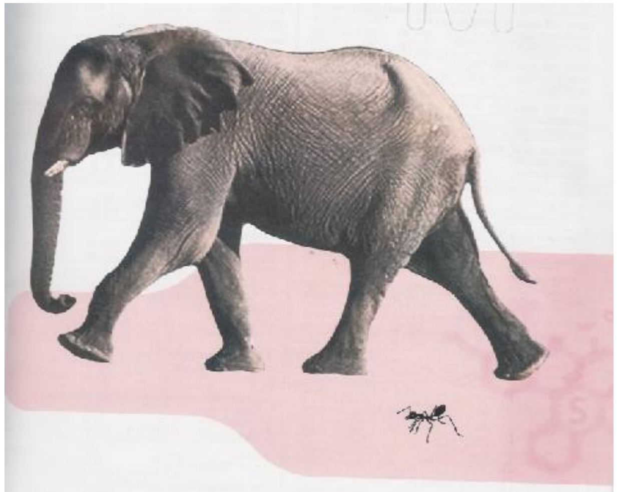


ASCENT …. …. …. DESCENT ?

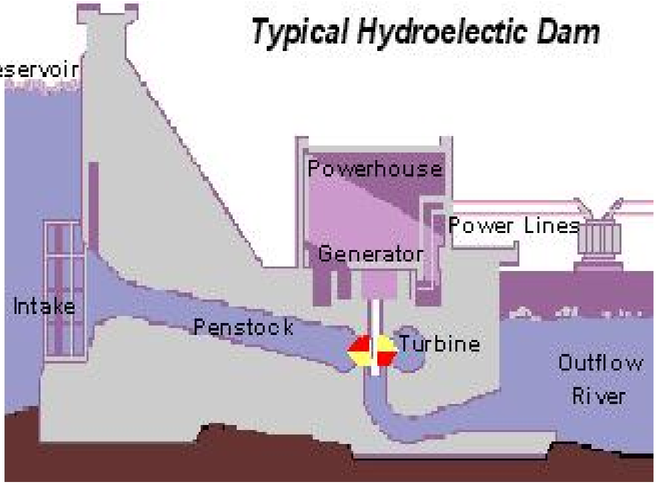


ITRC

DOMESTIC

AGRICULTURE

PUBLIC WATER SUPPLY



THERMAL POWER PLANT

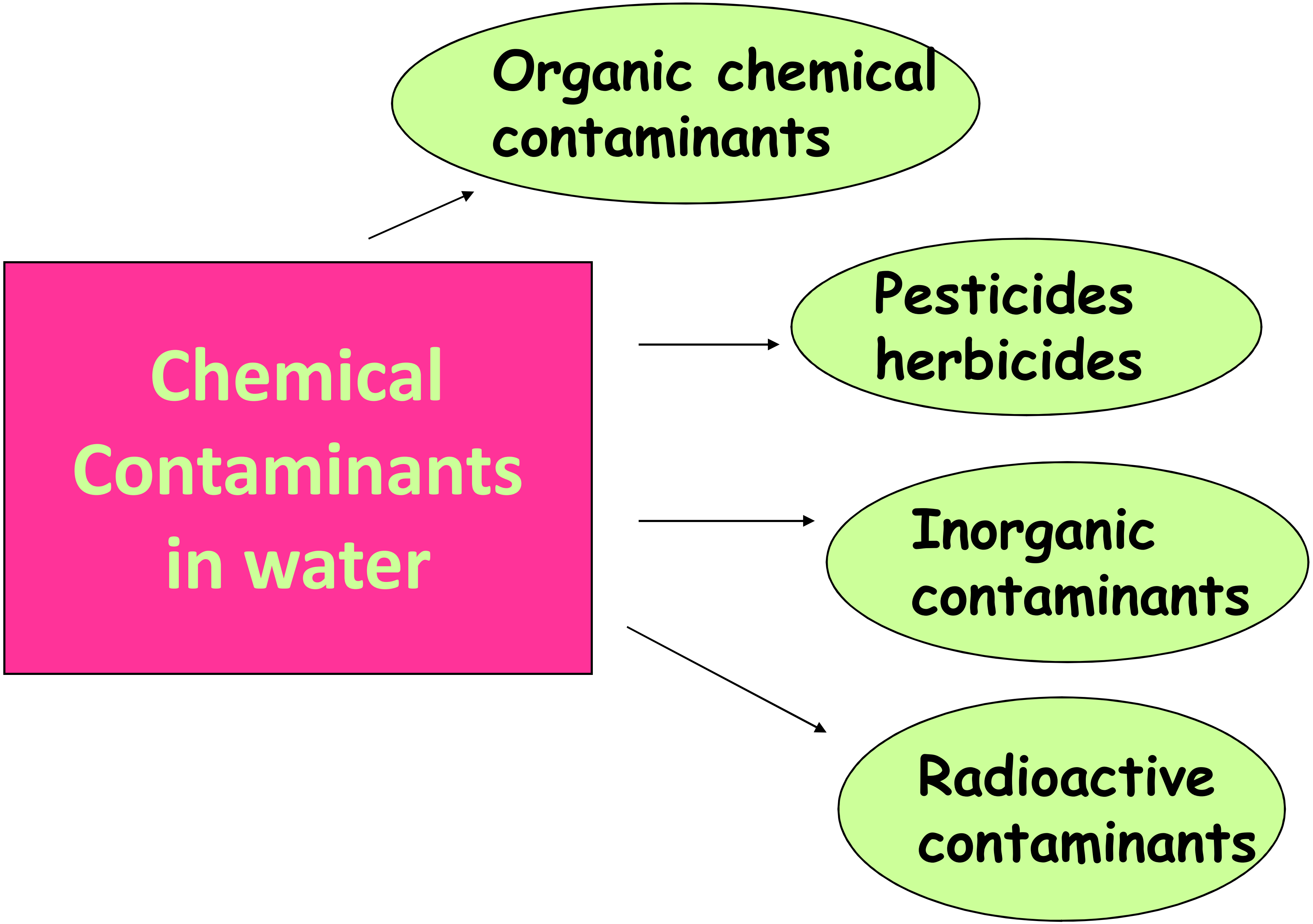
INDUSTRIES

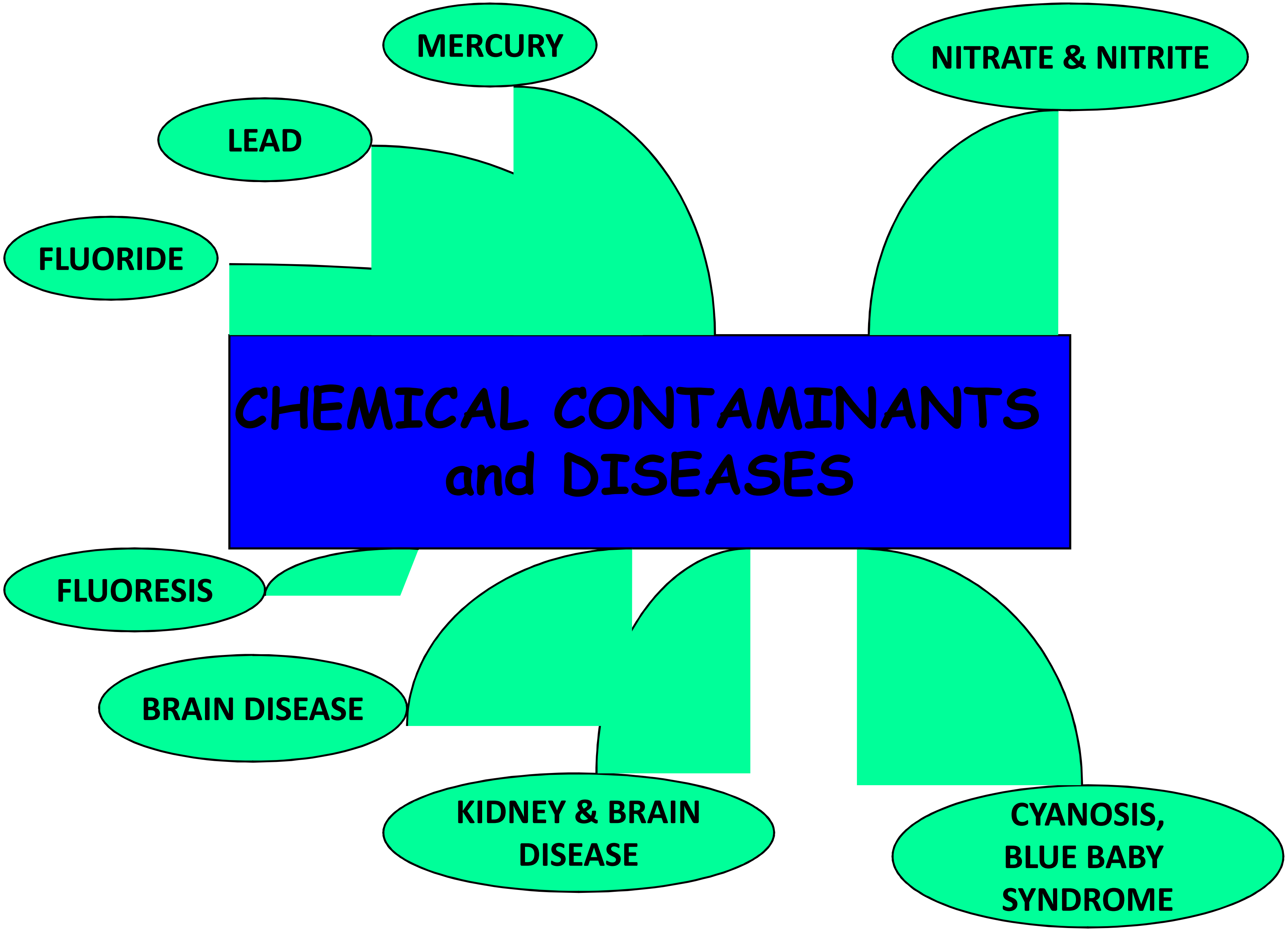
Water Myths and Realities

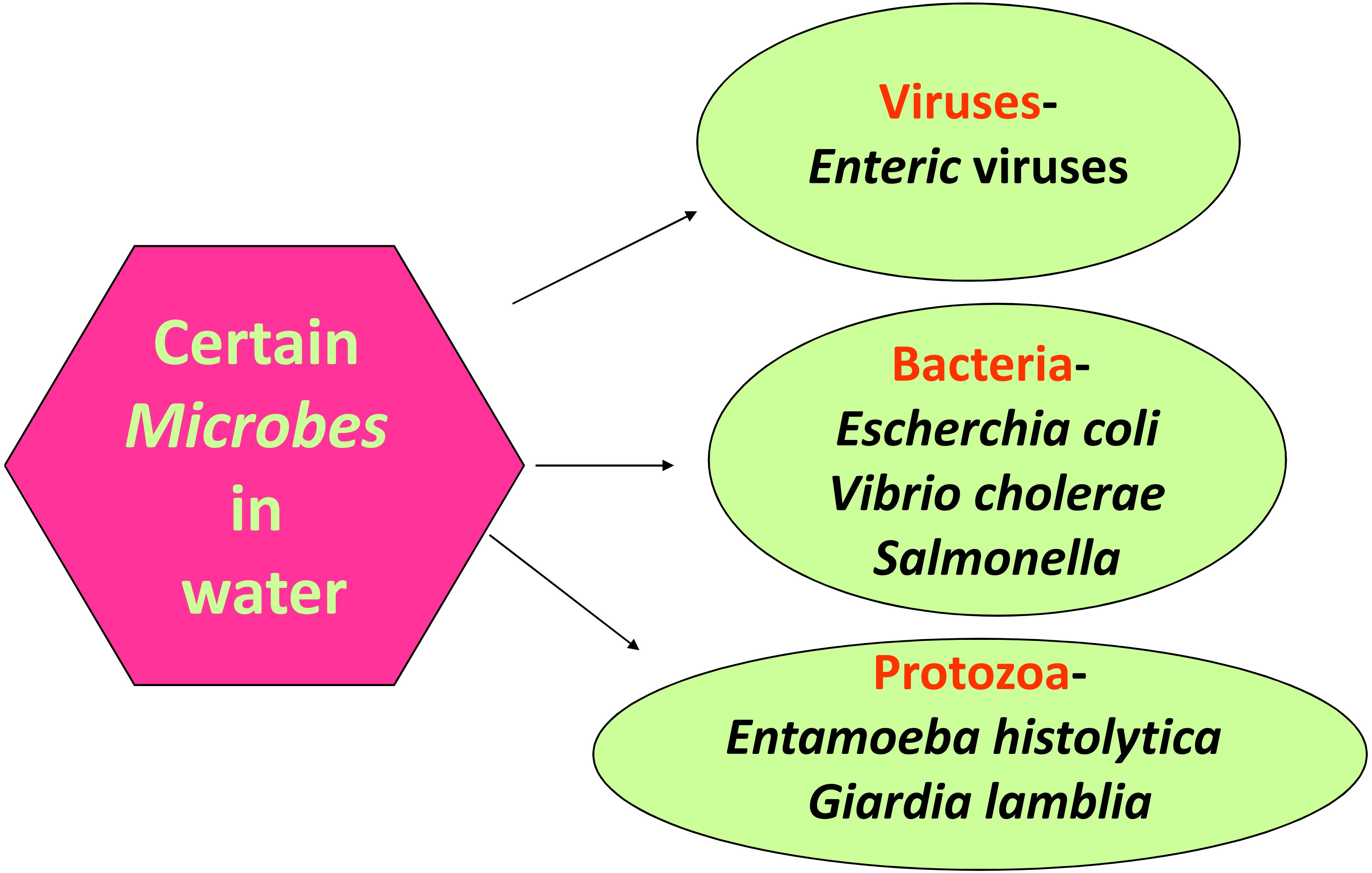
Myth	Reality
We have less water today than we did 100 years ago	Same amount of water is present on Earth, as was three billion years ago

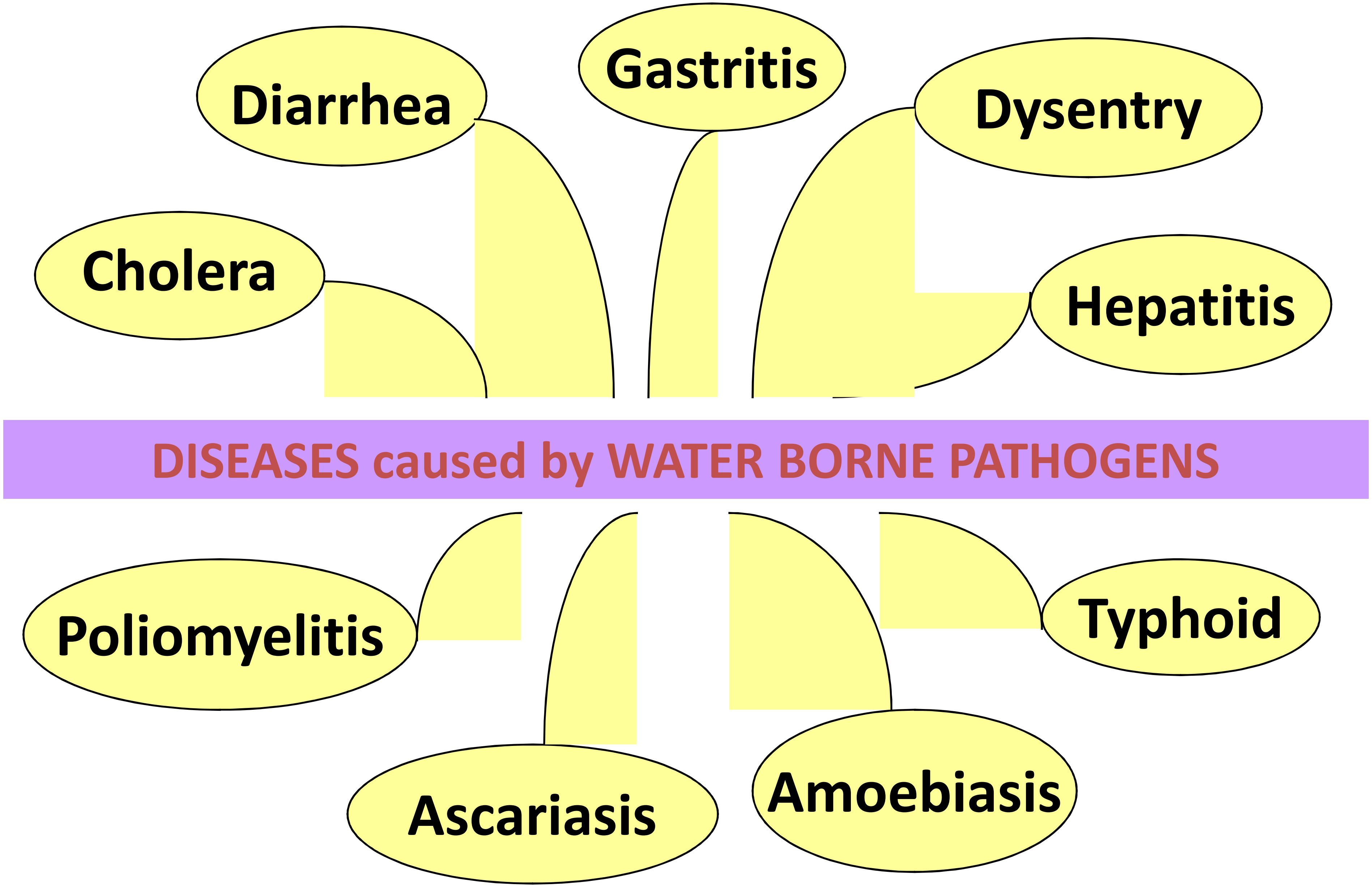
Water Myths and Realities

Myth	Reality
Water from River Ganga is pure	Untreated water has microbial contaminants. *Not fit for drinking*
Bottled water is safer than tap water	Unlike tap water, the quality of bottled water is not necessarily monitored by government agencies.


Chemical Contaminants in water
Organic chemical contaminants
Pesticides herbicides
Inorganic contaminants
Radioactive contaminants


MERCURY
NITRATE & NITRITE
LEAD
FLUORIDE
CHEMICAL CONTAMINANTS and DISEASES
FLUORESIS
BRAIN DISEASE
KIDNEY & BRAIN DISEASE
CYANOSIS, BLUE BABY SYNDROME


Certain *Microbes* in water
Viruses- *Enteric* viruses
Bacteria- *Escherchia coli* *Vibrio cholerae* *Salmonella*
Protozoa- *Entamoeba histolytica* *Giardia lamblia*

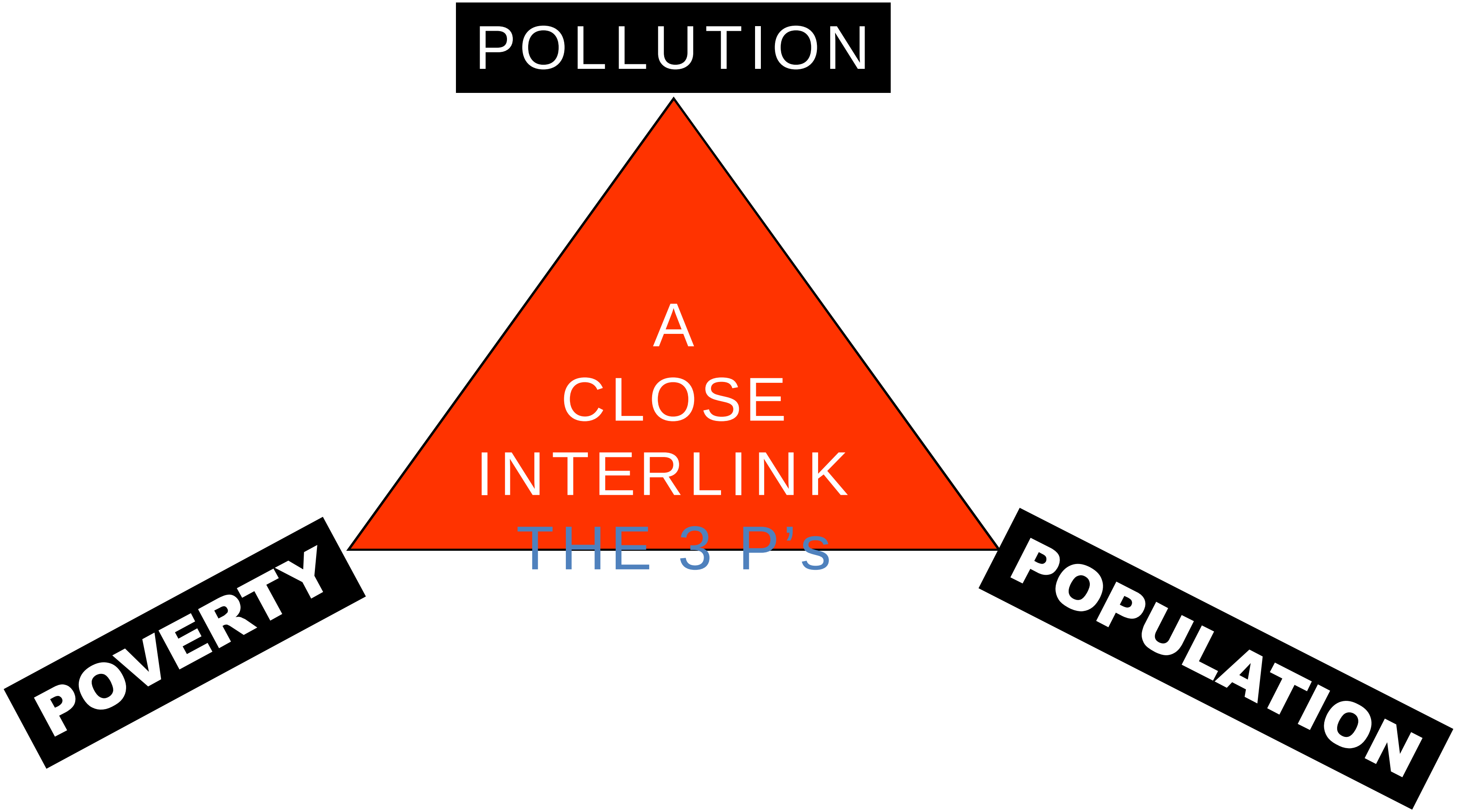

Gastritis
Diarrhea
Dysentry
Cholera
Hepatitis
DISEASES caused by WATER BORNE PATHOGENS
Poliomyelitis
Typhoid
Ascariasis
Amoebiasis

Water use in certain countries

Country	Annual water use per capita (Gallons)	Residential total water use (%)	Total water use in Industry/ Agriculture (%)
USA	525,000	10	90
India	132,000	3	97
China	122,000	6	94

Drinking Water Consumption

- Adults - Average 2 - 3 litres per day
- Children (10 Kg body wt.) - 1 litre
- Infants (5 Kg) - 0.75 litre

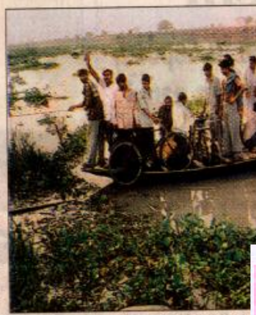

POLLUTION
A
CLOSE
INTERLINK
THE 3 P's
POVERTY
POPULATION

Coloured water: Mystery solved

TIMES OF INDIA JULY 1, 2003

Experts to investigate fish disaster

TIMES NEWS NETWORK



Water-hyacinth chokes the Gomati at Kudi

Lucknow: An expert committee was formed on Monday by housing and urban development minister Lalji Tandon, to get to the bottom of the ecological disaster that occurred in the Gomati, bringing the Jal Sansthan and Uttar Pradesh Pollution Control Board (UPPCB) in direct confrontation.

The five-member expert committee comprises one nominee from the district administration, two scientists from the Industrial Toxicology Research Centre (ITRC), one engineer from the Lucknow Municipal Corporation (LMC) and Rashid Khan, general manager of Jal Sansthan Rashid Khan. The committee is to submit its report within seven days.

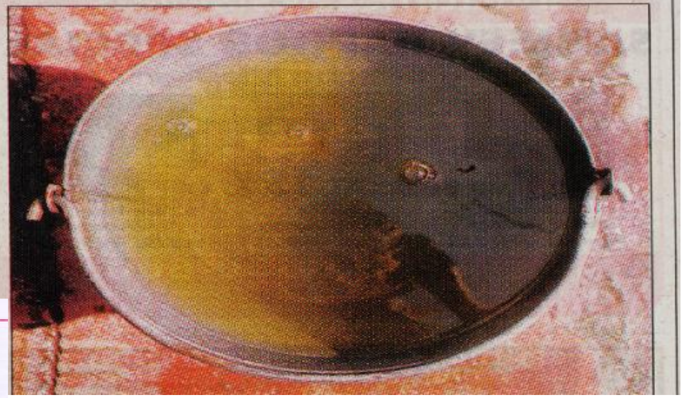
The committee will collect and

Dirty tap water causes health scare in city

TIMES NEWS NETWORK

Lucknow: Guess what do the UP chief minister Mayawati and urban development ministerLalji Tandon share apart from warm personal and political vibes? Stinking and yellow coloured water, supplied by the Jal Sansthan. Provided they ever bother to check, or are informed about it.

While the duo has not acknowledged the problem for obvious reasons, their



SC slams UP government over Gomati pollution

TIMES NEWS NETWORK

New Delhi: Perturbed over

grant-in-aid."

Ganga pollution: SC notice to 8 states

New Delhi: Taking serious note of continued pollution of Ganga river ... 15 municipalities. Panjwani had contended that CPCB was filing the ... and as a matter of fact are totally evasive to the responsibility for the

timescity.com
THE TIMES OF INDIA
Saturday,
May 18, 2002

Saturday, May 18, 2002 5

Epidemic catches officials napping

TIMES NEWS NETWORK

Allahabad: Two gastro- enteritis deaths in the district and the rising incidence of diarrhoea have not yet woken up authorities ...

secretaries and director-generals of the department, decided to set up special teams to monitor the sale of open food. However, despite the passage of a week, the urban

Polio epidemic is on the rise in state

TIMES NEWS NETWORK

New Delhi: The number of children crippled by the polio epidemic in Uttar Pradesh continues to increase steeply with the latest reports showing 347 cases of paralysis and a spillover into Delhi as well.

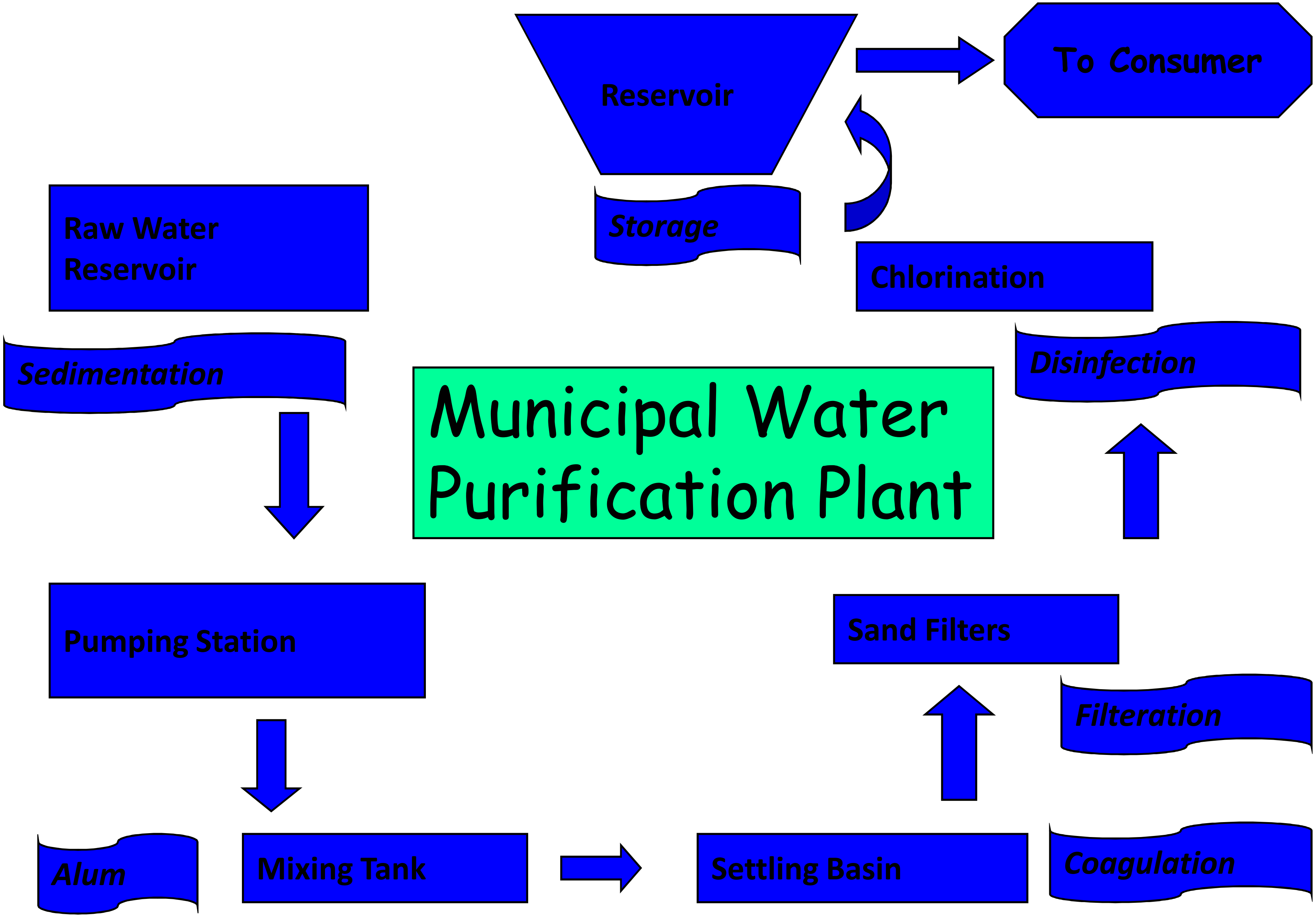
Officials say the numbers are bound to increase as blood samples

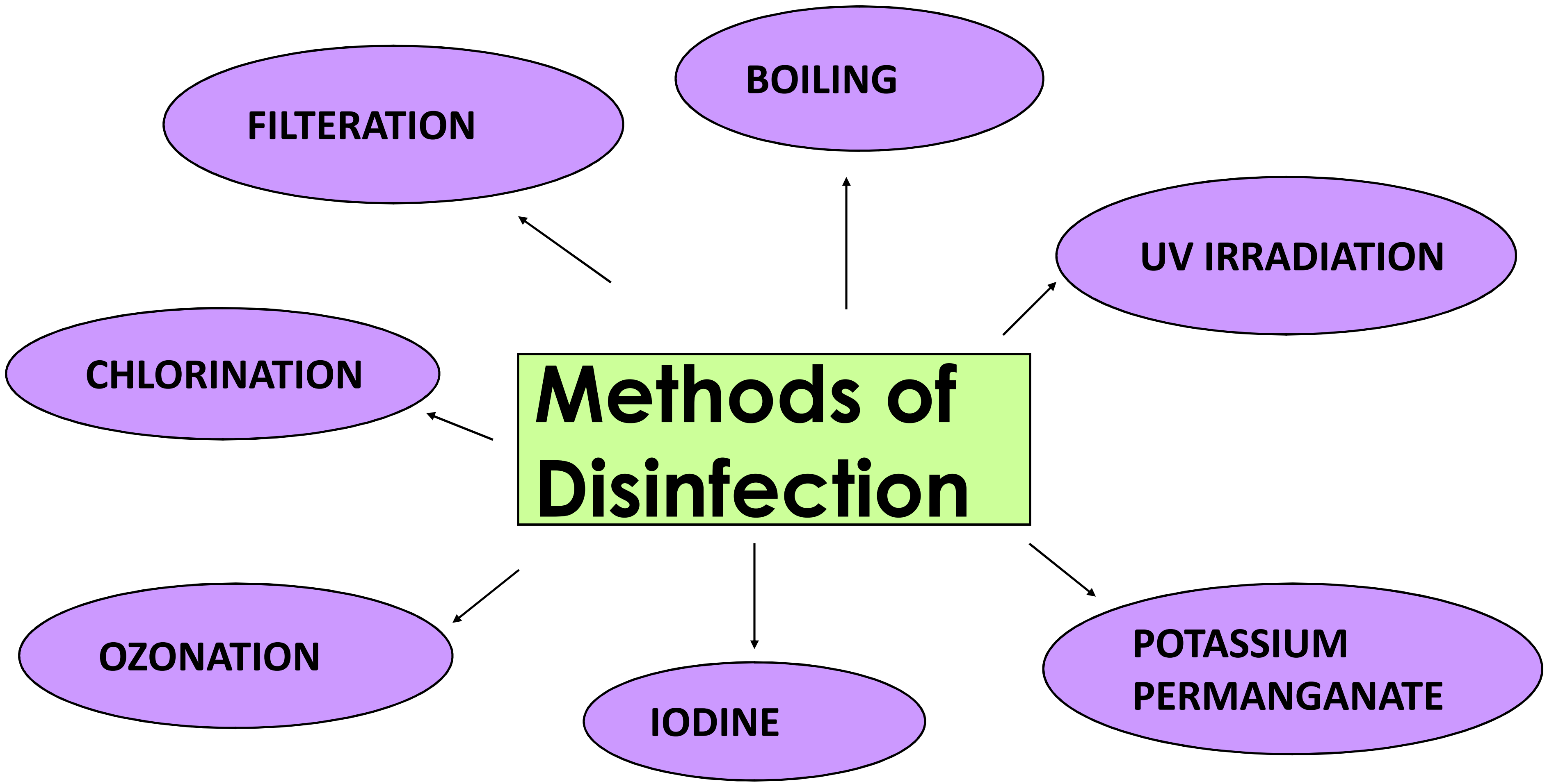
Alarm bells ringing

- The number of children crippled by the polio epidemic in Uttar Pradesh continues to increase steeply.
- A reports shows 347 cases of paralysis and a spillover into Delhi as well.

been covered," he says. In Azamgarh, officials say over 40 per cent houses with children were not included in immunisation drive at all.

Union minister for health and family welfare Shatrughan Sinha met the chief minister in Lucknow on Monday to express concern over this rapid increase in polio in the state. Senior officials from the


Municipal Water Purification Plant
Raw Water Reservoir
Sedimentation
Pumping Station
Alum
Mixing Tank
Settling Basin
Coagulation
Sand Filters
Filteration
Disinfection
Chlorination
Reservoir
Storage
To Consumer


FILTERATION
BOILING
UV IRRADIATION
CHLORINATION
Methods of Disinfection
OZONATION
IODINE
POTASSIUM PERMANGANATE

WATER DISINFECTION TECHNIQUIES

- CARBON BLACK
- HALOG ENATION
- OZONIZATI ON
- UV LIGHT
- REVERSE OSMOSIS
- ELECTROCHEMICAL
- DESALINATION
- EXTREME BOILING

POPULAR DEVICES

CANDLE FILTER
USHA BRITA
AMRIT KUMBH
BACT –O-KILL
AQUA PURA
AQUA PEN
ZERO B
AGUA GUARD

SPECIFICATIONS/GUIDELINES RELATED TO WATER

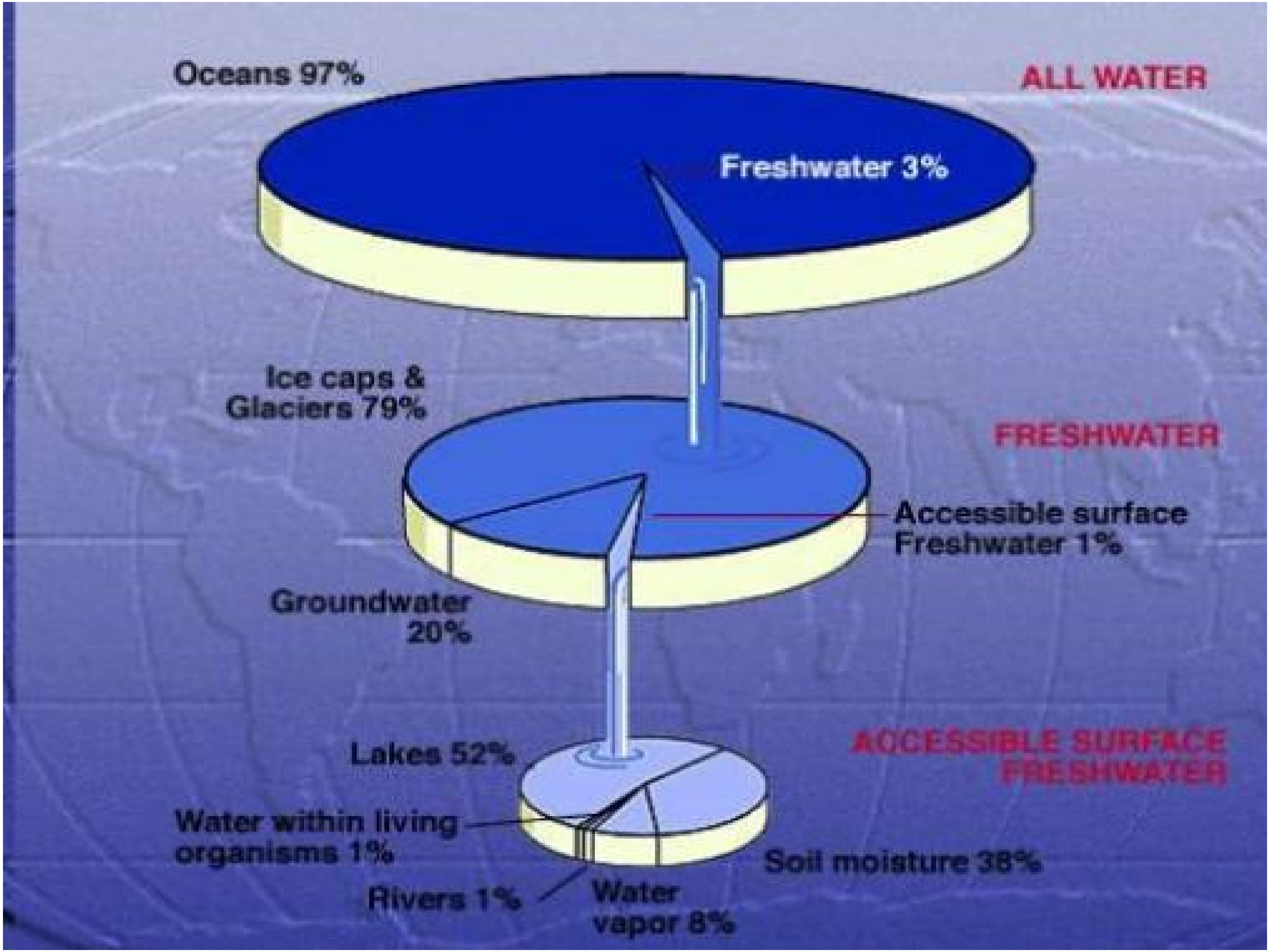
1	IS 10500:2012	Drinking Water Specification
2	IS 13428: 1998	Packaged Natural Mineral Water – Specification
3	IS 14543:1998	Package Drinking Water (Other than packaged natural mineral water) Specification
4	IS 3025: 1964	Method of Sampling and Test for Water and Wastewater
5	IS 12252: 1987	Polyalkyene terephthalates (PET &PBT) for their safe use in contact with food stuffs, pharmaceuticals, and drinking water
6	IS 10151: 1982	Polyvinyl chloride (PVC) and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water.
7	IS 10146: 1982	Polyethylene for its safe use in contact with foodstuffs, pharmaceuticals and drinking water.
8	IS 10148: 1982	Positive list of constituents of polyvinyl chloride and its copolymers in contact with foodstuffs, pharmaceuticals and drinking water.

ITRC

The next
WORLD WAR
will be over
WATER

? Why…

[Situation]

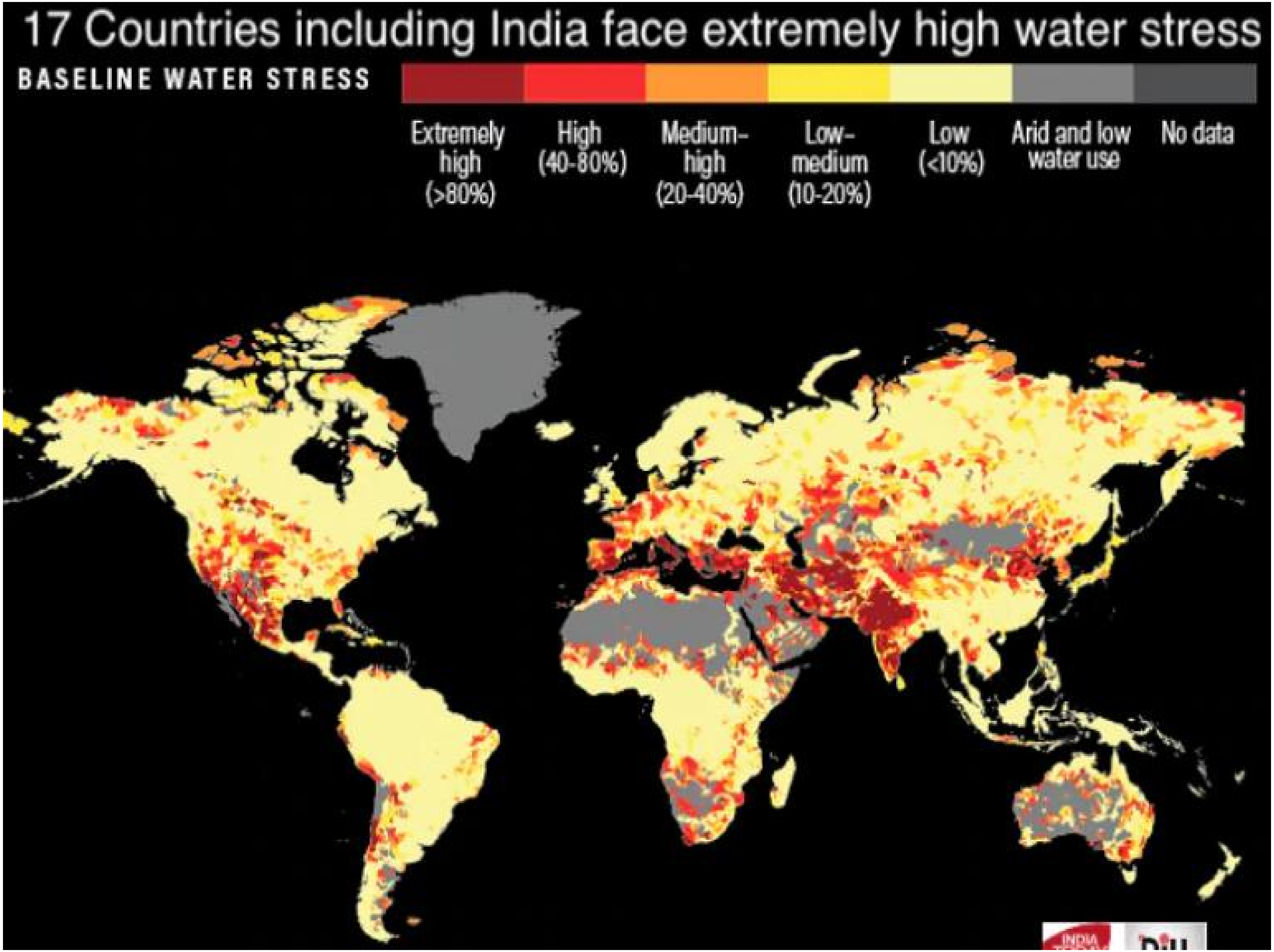


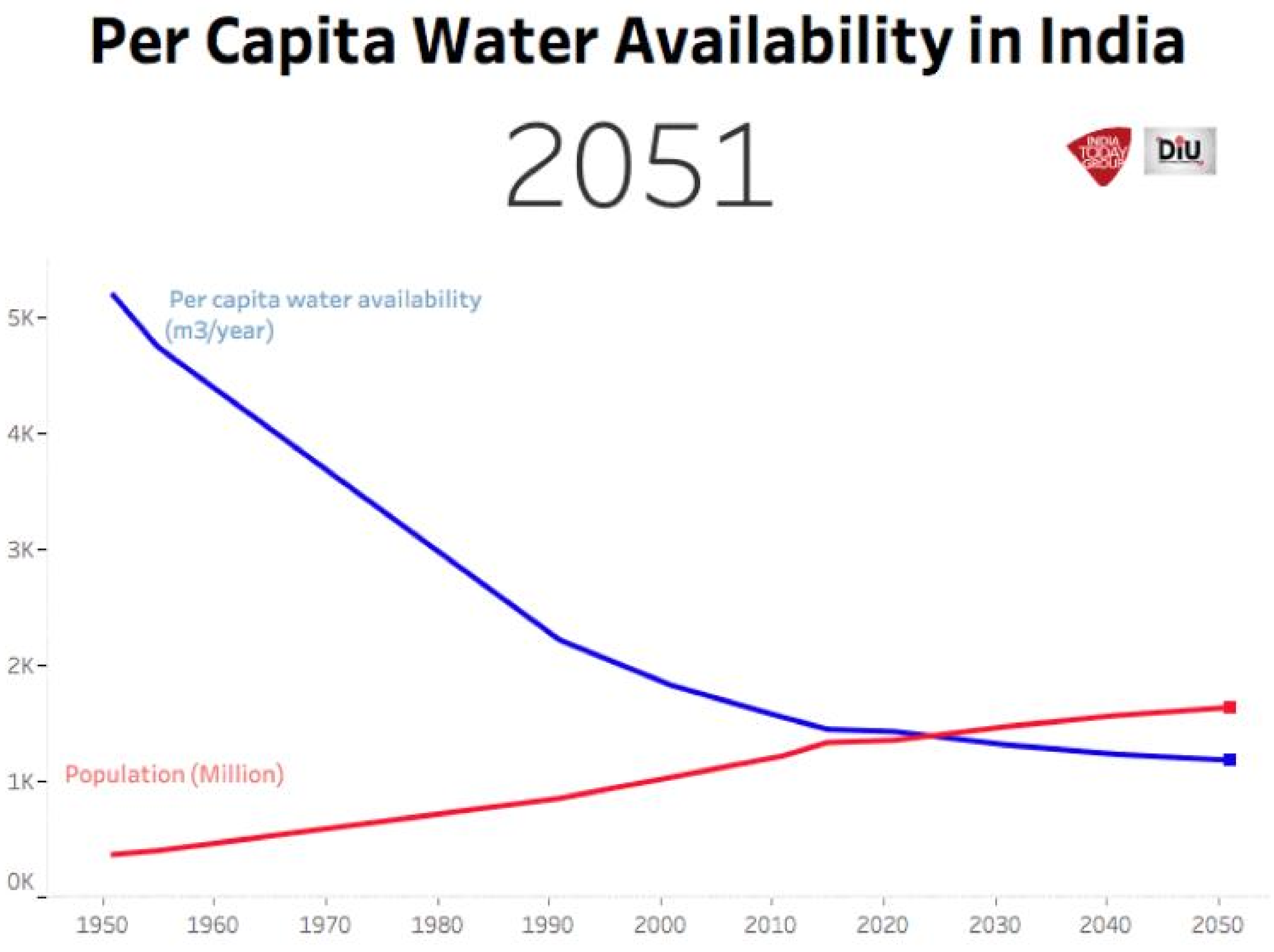
Oceans 97%
ALL WATER
Freshwater 3%
Ice caps &
Glaciers 79%
FRESHWATER
Accessible surface
Freshwater 1%
Groundwater
20%
Lakes 52%
ACCESSIBLE SURFACE
FRESHWATER
Water within living
organisms 1%
Soil moisture 38%
Rivers 1%
Water
vapor 8%

The Indian situation

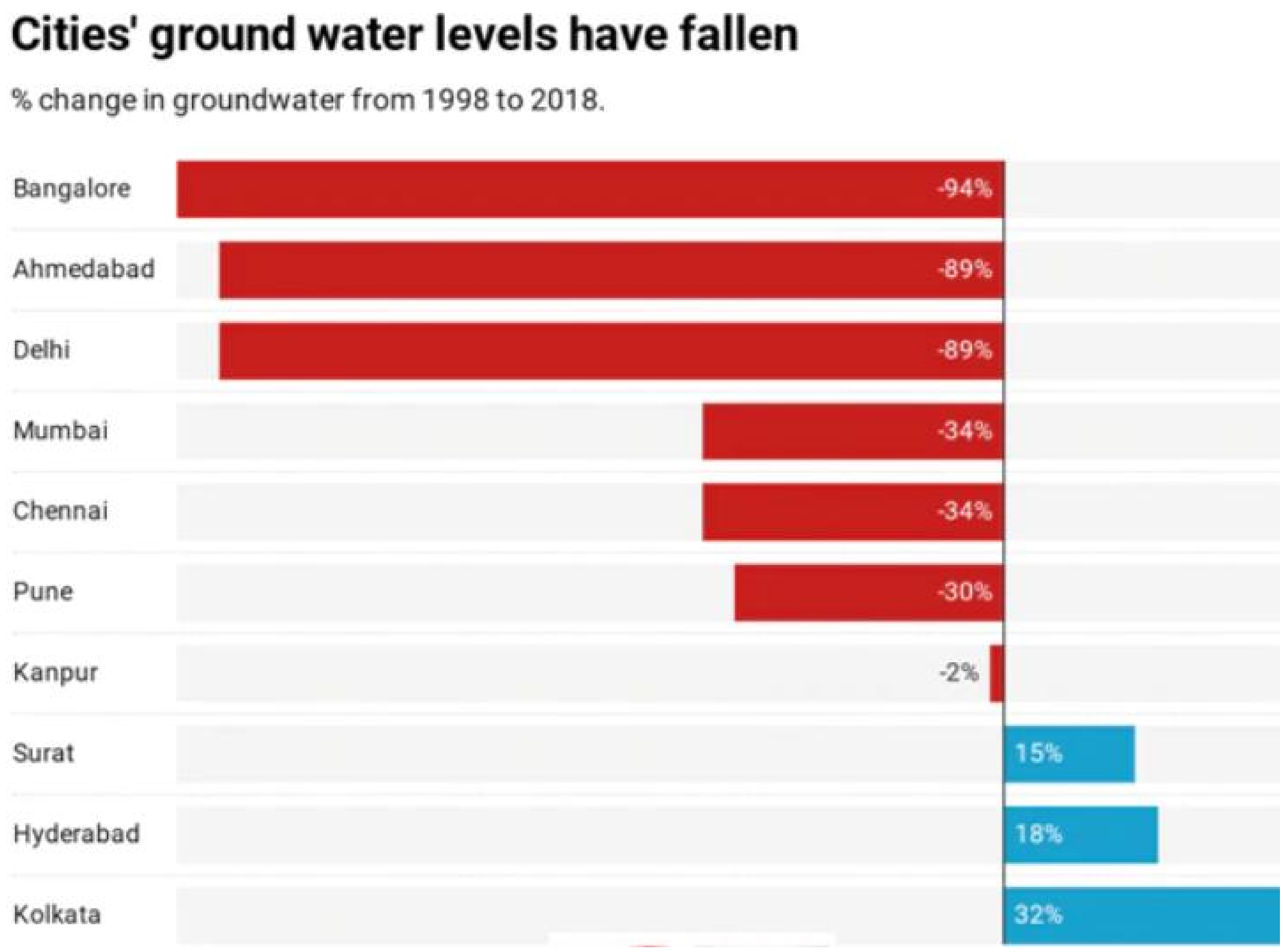
- Groundwater is the major source of water in our country with 85% of the population dependent.

- Groundwater water table decline - 33 centimeters per year.


17 Countries including India face extremely high water stress
BASELINE WATER STRESS
Extremely high (>80%)
High (40-80%)
Medium-high (20-40%)
Low-medium (10-20%)
Low (<10%)
Arid and low water use
No data

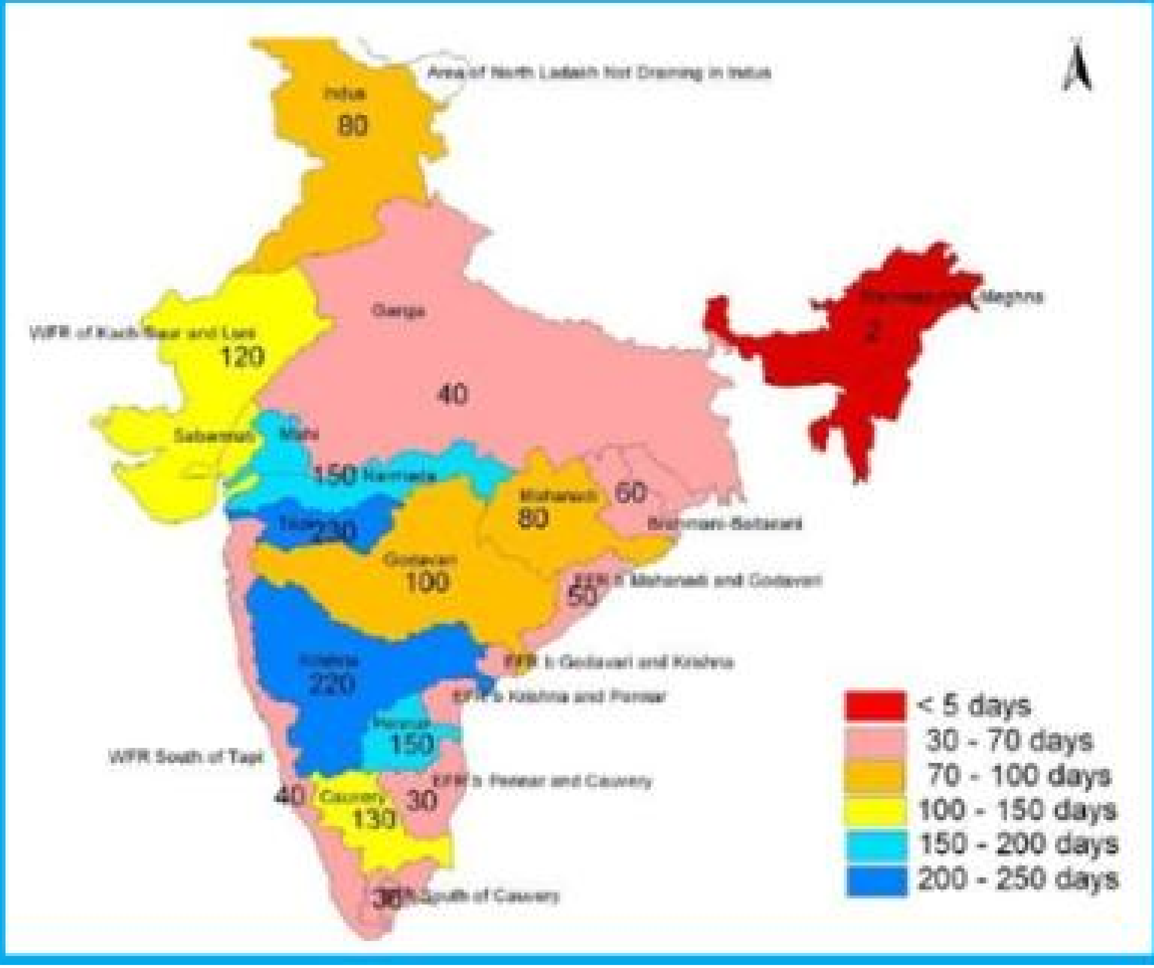


Per Capita Water Availability in India
2051
DiU
Per capita water availability (m3/year)
Population (Million)
5K
4K
3K
2K
1K
0K
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050


Cities' ground water levels have fallen
% change in groundwater from 1998 to 2018.
Bangalore
-94%
Ahmedabad
-89%
Delhi
-89%
Mumbai
-34%
Chennai
-34%
Pune
-30%
Kanpur
-2%
Surat
15%
Hyderabad
18%
Kolkata
32%

The Indian situation

India receives abundant rains compared to other water scared countries but…



This map shows how much water the Indian infrastructure fails to store!

The prime minister said on 15th, Auigust,2020 many states are reeling under the problem of acute water scarcity. PM Modi said his government is committed to provide drinking water to every household. This will be done under the Jal Jeevan Mission.

Challenges





Challenges

Industries
Over exploitation
Groundwater depletion
Pollution
Health Issues
Land Degraded
Groundwater & Surface water polluted
Agriculture Spoiled

Solution

Solutions to water problems require the consideration of cultural, educational, communication and scientific aspects.

Plant Trees
Avoid Pollution
Conserve water
Technologies and Innovations
Water Purification Systems
Seawater desalination
Water Footprint

Solution

- Rain Water Harvesting
- Irrigation Water Management
- Hydrological projects - Construction of Dams
- Artificial Recharge to Ground Water through Dug well

Solution

sAvE wAtEr SaVe WoRID

Be the first to clip this slide

The concept is simple

- Collect
- Store and use
- Recharge

Tap water | Bottled water | Distilled water | Carbonat... water

Sparkling water

- Tap **water**. ...
- Mineral **Water**. ...
- Spring **water**. ...
- Well **water**. ...
- Purified **water**. ...
- Distilled **water**: Distilled **water** or dimineralised **water** is one where the **water** has been subjected to a treatment that removes all its minerals and salt by the process of reverse osmosis and distillation. ...
- Sparkling **Water**.

Characteristics of Water:

- Water is a good solvent
- Water never occurs in its pure form
- All waters contain some dissolved substances
- The quality of water is determined by these substances.
- It has the ability to dissolve many inorganic and organic substances.

Water Quality Parameters:

Water has its own

- Physical properties
- Chemical composition and
- Biological Properties

Physical Properties:

- Temperature
- Colour
- Odor
- Turbidity
- Electrical Conductivity

Chemical properties:

- pH
- Total Dissolved Solids(TDS)
- Major ions
- Minor or trace elements
- Hardness
- Salinity
- Alkalinity

Harmful Chemicals

- Chlorides
- Sulphates
- Iron
- Nitrates
- Heavy Metals
- Pesticides

- **Poly Chlorinated Biphenyl (PCBs)**
- **Polycyclic Aromatic Hydrocarbon (PAHs)**
- **Tri Halo Methane**
- **Radioactive matterials**

Biological Properties:

- Dissolved Oxygen (DO)
- Biochemical Oxygen Demand(BOD)
- Chemical oxygen Demand(COD)
- Microorganisms-Bacterial counts

Water Quality Parameters:

- Limits the suitability of water for different purposes
- Drinking
- Domestic consumption
- Agriculture
- Industrial Processes
- Cleaning and Recreation.

Water Quality Standards

- Permissible limits
- United States Public Health Drinking Water Standards(USPH)
- Indian Standards Institution (ISI)
- World Health Organization (WHO)

WATER AND HEALTH

- Quality
- Quantity

IS: 10500 - Indian Standard for Drinking Water

S.No.	Parameter	Requirement Desirable Limit
1.	pH	6.5-8.5
2.	Total Dissolved Solids (TDS) in mg/l	500
3.	Total Hardness (mg/l)	300
4.	Chloride (mg/l)	250
5.	Fluoride (mg/l)	1.0
6.	Nitrate (mg/l)	450
7.	Sulphate (mg/l)	200
8.	Cyanide (mg/l)	0.05
9.	Total Alkalinity (mg/l)	200
10.	Arsenic (mg/l)	0.01
11.	Mercury (mg/l)	0.001
12.	Cadmium (mg/l)	0.01
13.	Lead (mg/l)	0.05
14.	Iron (mg/l)	0.3
15.	Manganese (mg/l)	0.1
16.	Chromium as Cr^{6+} (mg/l)	0.05
17.	Copper (mg/l)	0.05
18.	Zinc (mg/l)	5.0
19.	Pesticide	absent
20.	Total Coliform Bacteria	95% of samples should not contain coliform in 100 ml 10 coliform / 100ml
21.	E. coliform Bacteria	Nil / 100ml

(ix)	Nickel(as Ni)mg/l,Max	0.02	Beyond this,it may cause allergic reaction	No relaxation	3025 (part54)	-
(x)	Poly chlorinated biphenyls mg/l, Max	0.0005	May be carcinogenic	No relaxation	ASTM 5175/APHA 6630	
(xi)	Trihalomethanes					
(a)	Bromoform mg/l Max	0.1	May be carcinogenic above this limit	No relaxation	ASTM D-3973-85/ APHA	-
(b)	Dibromochloro methane mg/l, Max	0.1	-do-	-do-	-do-	
(c)	Bromodichloro methane mg/l, Max	0.06	- do-	-do-	-do-	-

Table. 5 Pesticides Residues limits and Test method

SI.No	Pesticide	Limit «g/l	Test method USEPA AOAC/ISO
(i)	DDT(o,p and p,p-Isomers of DDT,DDE and DDD	1	508 AOAC 990.06
(ii)	Gamma-HCH (Lindane)	2	508 AOAC 990.06
(iii)	2,4D	3	515.1
(iv)	Isoproturon	9	532
(v)	Alachor	20	525.2,507
(vi)	Atrazine	2	525.2,8141A
(vii)	Aldrin/Dieldrin	0.03	508

Table.4 Parameters concerning radioactive substances (Clause 4)

SI. No	Substance or Characterstic	Requirement (Desirable limit)	Undesirable Effect outside the desirable	Permissible limit in the absence of alternate source	Methods of Test (Ref to IS)	Remarks
(i)	Radioactive Materials:					-
	(a) Alpha emitters Bq/l,Max	0.1	May be carcinogenic above this limit	0.1	IS 14194 (Pt 2)	-
	(b) Beta emitters Bq/l Max	1.0	-	1	IS 14194 (Pt 1)	-

$$\text{Human Health Risk} = \frac{\text{Total Daily Intake (TDI)}}{\text{Acceptable Daily Intake (ADI)}}$$

If value is > 1 than health risk

Address <u>uncertainty</u>

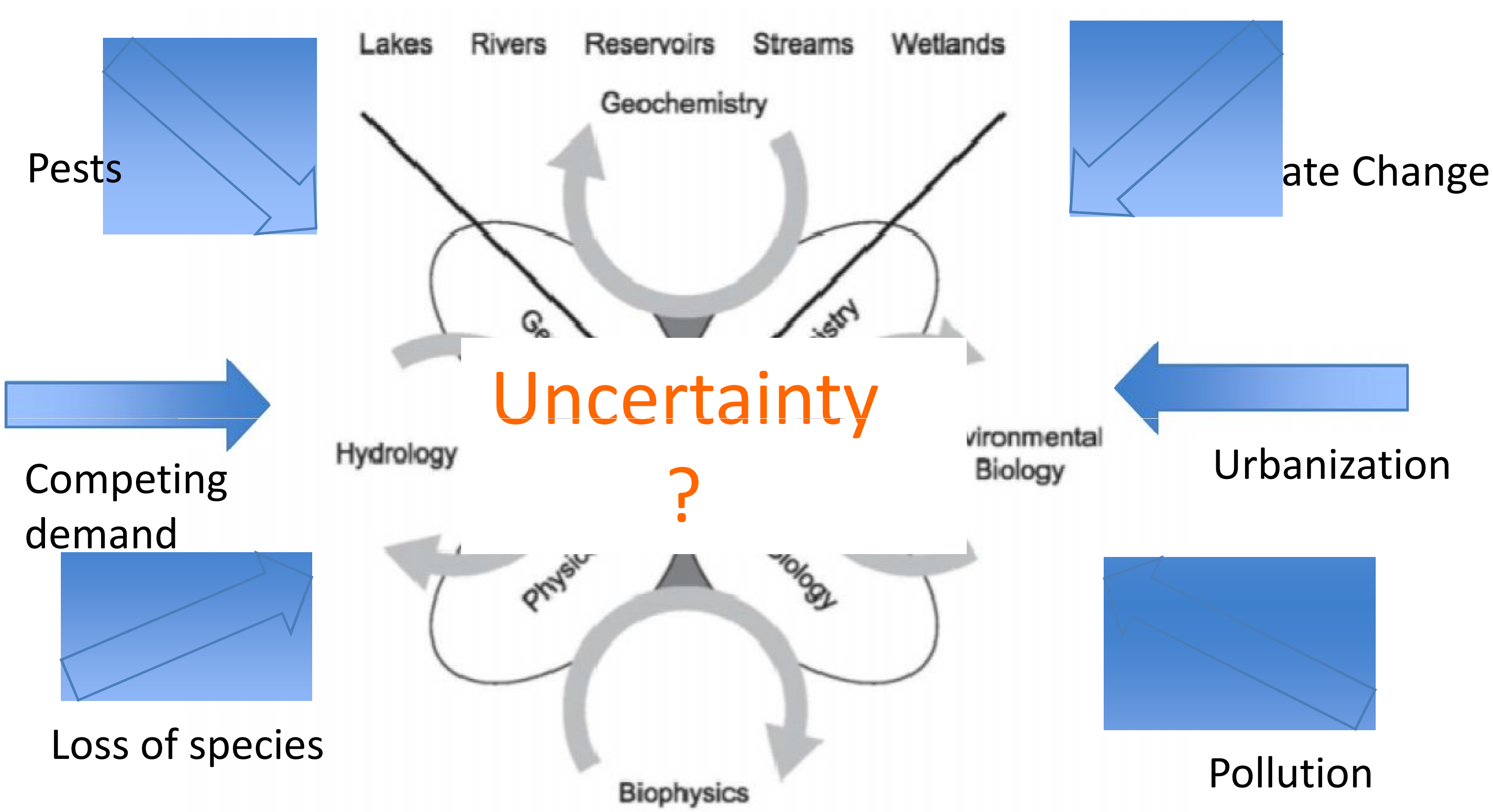
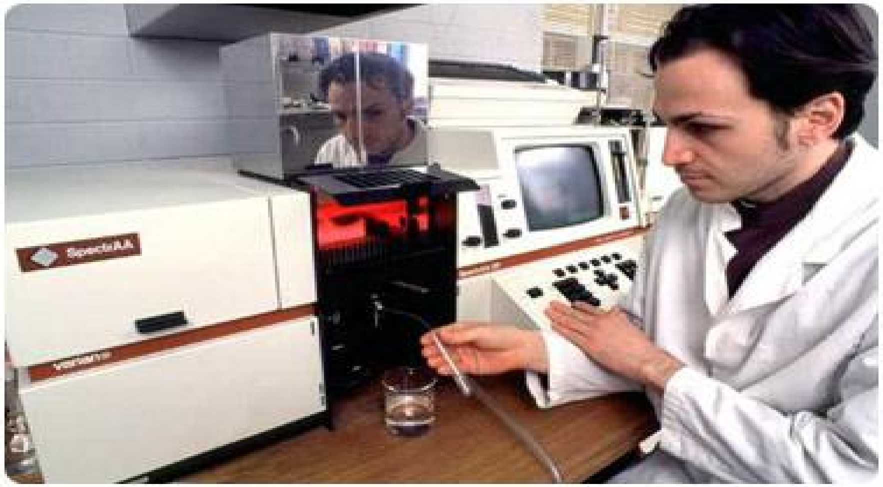


Figure 1. Limnology is the study of inland waters. Like oceanography, it is an integrative science that draws from many disciplines.

Sampling

Preservation

Processing



Analysis

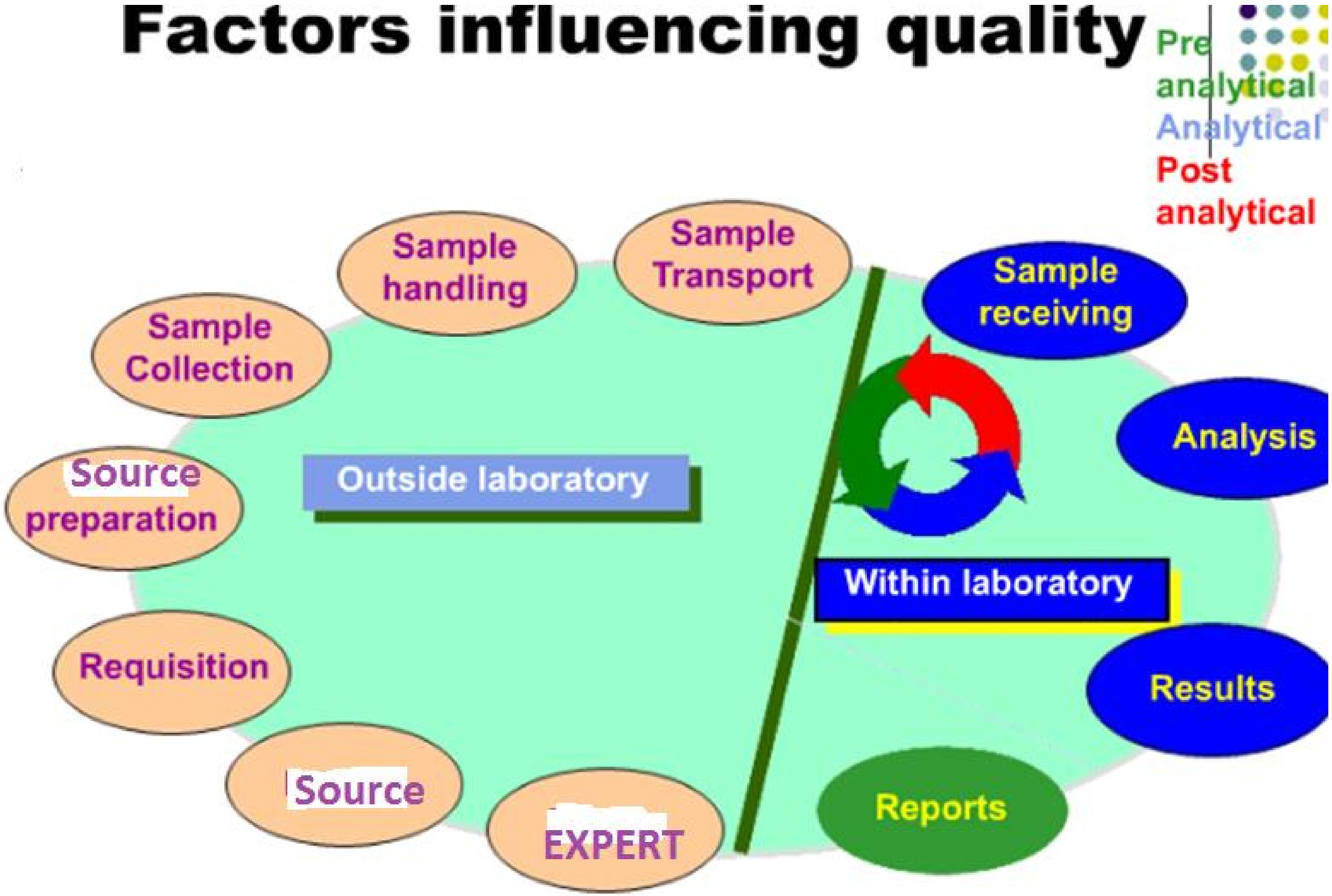
Collection of water sample

Analysis

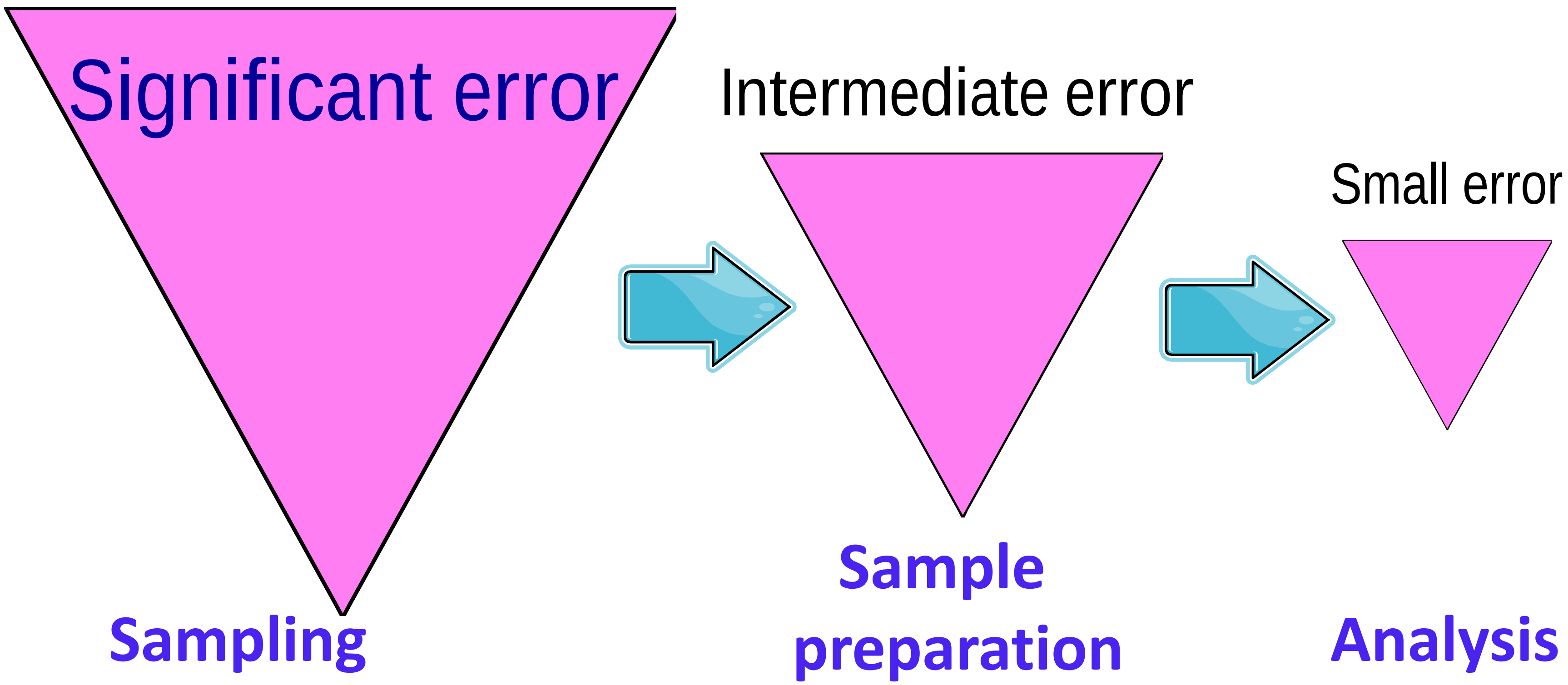
Instrument Application

Documentation

Factors influencing quality



Relative Contributions to Analytical Error



Overall (expanded) error = $\sum$ (individual errors)

Sampling is Important!

✓ Clear definition of sampling objectives

✓ Sample quality

✓ Sample integrity

✓ Sample representativeness

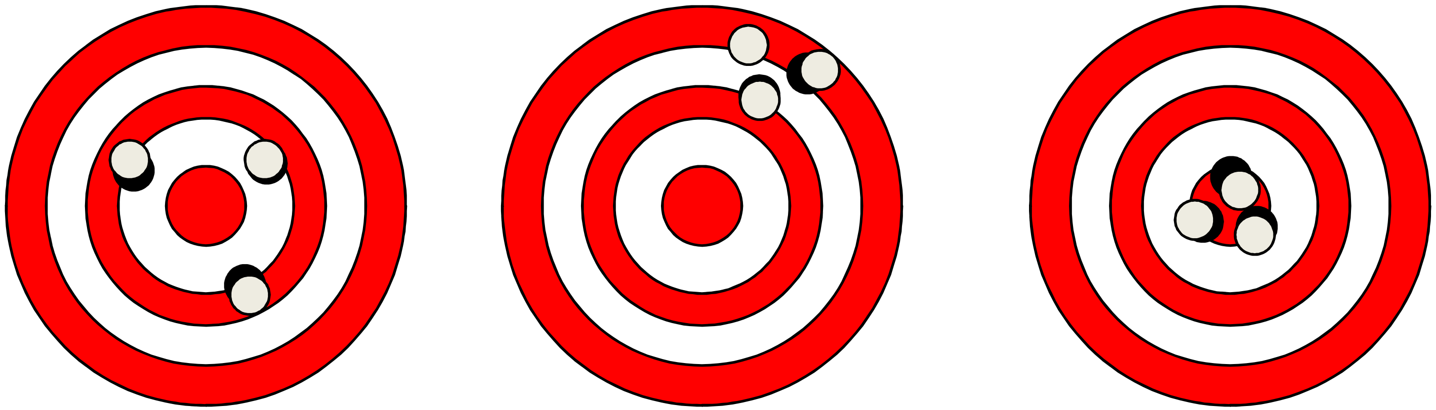
Sampling

Chemical Analysis

Data Interpretation

Sampling Personnel works under supervision of Qualified and trained personnel.

Accuracy versus Precision



Precision & Accuracy

- Is measured as "repeatability " or reproducibility

  Repeatability

  Measurement is repeated with a minimum of variations (same person, same laboratory, same equipment, over a short period of time.

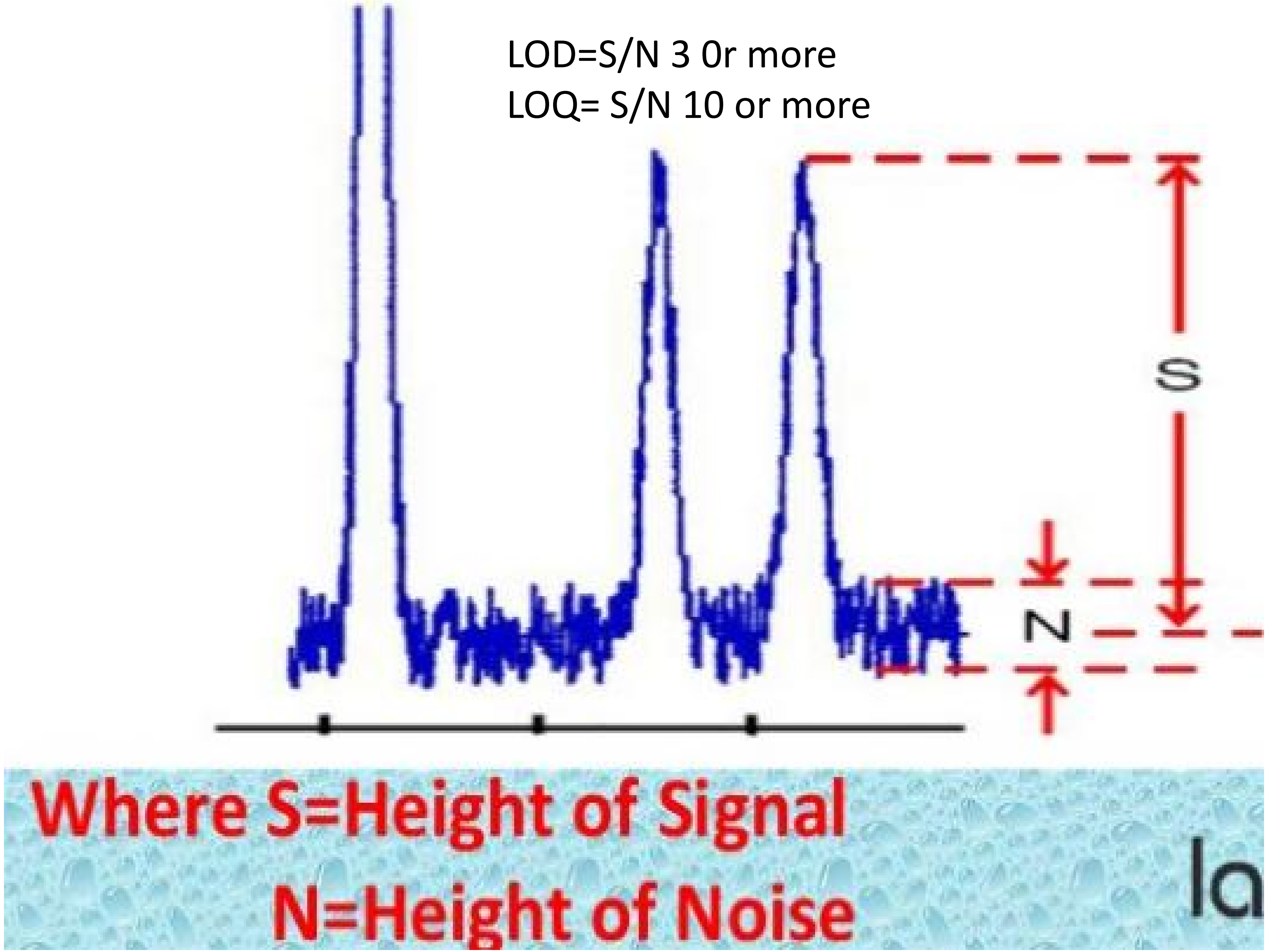
  Reproducibility

  Measurement is repeated with as much variation as possible. (Different analyst, different laboratory, different equipment, over a long period of time).

Limit of Detection (LOD)

- Point where the variability of the measurement is such that it is impossible to distinguish between random fluctuation in the value measured and actual signal.
  - $LOD = Y_B + 3XS_B$
    - $Y_{B\,=}$ Mean value measured from the blank
    - $S_{B\,=}$ Standard Deviation of the value measured from the blank

LOD=S/N 3 0r more
LOQ= S/N 10 or more



Limit of Detection

Replicate (n)	Instrument response	Calculated Concentration (ppb)
1	29550	0.100
2	28653	0.097
3	29401	0.099
4	28532	0.097
5	29712	0.101
6	29983	0.101
7	28167	0.095
Mean		0.099
StdDev		0.002
3 Times StdDev		0.007
Detection Limit		0.106

Limit of Quantification (LOQ)

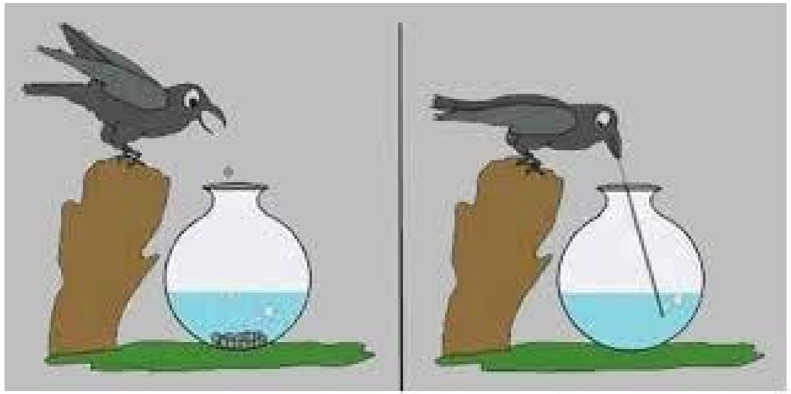
- Point where the measured value could be quantified reliably

$LOQ = Y_B + 10XS_B$

- Y_{B} = Mean value measured from the blank
- S_{B} = Standard Deviation of the value measured from the blank

Limit of Quantification (LOQ)

Replicate (n)	Instrument response	Calculated Concentration (ppb)
1	29550	0.100
2	28653	0.097
3	29401	0.099
4	28532	0.097
5	29712	0.101
6	29983	0.101
7	28167	0.095
Mean		0.099
StdDev		0.002
10 Times StdDev		0.020
LOQ		0.119



Requirements

- **Calibrated instruments**
- **Certified glasswares**
- **Analytical grade reagents**
- **Skilled manpower**

Instrumentation

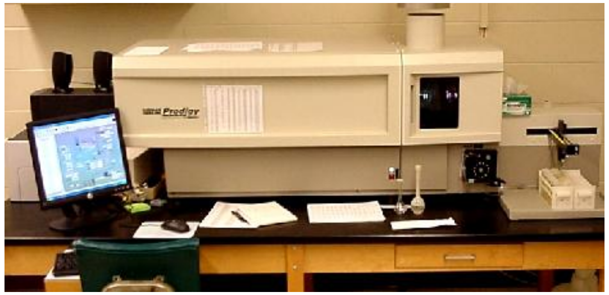
- **Spectrophotometer/Colorimeter**
- **Chromatographs (Gas/Liquid)**
- **Analytical Balance**
- **Hot Air Oven**
- **Refrigerator**

Spectrophotometer/Colorimeter

- **UV Visible Spectrophotometer**

- **Atomic Absorption Spectrophotometer (AAS)**

- **Inductively Coupled Plasma (ICP) Spectrophotometer**



Physico-chemical Parameters of Drinking Water

Physico-chemical Tests

- pH
- Temperature
- Conductivity
- Dissolved Oxygen
- Turbidity
- Colour
- Odour
- Hardness
- Dissolved Solids
- Nitrate
- Fluoride
- Chloride
- Bromide
- Iodide
- Sulphate

Metals

- As, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Zn , Se

Organic Contaminants

- Chlorinated Compounds
- Trihalomethanes
- Pesticides
- Polycyclic Aromatic Hydrocarbons
- Benzene and lower alkyl benzene
- PCBs
- Phthalates
- BOD
- COD
- TOC

Parameters and Test Methods

No	Parameter	Unit	Methods
1	pH	-	Electrometeric method
2	Turbidity	NTU	Turbidity Meter
3	True Color	Pt-Co Unit	Visual Comparison method
4	Electrical Conductivity	µS/cm	Electrical Conductivity method
5	Iron	mg / L	FerroVer method
6	Manganese	mg / L	PAN method
7	Sulfate	mg / L	SufalVar Turbidimetric method
8	Fluoride	mg / L	SPADNS method
9	Alkalinity	mg / L	Titration method
10	Total Hardness	mg / L	EDTA Titrimetric method
11	Chloride	mg / L	Argentometric method

Techniques used in water Quality Checks in Chemical

- ➢Direct Instrument use for Physical parameters: pH,Conductivity,temperature.turbidity
- ➢By use of specific equipment after processing :heavy metals,pesticide,PAHs,PCBs,THM
- ➢By Conventional method Like Gravimetric and volumetric analysis.
- TDS

Gravimetric Analysis Sulphate

TH,Ca,Mg

Volumetric Analysis Chloride

Alkalinity

How to Perform a Successful Gravimetric Analysis

- **What steps are needed?**

1. Sampled dried, triplicate portions weighed
2. Preparation of the solution
3. Precipitation
4. Digestion
5. Filtration
6. Washing
7. Drying or igniting
8. Weighing
9. Calculation

Gravimetric Analysis

- Gravimetric Analysis – one of the most accurate and precise methods of macro-quantitative analysis.
- Analyte selectively converted to an insoluble form.
- Measurement of mass of material
- Correlate with chemical composition
- Why?
- Simple
- Often required for high precision

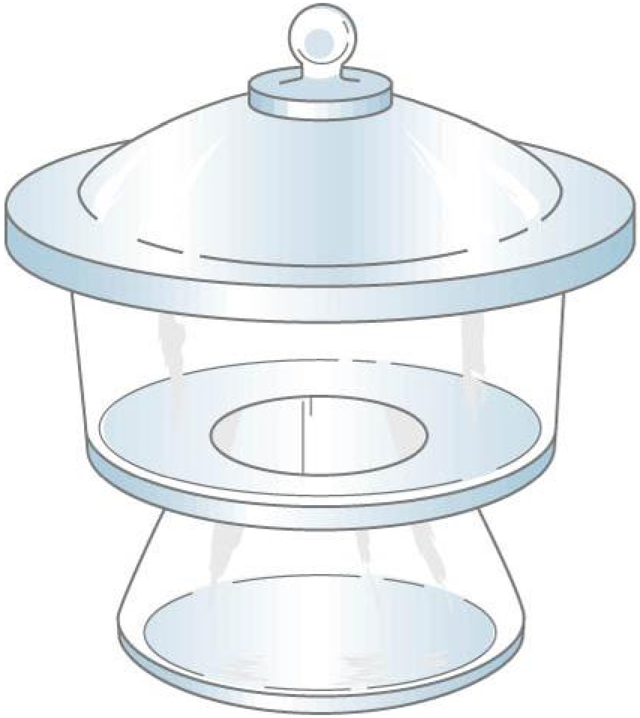
Gravimetric Analysis

- How?
- Quantitative collection of material of known composition
  - Precipitation of analyte with selective agent
  - Volitization and collection of analyte
  - w/o loss of material in handling/processing
  - Free from solvent, impurities
- Determination of mass
  - Direct or
  - By difference

Use a desiccator to cool a dried or ignited sample.

Cool a red hot vessel before placing in the desiccator.

Do not stopper a hot weighing bottlle (creates a partial vacuum on cooling).



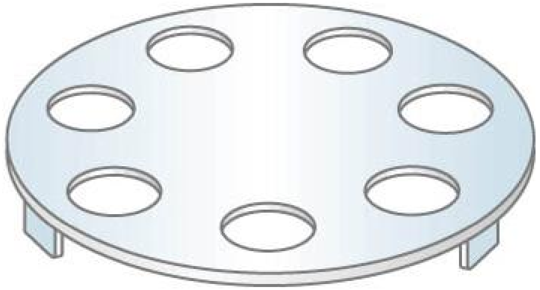


Fig. 2.16. Desiccator and desiccator plate.

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$CaCl_2$ is commonly used.

It needs periodic replacement when wet or caked.

Table 2.5

Some Common Drying Agents

Agent	Capacity	Deliquescent[a]	Trade Name
$CaCl_2$ (anhydrous)	High	Yes	
$CaSO_4$	Moderate	No	Drierite (W. A. Hammond Drierite Co.)
CaO	Moderate	No	
$MgClO_4$ (anhydrous)	High	Yes	Anhydrone (J. T. Baker Chemical Co.); Dehydrite (Arthur H. Thomas Co.)
Silica gel	Low	No	
Al_2O_3	Low	No	
P_2O_5	Low	Yes	

[a] Becomes liquid by absorbing moisture.

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This provides a good seal and prevents air bubbles from being drawn in.

Suction from the weight of the water in the stem increases the filtration rate.

Let the precipitate settle in the beaker before beginning filtration.

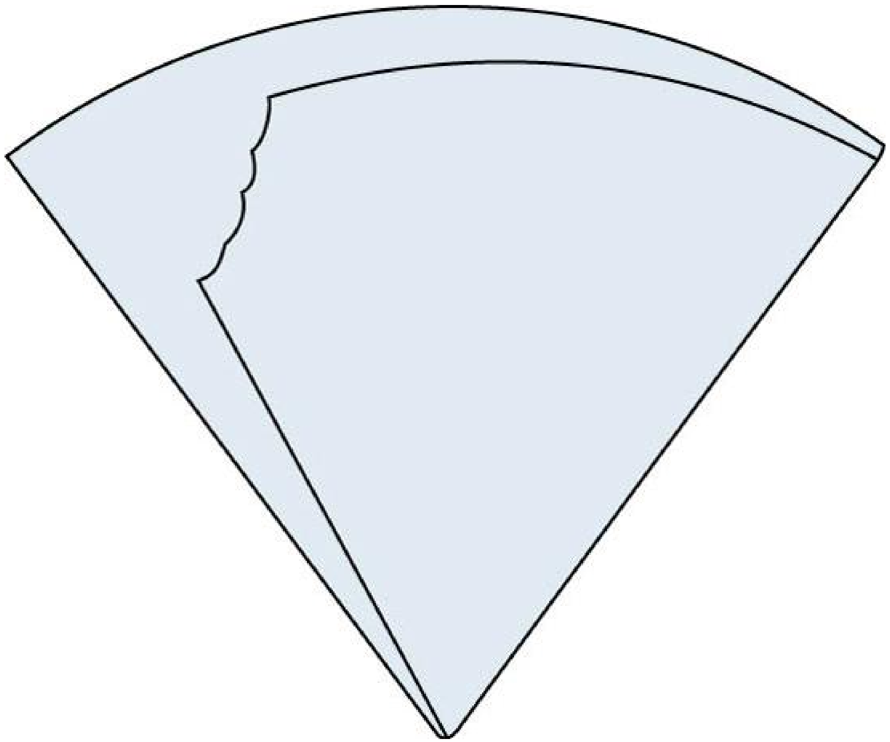

Fig. 2.23. Properly folded filter paper.

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These are ashless filter papers.

They are ignited away after collection of the precipitate.

Use for gelatinous precipitates.

Table 2.6

Types of Filter Papers

Precipitate	Whatman	Schliecher and Schuell
Very fine (e.g., $BaSO_4$)	No. 42 (2.5 μm)	No. 589/2 or 5, Blue or Red Band (2–4 μm)
Small or medium (e.g., AgCl)	No. 40 (8 μm)	No. 589/2, White Band (4–12 μm)
Gelatinous or large crystals (e.g., $Fe_2O_3 \cdot xH_2O$)	No. 41 (20–25 μm)	No. 589/1, Black Band (>12–25 μm)

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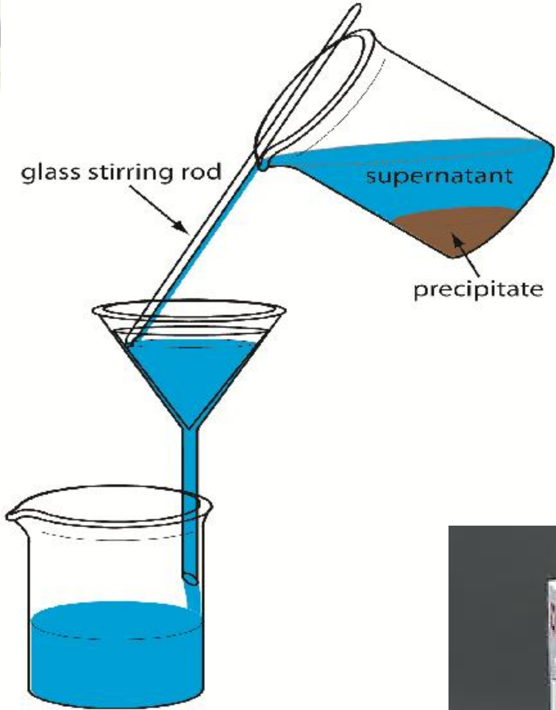
hmquartz.en.alibaba.com


glass stirring rod
supernatant
precipitate


HH-S WATER BATH


VOLUMETRIC ANALYSIS

Following methods or techniques are being used to measure any chemical parameter

- Volumetric
- Gravimetric
- Potentiometric
- Coulometric
- Voltametric
- Spectrometry
- Mass spectrometry
- Chromatography
- Chromatography mass spectrometry

Percentages of different methods of analysis used in the certification of Standards samples of geological objects in1951-2005. %

Methods of analysis	**1951**	**1971-1973**	**2004-2005**
Gravimetric	28.5	16.4	4.20
Titrimetric	12.8	16.9	3.5
Electrochemical	1.0	1.3	0.4
Colorimetric/photometric	24.1	12.8	7.1
Atomic emission	15.0	21.9	14.2
Flame photometer	6.4	9.5	3.5
Atomic absorption	-	6.7	10.4
X-ray fluorescence	0.7	7.2	22.1
Mass spectrometer	3.7	-	24.1

Storage Condition:

Room Temperature= 25±2ºC needs BOD incubator

Fridge or deep fridge:

Standard

- Stock solutions from primary standard
- Intermediate solutions from stock solution of primary standard
- Working standard proposed from intermediate solutions

Traceability to be maintained by having

- CRMs or high purity Reference material
- Calibrated analytical balance
- Calibrated weight box
- Calibrated thermometer
- Calibrated Glass wares

Consumption records of CRMs/RM

By documentation

Introduction:- A technique for determining the concentration of a solution by measuring the volume of one solution needed to completely react with another solution. Titration process involves addition of solution of known conc. from burette to the measured volume of analyte.

Principle of titration:- *It is based on the complete chemical reaction between the analyte and the reagent (titrant) of known concentration.*

Analyte + Titrant → Product

Terms used in titration

Analyte:- The solution of unknown concentration but known volume.

Titrant:- The solution of known concentration.

__Standard solution__:- A solution of known concentration is called the standard solution.

__Types of standard solution__:-

1) __Primary standard__:- It has certain properties:-

(a) Extremely pure.

(b) Highly stable.

(c) Can be weighed easily.

For e.g. Na_2CO_3, KHP

Secondary standard:- It has certain properties:-

(a) Less pure than primary standard.

(b) Less stable than primary standard.

(c) Can not be weighed easily.

For e.g. NaOH, HCl

Euivalence Point:- Point where the amount of two reactants are just equivalent .

End point:- Point at which the reaction is observed to be complete, this point is usually observe with the help of indicator.

Indicator:- An auxiliary substance which helps in the usual detection of the completion of the titration process at the end point.

For examples:- Methyl orange, Phenolphthalein, Cresol red, Thymol blue.

Concentration Terms:-

The concentration of standard solutions (titrants) are generally expressed in units of either molarity (C_M, or M) or normality (C_N, or N).

Molarity (M):-It is the number of moles of a solute per liter of solution.

Normality:- It is the gram equivalent weight of solute dissolved per litre of solution.

Molality:- It is the number of moles of solute present in per kilogram of solvent.

Titrimetric calculation :-

It is based on the following law of equivalence:-

$$NaVa = NsVs$$

or

$$MaVa = MsVs$$

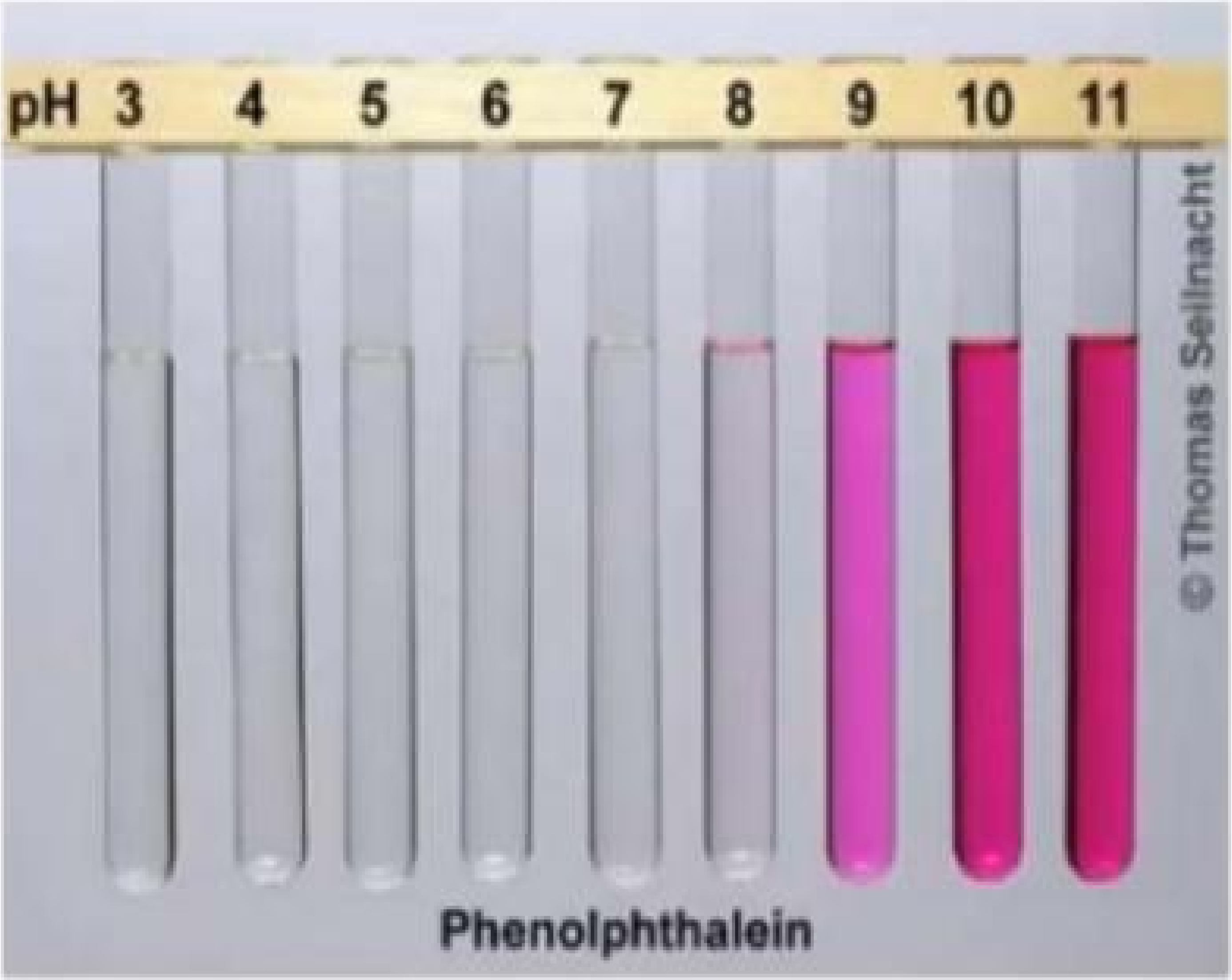
Where, *Na is the normality of analyte.*
Va is the volume of the analyte.
Ns is the normality of standard solution.
Vs is the volume of standard solution used.

Ma is the molarity of analyte.
Ms is the molarity of standard solution.

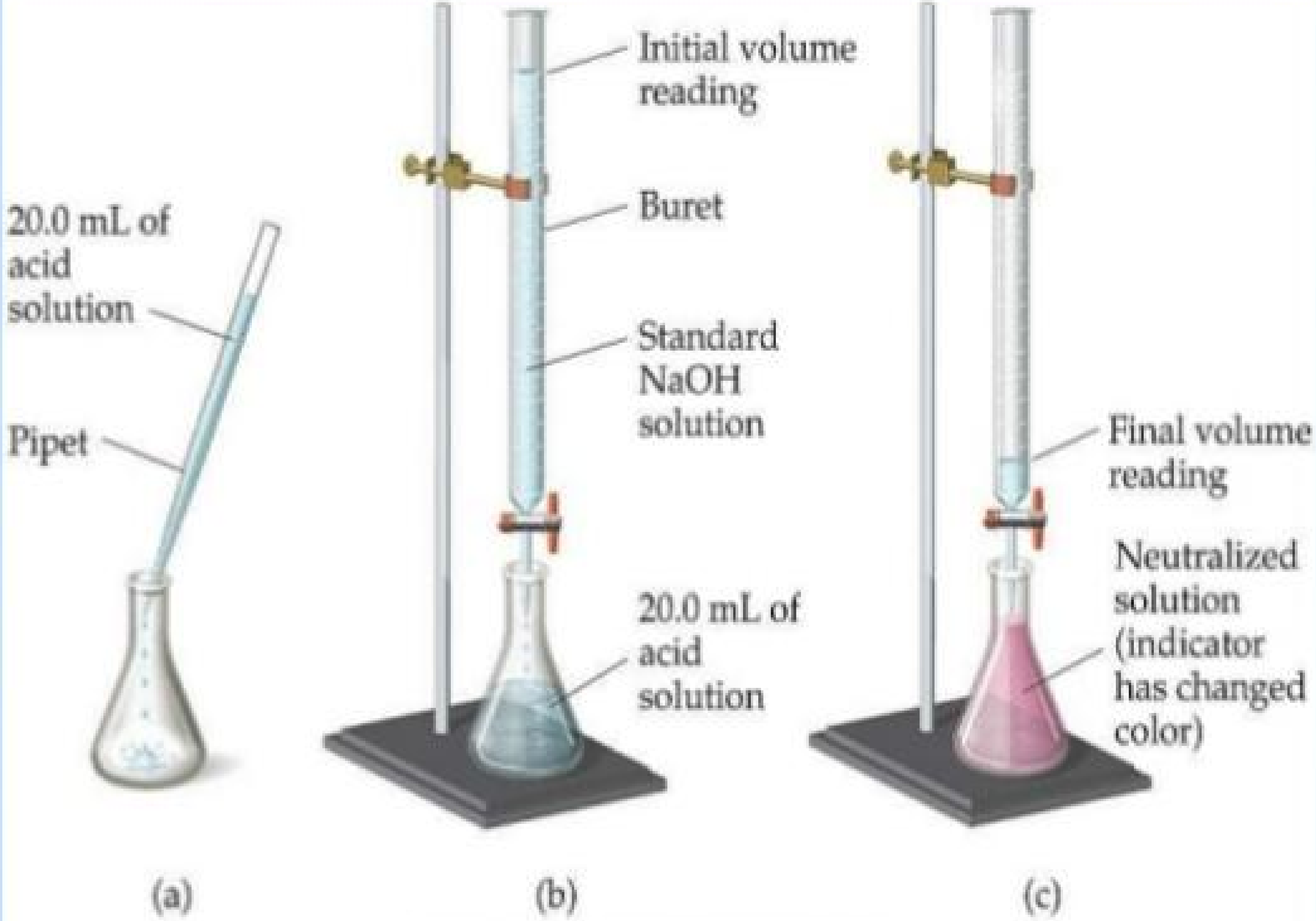
Acid-Base Indicators

Indicator	Color on acidic side	Range of color change	Color on basic side
Methyl violet	Yellow	0.0–1.6	Violet
Bromophenol blue	Yellow	3.0–4.6	Blue
Methyl orange	Red	3.1-4.4	Yellow
Methyl red	Red	4.4-6.3	Yellow
Litmus	Red	5.0-8.0	Blue
Bromothymol blue	Yellow	6.0-7.6	Blue
Phenolphthalein	Colorless	8.3-10.0	Pink
Alizarin yellow	Yellow	10.1-12.0	Red

Range of color indicator change



Titrimetric apparatus :-



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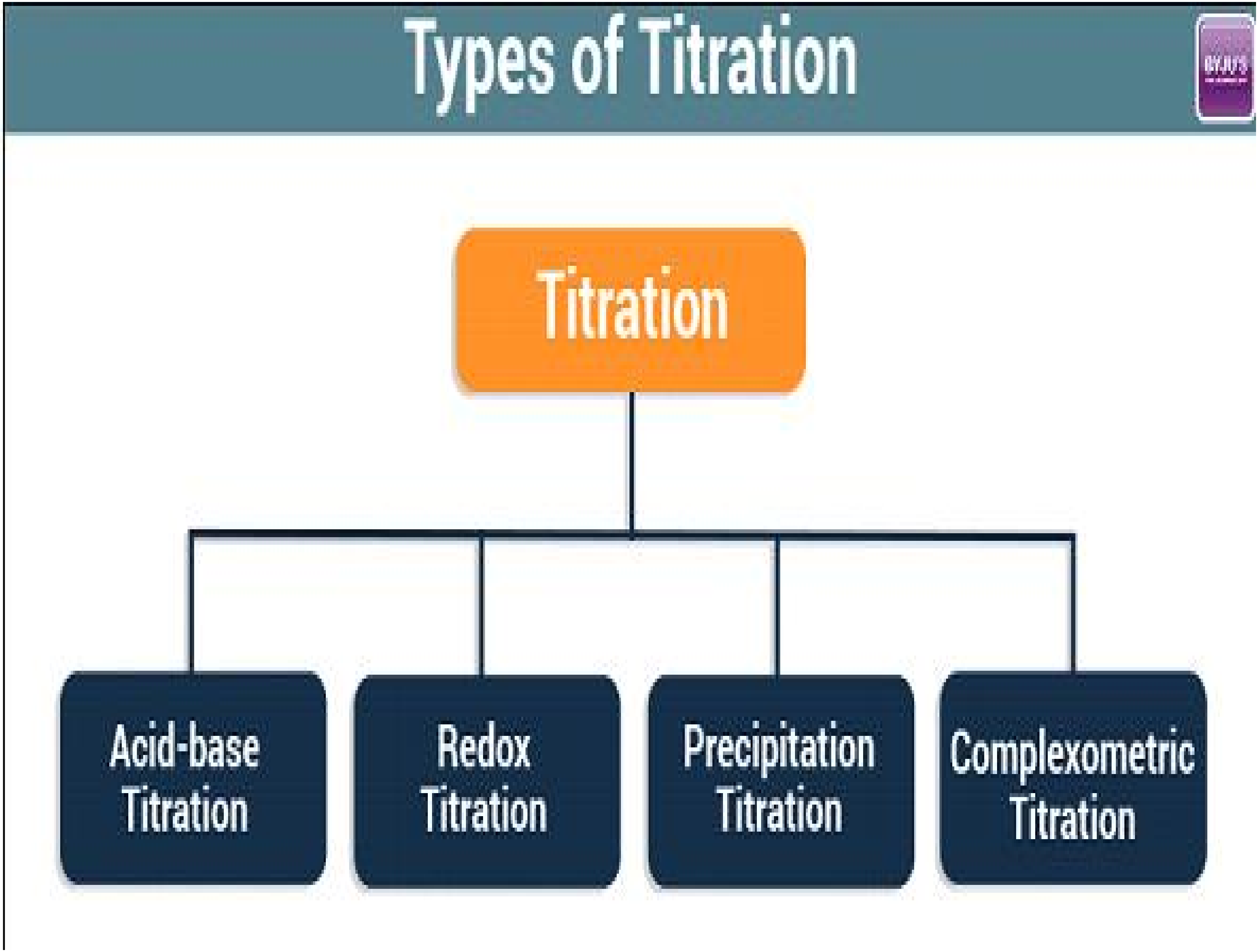

Types of Titration
Titration
Acid-base Titration
Redox Titration
Precipitation Titration
Complexometric Titration

Complexometric Titrations:- *As the name indicates, the end point is seems by formation of a complex molecule. Here titrant and titrand react to form a complex till end point is reached. Once complex is formed, the complex is stable and not further reaction takes place.*

$$Ca^{+2} + EDTA^{-4\,-} \text{----->} CaEDTA^{-2}$$

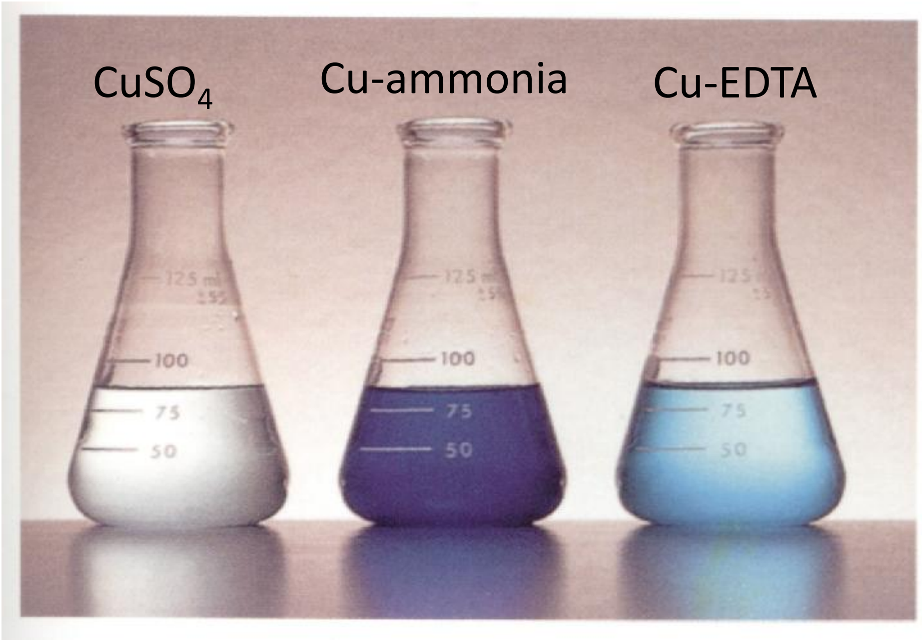
$$Mg\ In + EDTA^{-4} \text{------>} MgEDTA^{-2} + In^{-2}$$

EDTA Titrations

Auxiliary Complexing Agents

2.) Illustration:

- Titration of Cu^{+2} ($CuSO_4$) with EDTA
- Addition of Ammonia Buffer results in a dark blue solution
  - Cu(II)-ammonia complex is formed
- Addition of EDTA displaces ammonia with corresponding color change

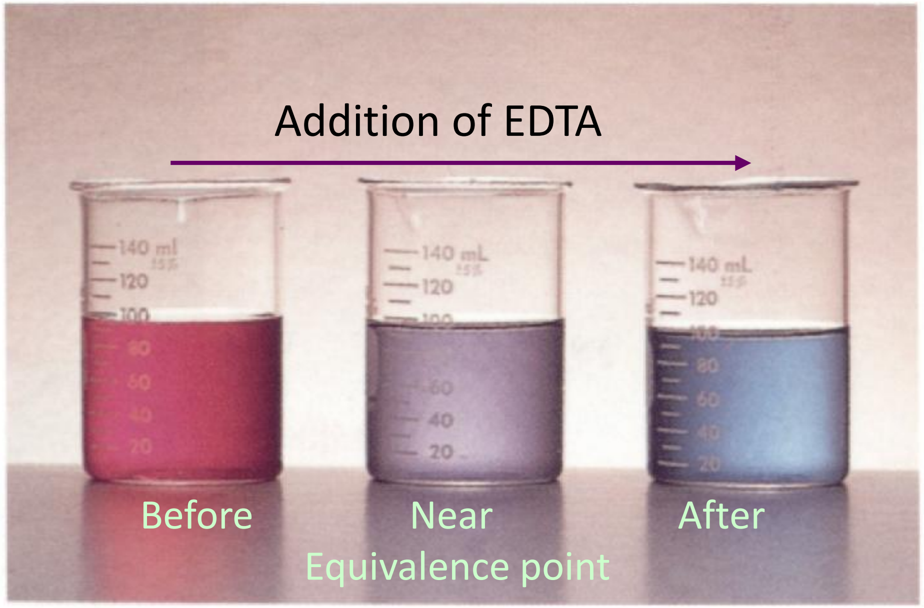


EDTA Titrations

Metal Ion Indicators

2.) Illustration

- Titration of Mg^{2+} by EDTA
  - Eriochrome Black T Indicator



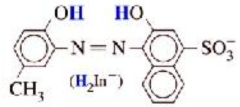
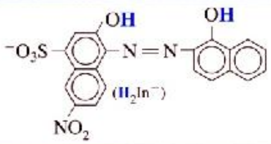
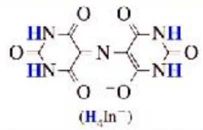
EDTA Titrations

Metal Ion Indicators

3.) Common Metal Ion Indicators

- Most are pH indicators and can only be used over a given pH range

Table 12-3 Common metal ion indicators

Name	Structure	pK_a	Color of free indicator	Color of metal ion complex
Calmagite		$pK_2 = 8.1$ $pK_3 = 12.4$	H_2In^- red HIn^{2-} blue In^{3-} orange	Wine red
Eriochrome black T		$pK_2 = 6.3$ $pK_3 = 11.6$	H_2In^- red HIn^{2-} blue In^{3-} orange	Wine red
Murexide		$pK_2 = 9.2$ $pK_3 = 10.9$	H_4In^- red-violet H_3In^{2-} violet H_2In^{3-} blue	Yellow (with Co^{2+}, Ni^{2+}, Cu^{2+}); red with Ca^{2+}
Xylenol orange		$pK_2 = 2.32$ $pK_3 = 2.85$ $pK_4 = 6.70$ $pK_5 = 10.47$ $pK_6 = 12.23$	H_5In^- yellow H_4In^{2-} yellow H_3In^{3-} yellow H_2In^{4-} violet HIn^{5-} violet In^{6-} violet	Red
Pyrocatechol violet		$pK_1 = 0.2$ $pK_2 = 7.8$ $pK_3 = 9.8$ $pK_4 = 11.7$	H_4In red H_3In^- yellow H_2In^{2-} violet HIn^{3-} red-purple	Blue

__Redox titration__:- Redox titration is based on the redox reaction (oxidation-reduction) between analyte and titrant.

For example:-

$$6\ Fe^{2+} + 14\ H^{+} + Cr_2O_7^{2-} \Rightarrow 6\ Fe^{3+} + 2Cr^{3+} + 7\ H_2O$$

$$MnO_4^{-} + 8\ H^{+} + 5\ Fe^{2+} \Longrightarrow Mn^{2+} + 5\ Fe^{3+} + 4\ H_2O$$

__Precipitation titrations__:- The titrations which are based on the formation of insoluble precipitates, when the solutions of two reacting substances are brought in contact with each other, are called Precipitation titration.

$$Ag^{+}(aq) + Cl^{-}(aq) \rightleftharpoons AgCl(s)$$

Requirement For Successfu Volumetric Titration

Clip slide

- Reaction must be **stoichiometric**, well defined reaction between titrant and analyte.
- Reaction should be **rapid**.
- Reaction should have **no side reaction, no interference** from other foreign substances.
- Must have some **indication of end of reaction**, such as color change, sudden increase in pH, zero conductivity, etc.
- Known **relationship** between endpoint and equivalence point.

- Concentration: is a general term expressing the amount of solute contained in a given material. Expressed by different ways
- Molarity(M): The number of moles of solute divided by the number of liters of solution containing the solute. (is gram molecular weight dissolved in one liter of solution)
- Molarity = moles of solute / volume in liters
- Milli moles of solute / volume in milliliters.
- Moles = weight (gms) / MW or
- Millimoles = weight(mg) / MW

Normality (N)

- Defined as no of equivalents of solute divided by the number of liters of solution containing the solute. (gm equivalent weight dissolved in one liter of solution)
- Normality = equivalents of solute / volume in liters
- Milli eq. of solute / volume in milliliters.
- Equivalents = weight (gms) / EW or
- Milliequivalent = weight(mg) / EW

Relation of Normality and Molarity

- Molarity = weight / MW x Volume
- MW = Weight / Molarity x volume   similarly
- Normality = weight / EW x Volume
- EW = Weight / normality x volume
- EW = MW / h
  - Where h reacting unit.
  - For acid H^+ is reacting unit and for base OH^-
  - For Oxd^n red^n e^- is reacting unit
  - For Ionic species valences

Equivalent weight

- Is defined as part by wt of substance which is chemically equivalent to one part by wt of hydrogen or 8 part by wt of oxygen or 35.5 part by wt of chlorine.
- Thus in finding out equlent. wt we find out how many grams of that sub are directly or indirectly eq to one gm of hydrogen
- It depends on reaction in which it takes place

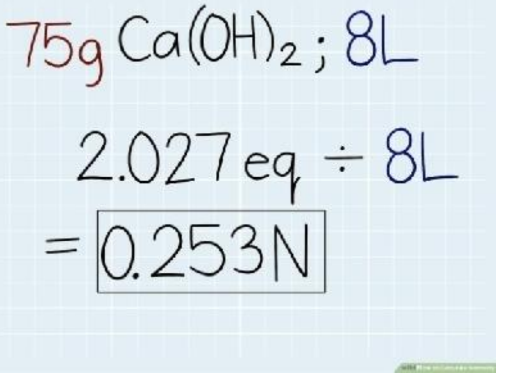
Percent (%)

- Weight percent (w/w) = $\frac{\text{weight of analyte}}{\text{weight of sample}} \times 100$
- Volume percent (v/v) = $\frac{\text{volume of analyte}}{\text{volume of sample}} \times 100$
- Weight percent (w/v) = $\frac{\text{weight of analyte}}{\text{volume of sample}} \times 100$

Requirements of Primary Standards

- It should be 100% pure or with known purity
- Should be stable to drying temp.
- Usually solid to make it easier to weigh
- Easy to obtain, purify and store, and easy to dry
- Inert in the atmosphere
- High formula weight so that it can be weighed with high precision
- It should not absorb moisture, or should not react with oxygen or CO_2
- Reaction with analyte should be single, rapid complete and stoichiometric

Equivalent Weight :It is defined as the number of parts by weight, chemical species combined with or displaced by 1.008 parts of hydrogen,8patrs of oxygen or 35.5 parts by weight of chlorine and 127 part of iodine..



Oxidizing Agent :Pot.Permagnate

Reactions of oxalic acid

A. Chemical equations

Reduction half reaction : $2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5\,[O]$

Oxidation half reaction : $H_2C_2O_4 + [O] \xrightarrow{60°C} 2CO_2 + H_2O] \times 5$

$$2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10\,CO_2$$

$2KMnO_4 = 5O$

2MW 5x16

Eq Wt =MW/5 =158/5=31.606

Oxidizing Agent :Pot.dichromate

$$K_2Cr_2O_7 + 4H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H2O+3O$$

Available Oxygen =3atoms=3x16

$K_2Cr_2O_7$ = 3O

MW= 3x16

Eq Wt = MW/6= 294.18/6= 49.03

Reducing Agent Equivalent Weight

Ferrous Sulphate

$2FeSO_4 + H_2SO_4 + O \longrightarrow Fe_2(SO_4)_3 + H2O$

$2FeSO_4 = O$

2MW= 16

Eq Wt =2MW/2=MW=152

Ferrous Ammonium sulphate

$2[FeSO_4.(NH_4)_2SO_4.6H2O] + H_2SO_4 + O \longrightarrow$

$Fe_2(SO_4)_3 + 2(NH_4)SO_4 + 13H2O$

O=16

Eq Wt=2MW/2=392

Oxalic Acid

COOH
| .$2H_2O$ +O → $2CO_2$ +$3H_2O$
COOH

MW = O=16

Eq Wt=MW/2= 126/2=63

Sodium thiosulphate(Hypo)

$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$

2MW= 2I

2 MW= 2x127

EqWt=MW

Iodimetric Titrations: Iodimetric titrations are defined as those iodine titration in which a standard iodine siolotion is used as oxidants and iodine is directly titrated with the reducing agents like thiosulphate,sulphite,arsenite by titrating them against standard solution of iodine run in from a burette .

Iodometric Titrations: Iodometric titrations are defined as those iodine titration in which some oxidiging agent librates iodine from an iodide and the librated iodine is titrated against standards solution of reducing agent from the burette.

Some basic question generally asked to chemist :

- Have Chemical Instruments improved in recent years?
- Do Chemists provide meaning full answer to problems?
- Are chemists providing answer with better accuracy and precision compared to 60 years ago?

YES : There has been revolution in Analytical chemistry

- New instruments .
- Computing power and improved quality of information through computing .
- More detailed analysis can be done.
- Detection of ultra trace amounts.
- Faster methods of sample preparation :
  - microwave
  - Ultrasonic

Fluoride

Fluorides are properly defined as binary compounds or salts of fluorine with another element (like Na, K etc.) combined chemically in the form of fluorides.

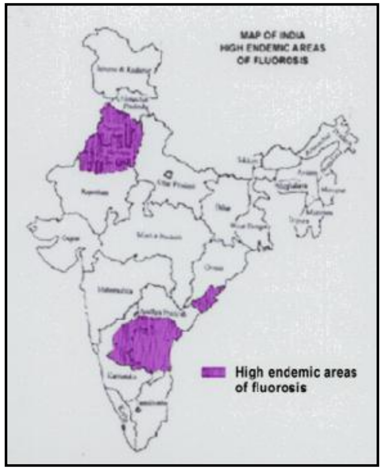
High pH of water favours high fluoride content in water .

Naturally, although the controlled enrichment of drinking water with Fluoride is essential for humans because traces of fluorine are necessary for normal mineralization, formation of caries – resistant enamel, strong teeth, healthy bones and for normal reproduction.

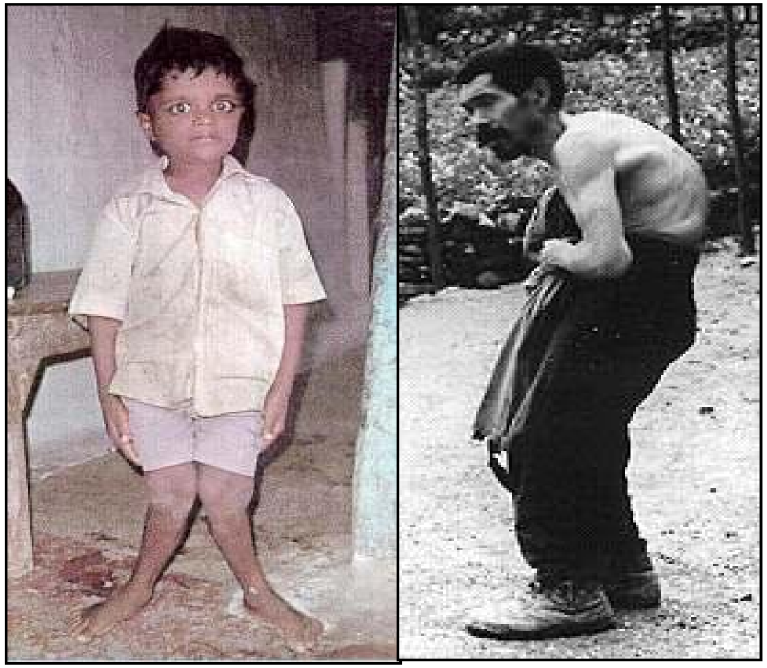
According to WHO 1984 and Bureau of Indian Standard Drinking Water Specification 2002, the maximum permissible limit of fluoride in drinking water is 1.5 ppm and highest desirable limit 1 ppm.

Fluoride concentration above 1.5 ppm in drinking water cause dental fluorosis and much higher concentration skeletal fluorosis, low concentration (0.5 ppm) provide protection against dental caries.

FLUOROSIS



Dental Fluorosis



Skeletal Fluorosis

- **Permissible limit of fluoride in drinking water is 1.5 ppm and highest desirable limit 1 ppm.**
- **Fluoride concentration above 1.5 ppm in drinking water cause dental fluorosis much higher concentration skeletal fluorosis.**
- **Low fluoride concentration (0.5 ppm) provide protection against dental caries.**

Electrode Method (0.1 to > 10 mg/l)

Selection of Methods

SPADNS Colorimetric Method(0 to1.4mg/l)

Sampling & Storage: Polythene/Glass bottle rinsed with portion of sample. Dechlorination using sod. arsenite rather than sod thiosulphate.

Preliminary Distillation Step: To remove nonvolatile materials from water.

400ml DW +200ml Conc. sulphuric acid

heat 180° C

Acid mixt

Distillate (discarded)

cool to 80 °C add 300ml sample heat at 180 °C

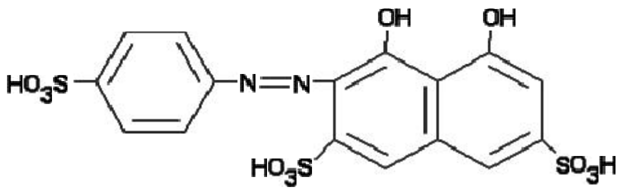
Residual acid mixt

distillate used for analysis

SPADNS Spectrophotometric Method for Analysis of Fluoride

- **Fluoride reacts with certain zirconium dyes to form a colourless complex and another dye**
- **The dye becomes progressively lighter as fluoride concentration increases**
- **Absorbance is measured at 570 nm**
- **Prepare calibration curve using absorbance values for known standards**
- **Read fluoride values for the samples**

SPECTROPHOTOMETER



SPADNS

Sod. 2-(parasulfophenylazo)-1,8 dihydroxy3,6naphthalene disulphate

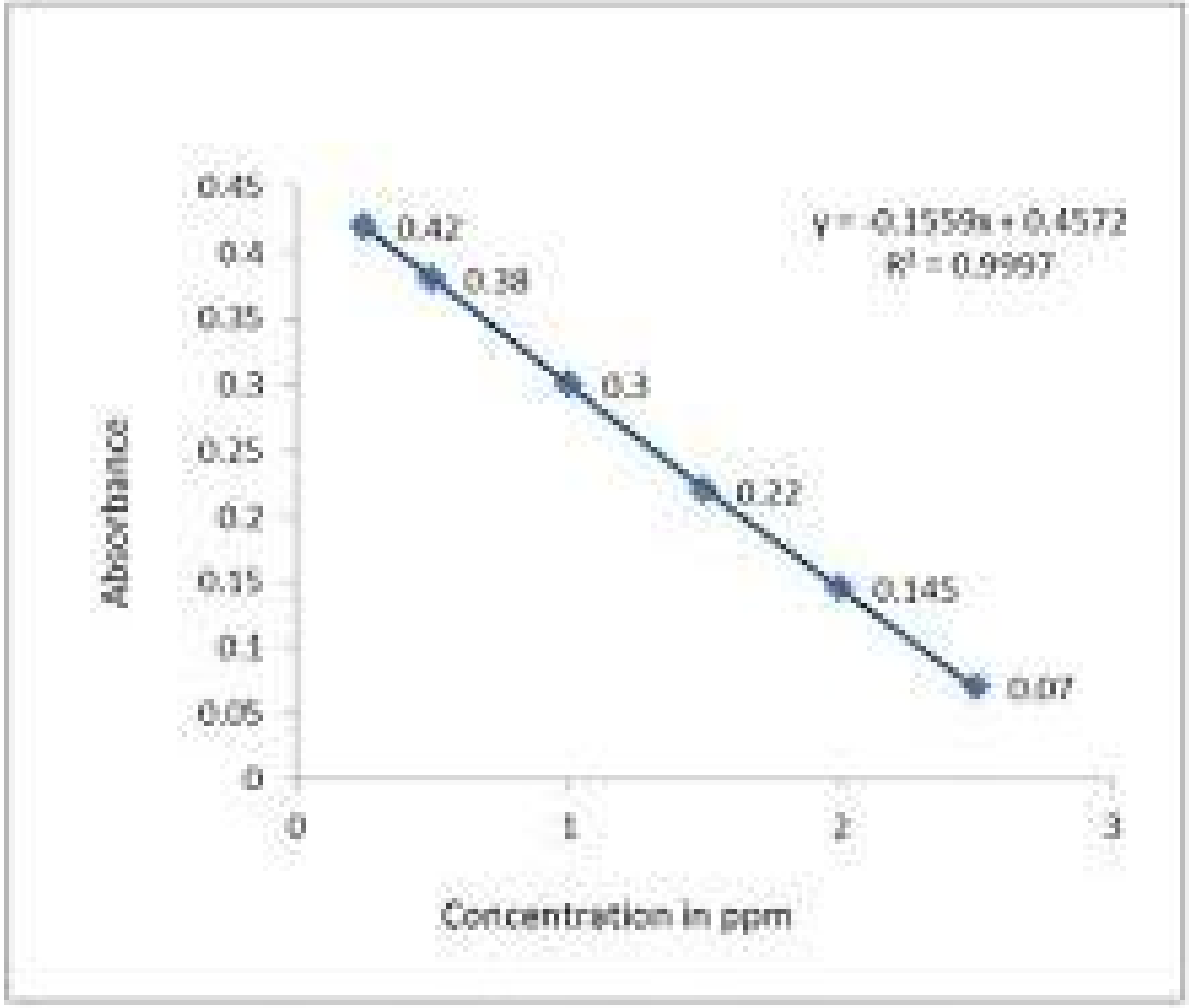
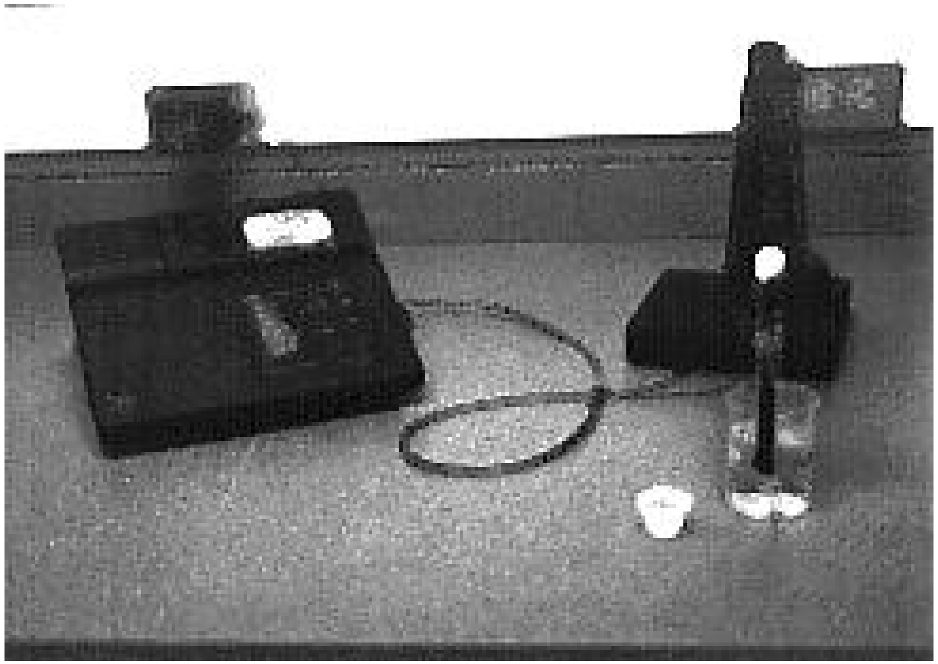
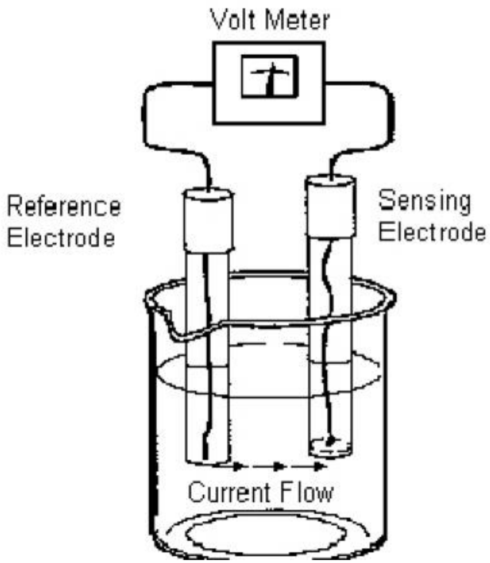


Figure 2: Fluoride standard calibration curve.

Ion Selective Electrode Method

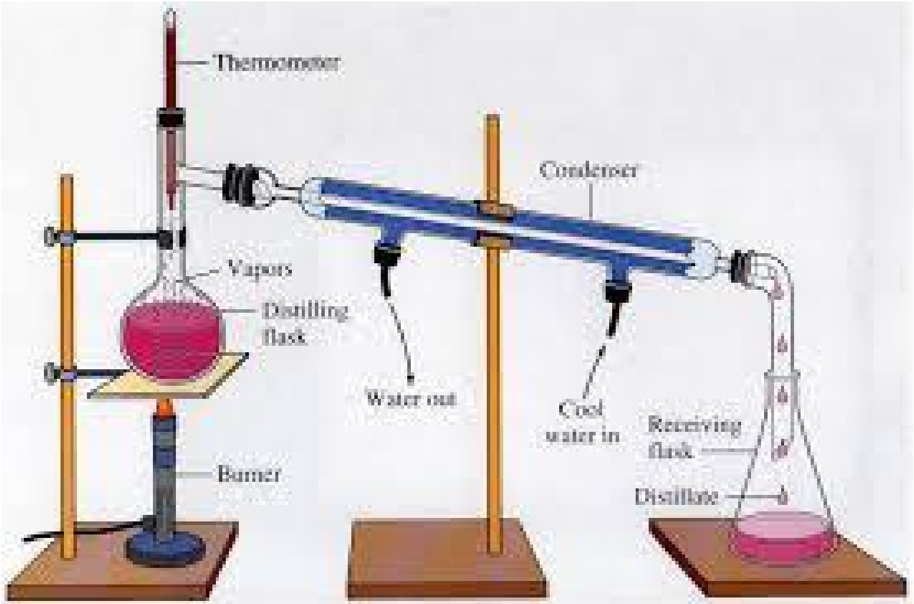
- **It is ion selective sensor, Laser type doped Lanthanum fluoride crystal across within a potential is established by fluoride solution.**
- **Ag |AgCl, Cl(0.3M),F90.001M) LaF3 Test|**





Phenolic Compound

a. Principle: Steam-distillable phenols react with 4-aminoantipyrine at pH 7.9 ± 0.1 in the presence of potassium ferricyanide to form a colored antipyrine dye. This dye is extracted from aqueous solution with $CHCl_3$ and the absorbance is measured at 460 nm. This method covers the phenol concentration range from 1.0 μg/L to over 250 μg/L with a sensitivity of 1 μg/L.



Sample Collection for Heavy Metals

All metals except Hg :

Container : Reagent bottle or polyethylene bottle

Combining with 0.5% HNO_3

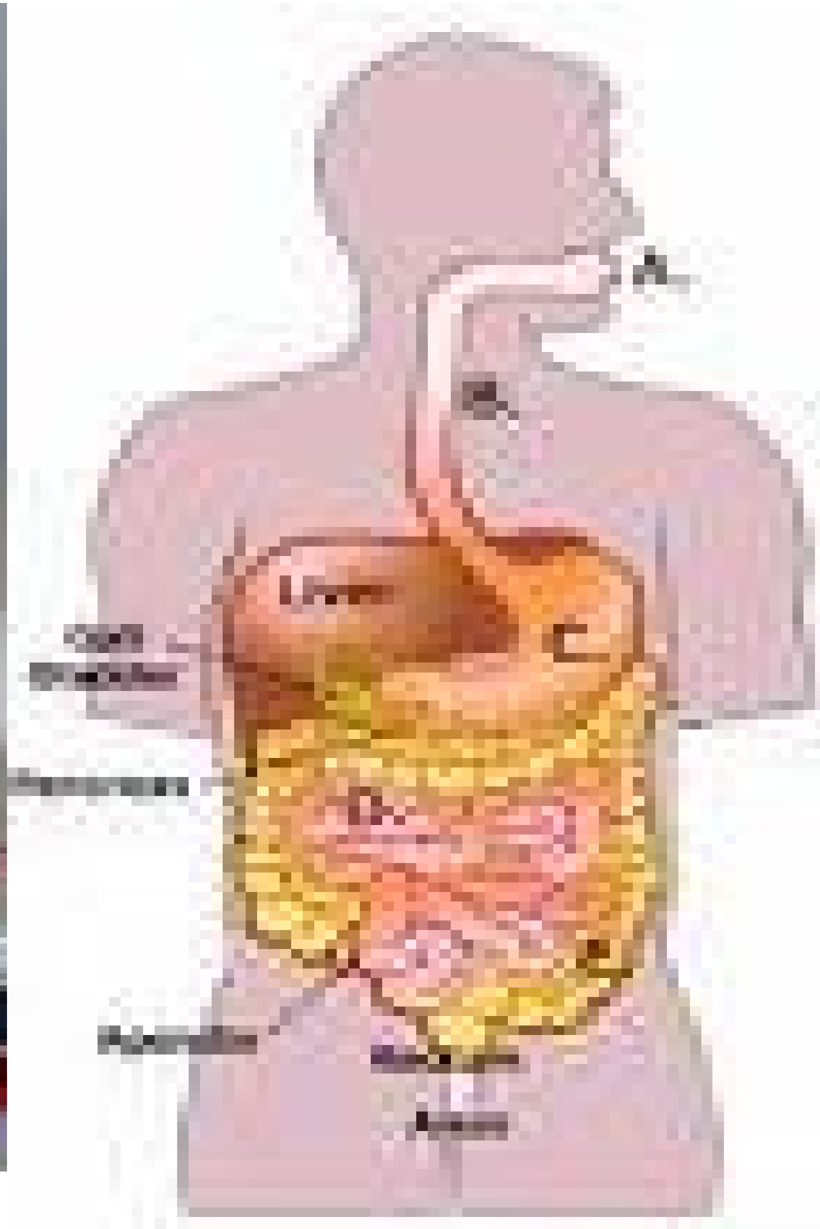
Store up to maximum 1 month.

Hg:

Prewashed reagent bottle. Rinse the bottle twice with sample.

2 ml of 4M nitric acid and5 ml of 2.5% Pot. Dichromate.

Store up to 5 weeks (maxm) in freeze.



Organic matrix + Oxidizing agent
$CO_2 + H_2O$

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

Type of Sample Preparation

- Acid Digestion → Hot / Cold

- Fusion With alkali carbonates

- Ashing in muffle furnace

- Micro wave digestion

Cold digestion For Volatile metals (Hg, As) estimation

Digestion of organic using nascent Oxygen produced by reaction of Potassium permagnate with Conc. sulfuric acid.

$2KMnO_4+3H_2SO_4$ Ì $K_2SO_4+2MnSO_4+3H_2O$ $+5O$

$(CH_2)n + H_2O$ Ì $CO_2 + H_2O$

Example:

0.5 g of tissue or 1ml blood in conical flask containing 5 ml conc. sulfuric acid(cooled in ice bath).

Stopper the flask and heat for 2 hrs at 70 °C.

15 ml of 20% w/v hydroxylamine hydrochloride is added to reduce the excess of permagnate.

The sample is ready for analysis using AAS –VGA.

Figure : Times typically required for digestions

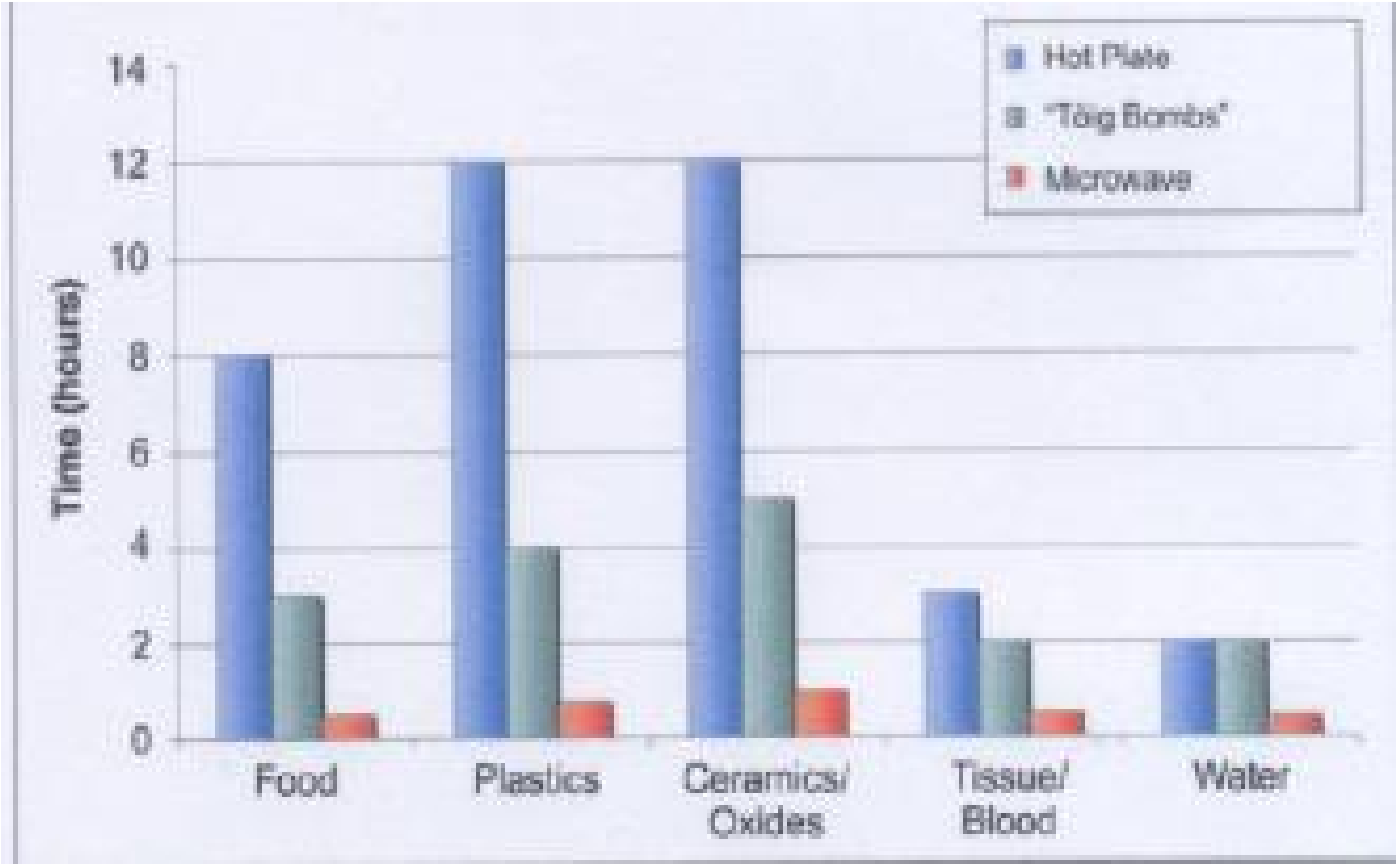
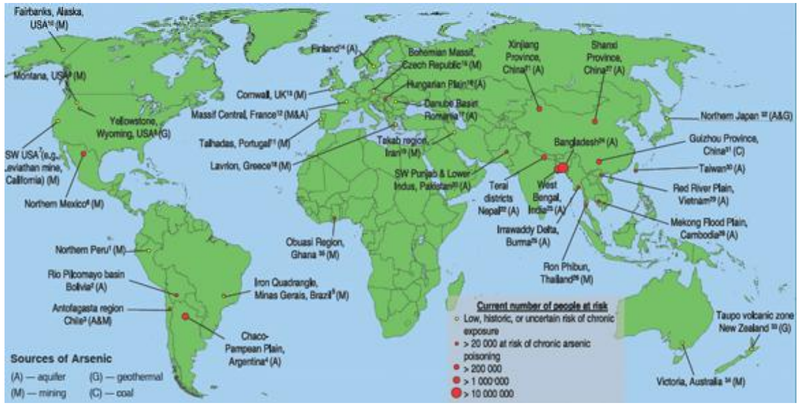


Table: Effect of Laboratory Atmosphere on Pb Blank Levels

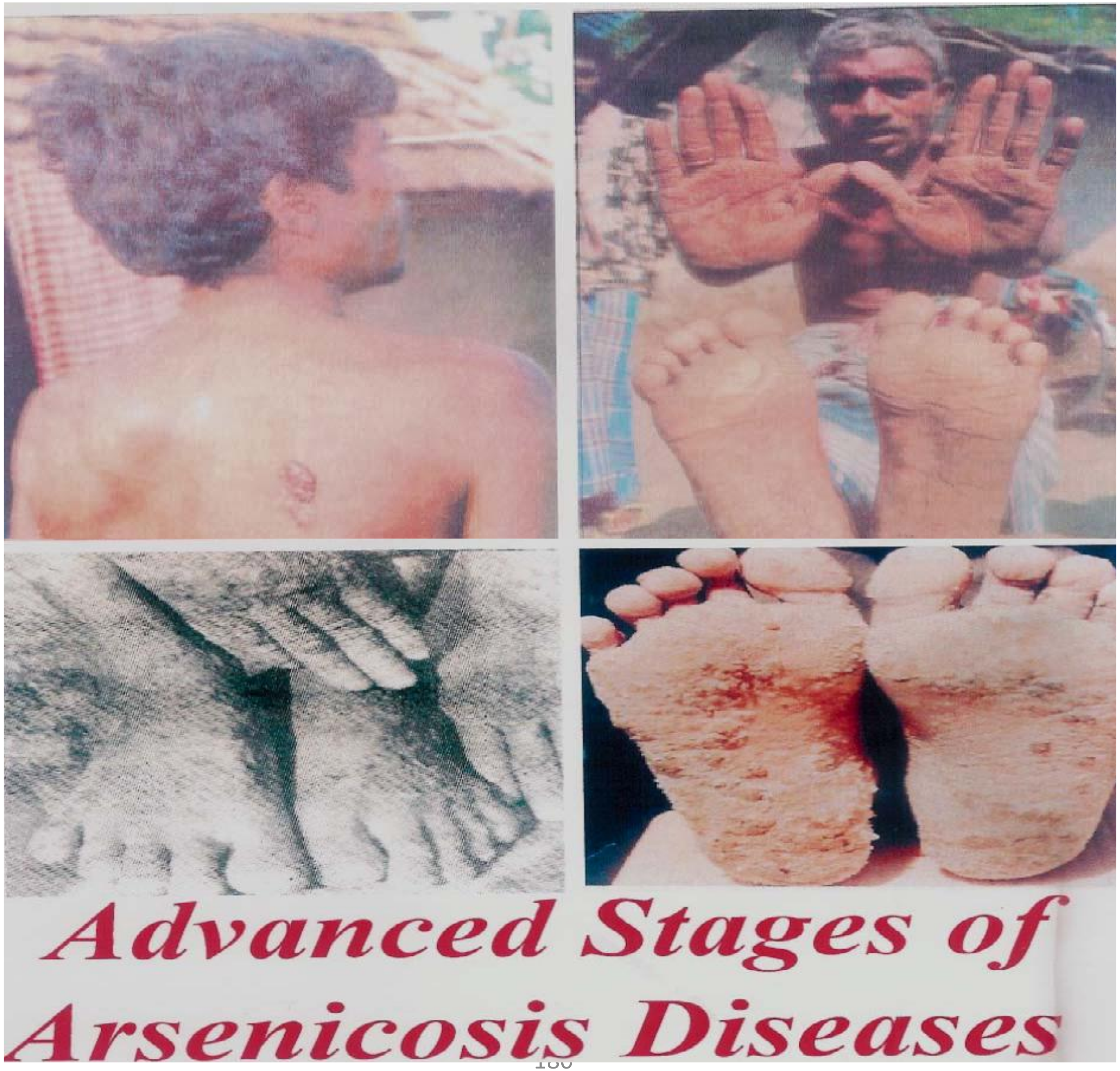
	ng Pb found in 1 mL of Acid
Acid Blank	2
Covered for 2 hrs on bench	1, 1.5
Uncovered for 2 hrs on bench	5.5, 6.2
Covered in hood for 3 hrs	4.5
Uncovered in hood for 3 hrs	25

ARSENIC TOXICITY



- **Arsenite - As (III) is more toxic than Arsenate – As (V).**
- **Maximum permissible level for arsenic in drinking water is 10 ppb.**

Arsenic



Arsenic

Zn/HCl

As (III) ⟶ AsH_3

↓ Scrubber having lead acetate

Silver diethydithiocarbamate in morphaline-chloroform

↓

Red Colour complex read at 520nm

MDL :1µ As

Spectrophotometer

Vapour Generation Accessory (VGA)

Vaporize

Flame  **air –acetylene temp.**

(2125-2400°C)

Atoms like As,Sb,Se,Te,Bi,Sn,Hg and Zr

Causing less availability of atomize atoms ,resulting less sensitivity

Hence it is required to convert them into their respective hydride

Atomize at low temperature say 1000°C.

Atomic Absorption Spectrophotometer

Atomic Spectrophotometer

A + Energy → A* → A + hν

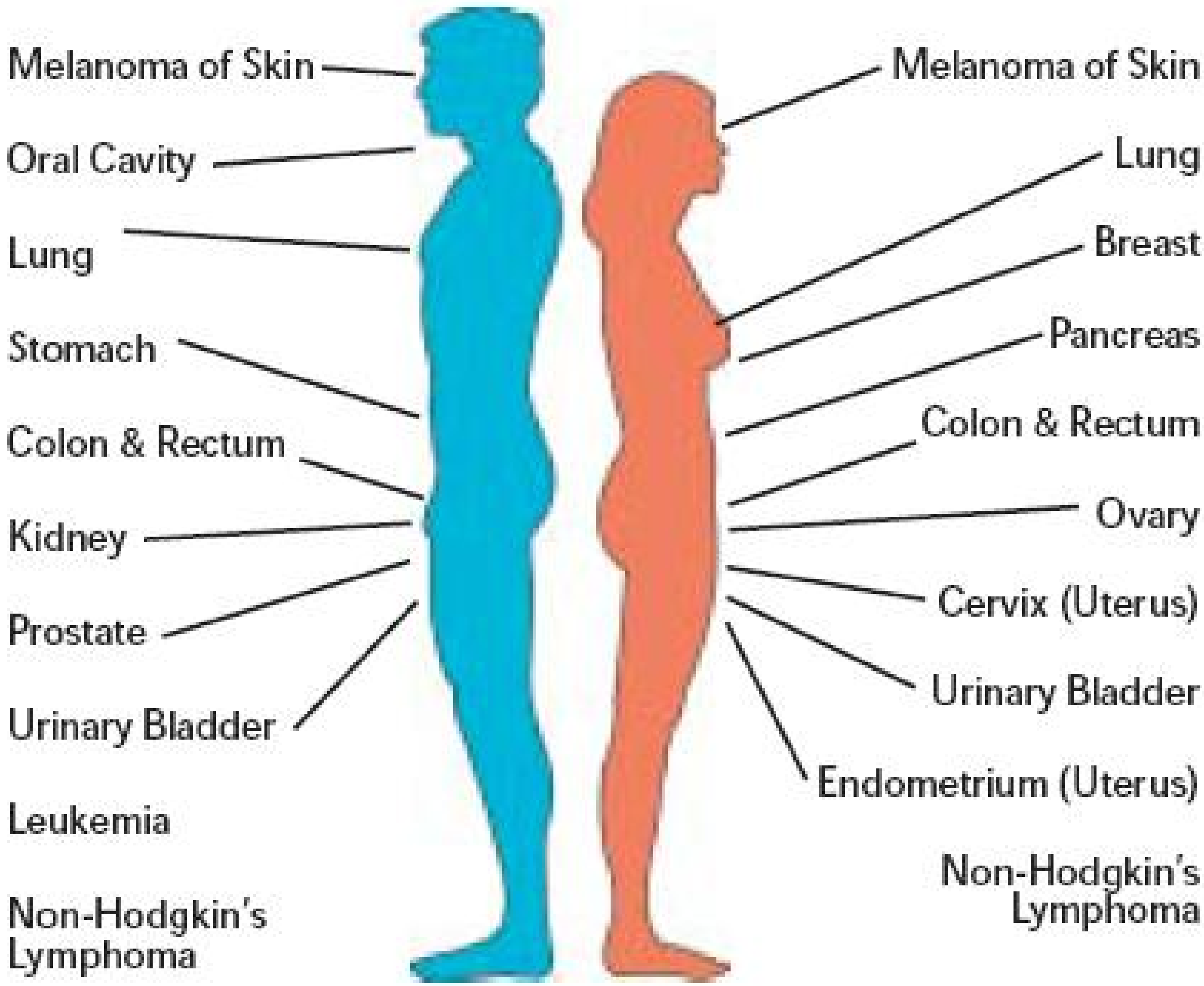
Atom — Excited atom — Atom — emission/fluorescence

Quantitation → AAS

Pesticides

Pesticides are widely used in agriculture to protect crops against insects (insecticides) fungus (fungicides) and weed (herbicides).

- **Organochlorine**
- **Organophosphorus**
- **Carbamates**
- **Botanical pesticide**



Some of the cancers linked to pesticide use.

Strength of solution is expressed in

- Percentage
- Molality
- Molarity
- Normality
- Parts per million (ppm)
- Parts per billion (ppb)
- Parts per trillion (ppt)

Concept of ppm & ppb

One part per million (**ppm**): Denotes one part per 1,000,000 parts, one part in 10^6, and a value of 1×10^{-6}. This is equivalent to one drop of water diluted into 50 liters (roughly the fuel tank capacity of a compact car), or one second of time in approximately 11½ days. 1mm in 10 Km.

ppm= mg/kg = µg/g

One part per billion (**ppb**): Denotes one part per 1,000,000,000 parts, one part in 10^9, and a value of 1×10^{-9}. This is equivalent to 1 drop of water diluted into 250 chemical drums (50 m^3), or one second of time in approximately 31.7 years.

10 ppb= A pinch of salt in 10 tons potato chips .

1mm in 1000 Km (approxm distance between Lucknow and Kolkata)

ppb= µg/kg = ng/g

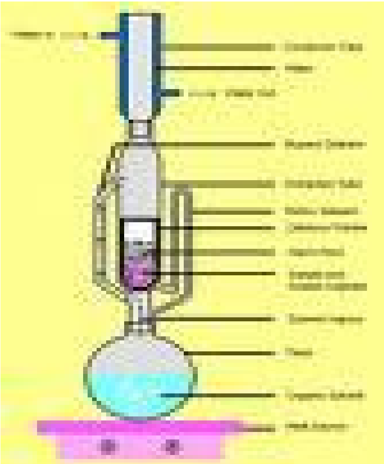
Pesticide Residue Analysis :

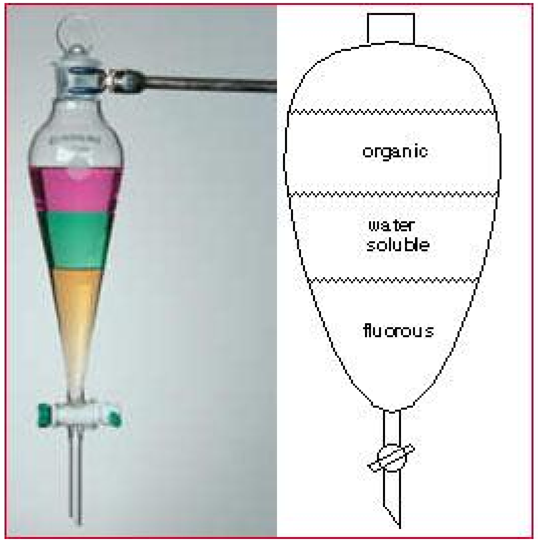
1. Sampling
2. Storage
3. Extraction
4. Demoisturization
5. Clean up
6. Concentration
7. End Analysis
8. Identification and Quantification

Extraction

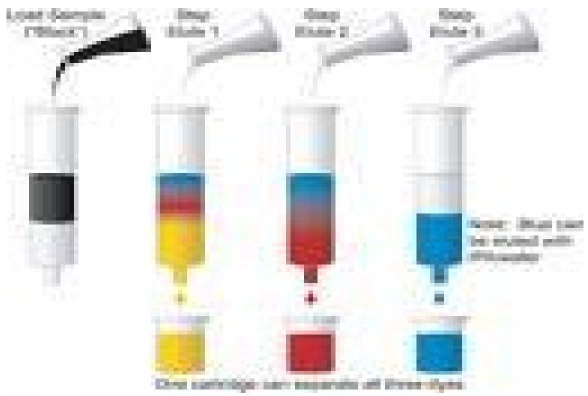
Liquid –Liquid Extraction using separating funnel

Solid Sample using solid-liquid Extraction: Soxlet Apparatus



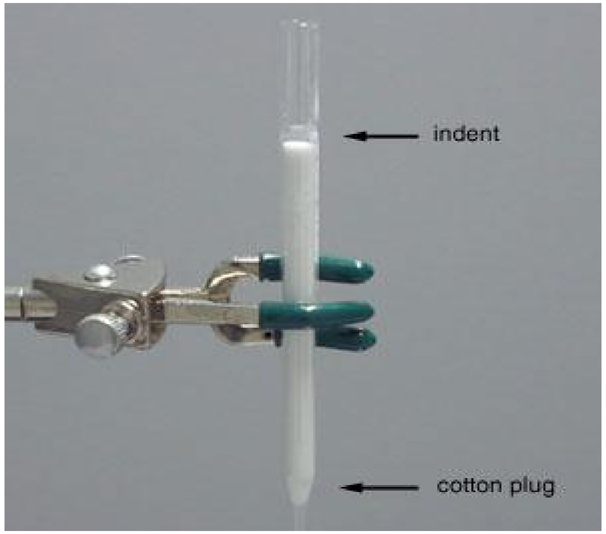


Solid Phase Extractor (SPE)



Demoisturization : Using anhyd. Sodium sulphate

Cleanup: Using column Chromatography:-

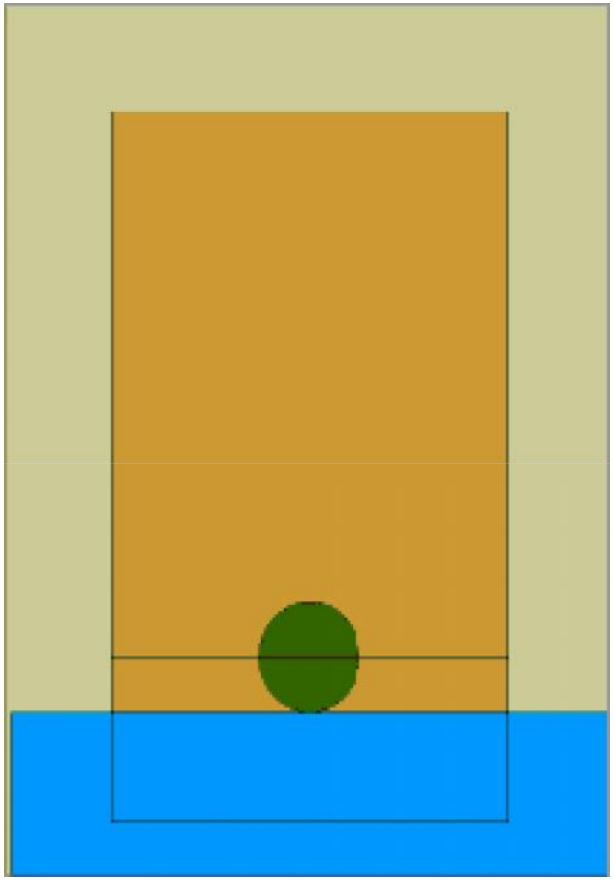


- Alumina
- Silica
- Florosil (Magnesium silicate)

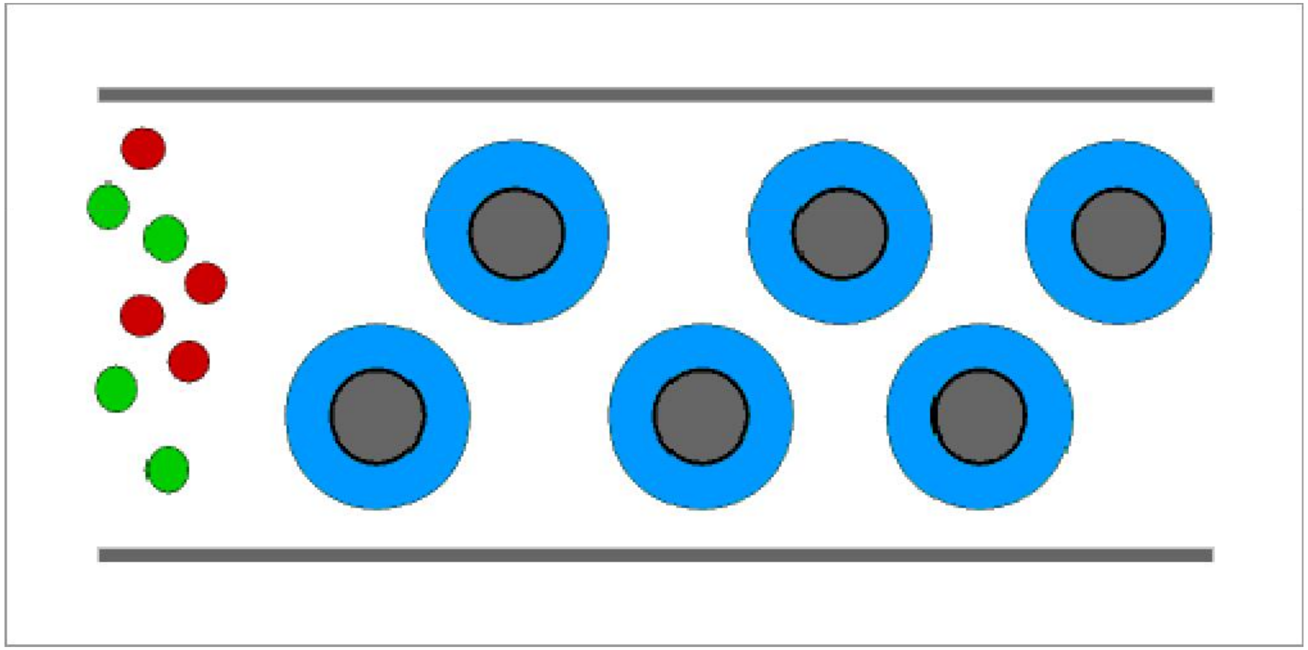
Pre wet column with 20ml n-hexane, load the concentrate extract and elute with mixture of diethyl ether with n-hexane (6%,15%,50%)

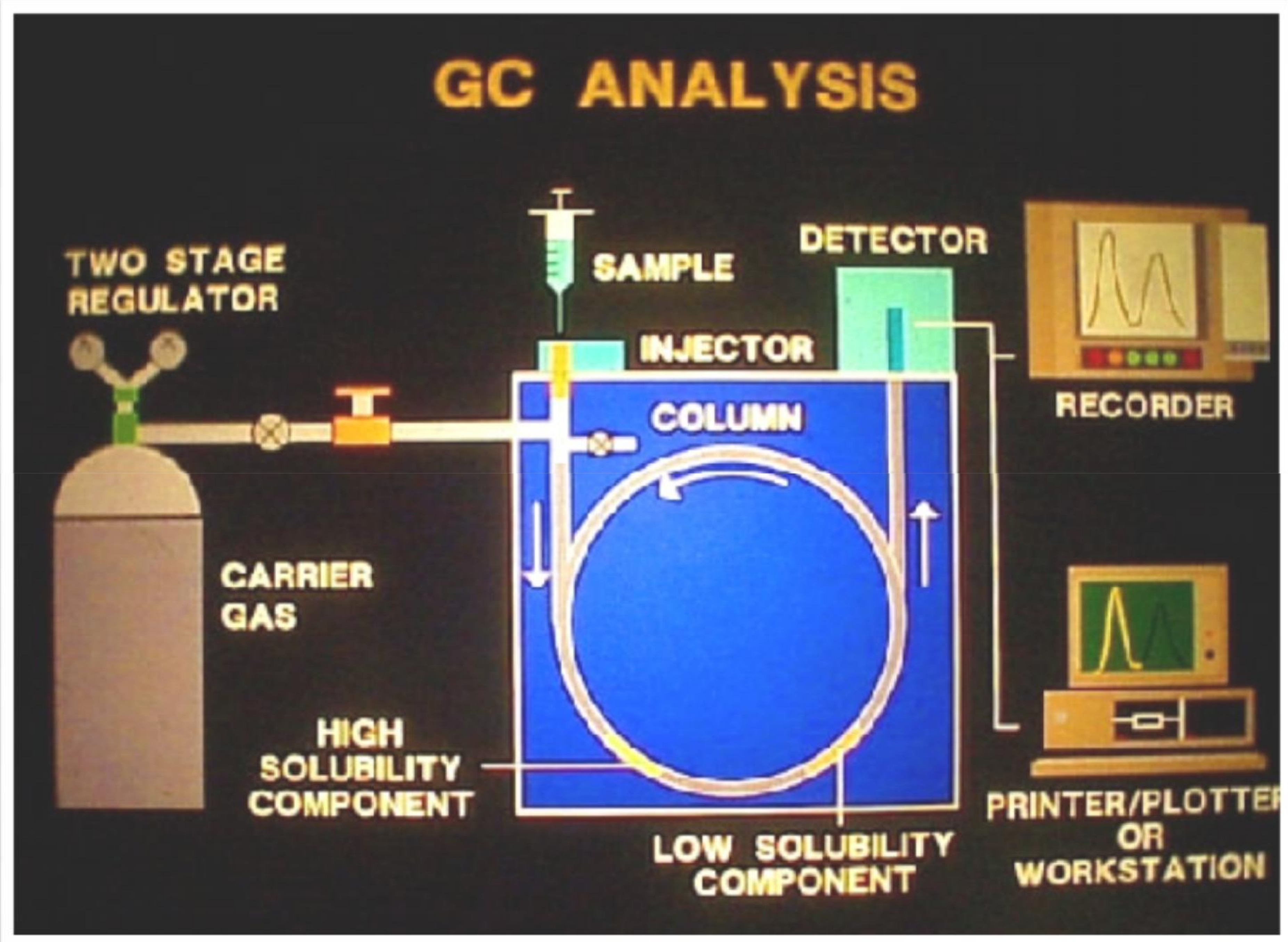
Concentration of Extract (i) By using Rotary Evaporator

(ii) By using gentle stream of nitrogen



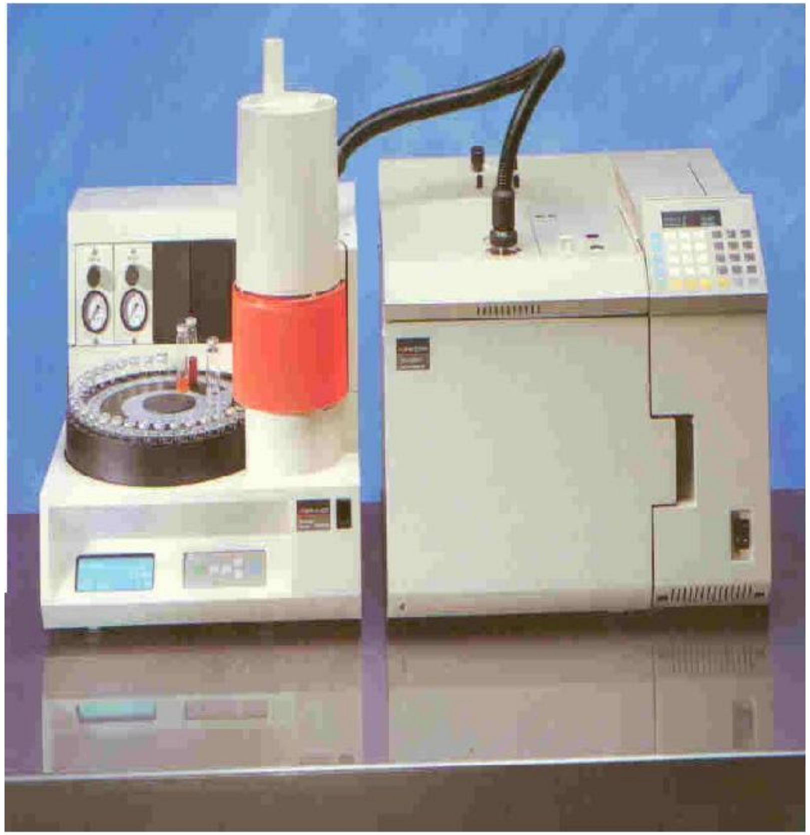
In the animation below the red molecules are more soluble in the liquid (or less volatile) than are the green molecules.

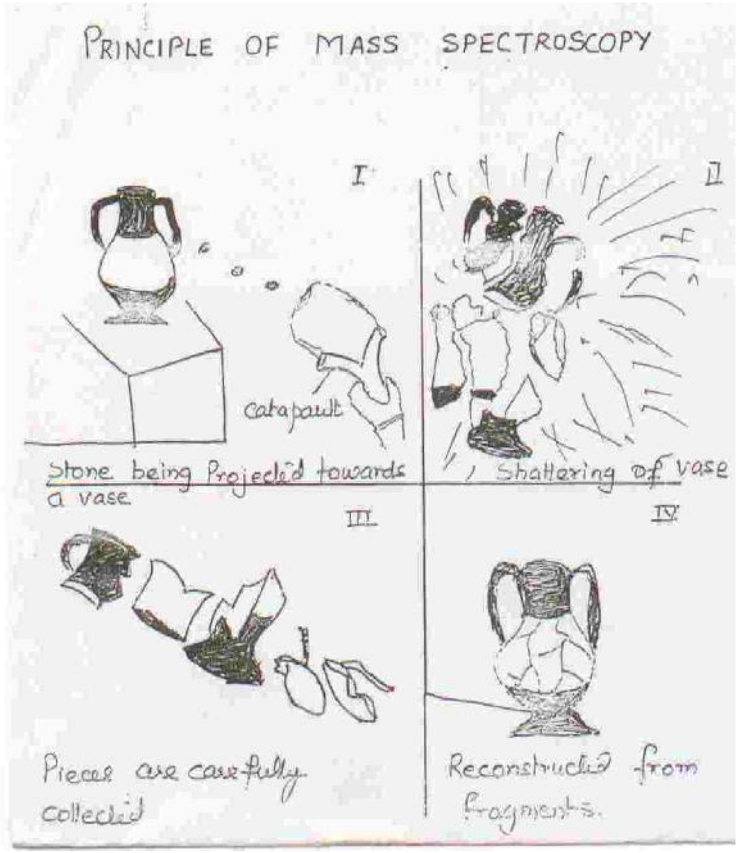



GC ANALYSIS
TWO STAGE REGULATOR
SAMPLE
DETECTOR
INJECTOR
COLUMN
RECORDER
CARRIER GAS
HIGH SOLUBILITY COMPONENT
LOW SOLUBILITY COMPONENT
PRINTER/PLOTTER OR WORKSTATION

Detectors

Detector	Type	Support gases	Selectivity	Detectability	Dynamic range
Flame ionization (FID)	Mass flow	Hydrogen and air	Most organic cpds.	100 pg	10^7
Thermal conductivity (TCD)	Concentration	Reference	Universal	1 ng	10^7
Electron capture (ECD)	Concentration	Make-up	Halides, nitrates, nitriles, peroxides, anhydrides, organometallics	50 fg	10^5
Nitrogen-phosphorus	Mass flow	Hydrogen and air	Nitrogen, phosphorus	10 pg	10^6
Flame photometric (FPD)	Mass flow	Hydrogen and air possibly oxygen	Sulphur, phosphorus, tin, boron, arsenic, germanium, selenium, chromium	100 pg	10^3
Photo-ionization (PID)	Concentration	Make-up	Aliphatics, aromatics, ketones, esters, aldehydes, amines, heterocyclics, organosulphurs, some organometallics	2 pg	10^7
Hall electrolytic conductivity	Mass flow	Hydrogen, oxygen	Halide, nitrogen, nitrosamine, sulphur		




PRINCIPLE OF MASS SPECTROSCOPY
I
II
catapault
Stone being Projected towards a vase
Shattering of vase
III
IV
Pieces are carefully collected
Reconstructed from fragments.

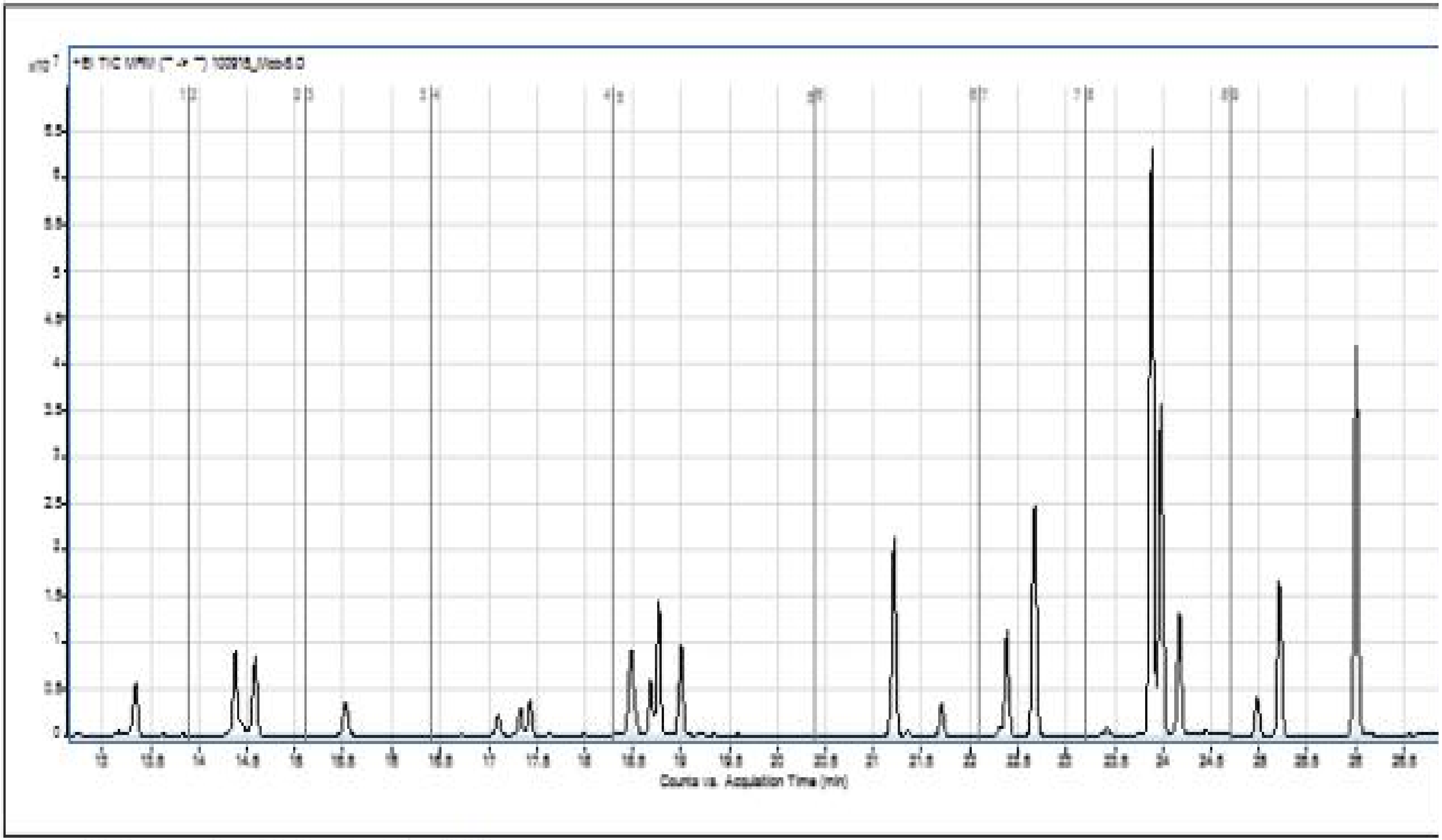
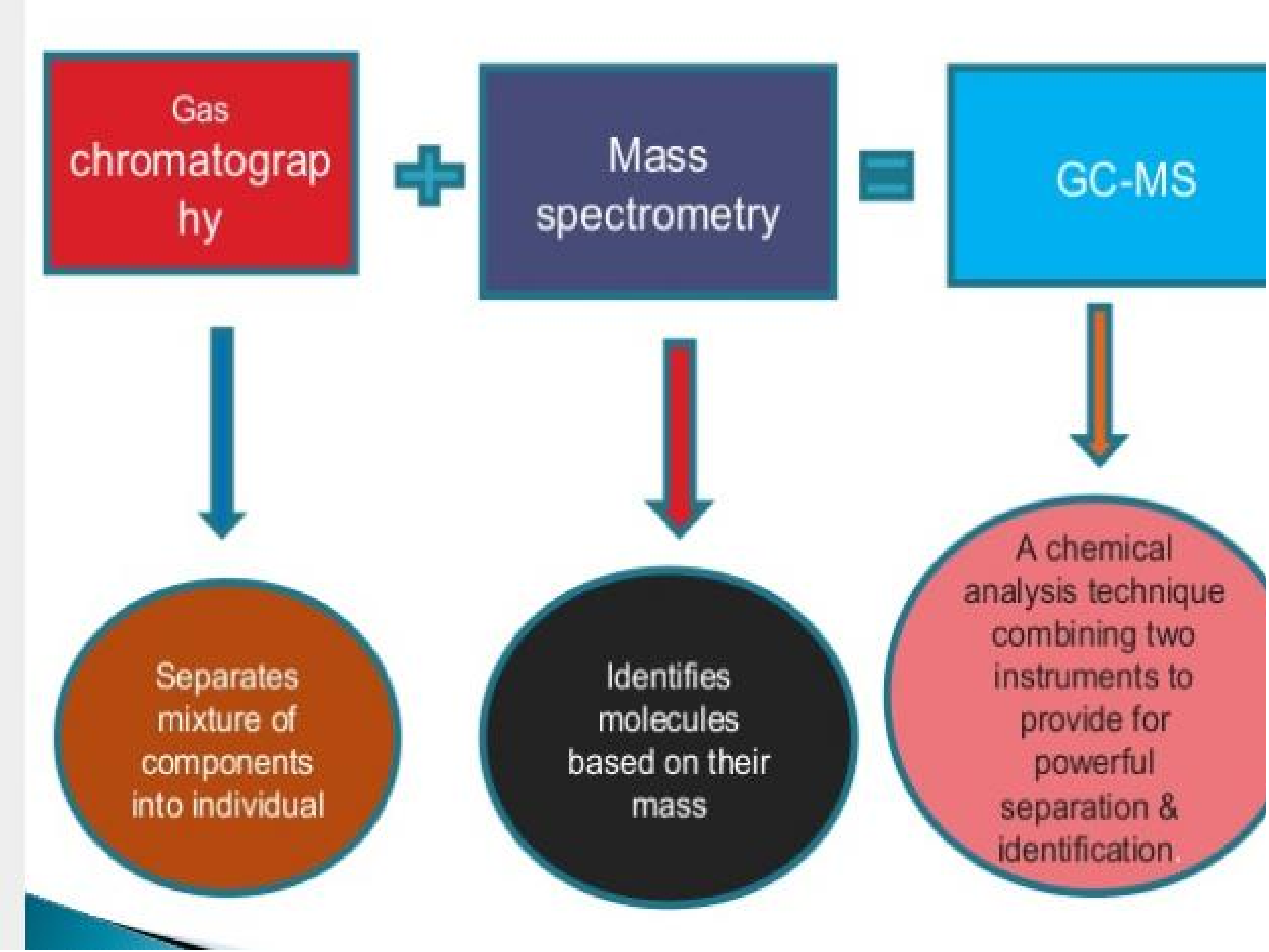


Figure 1. Extracted pesticides standard TIC.

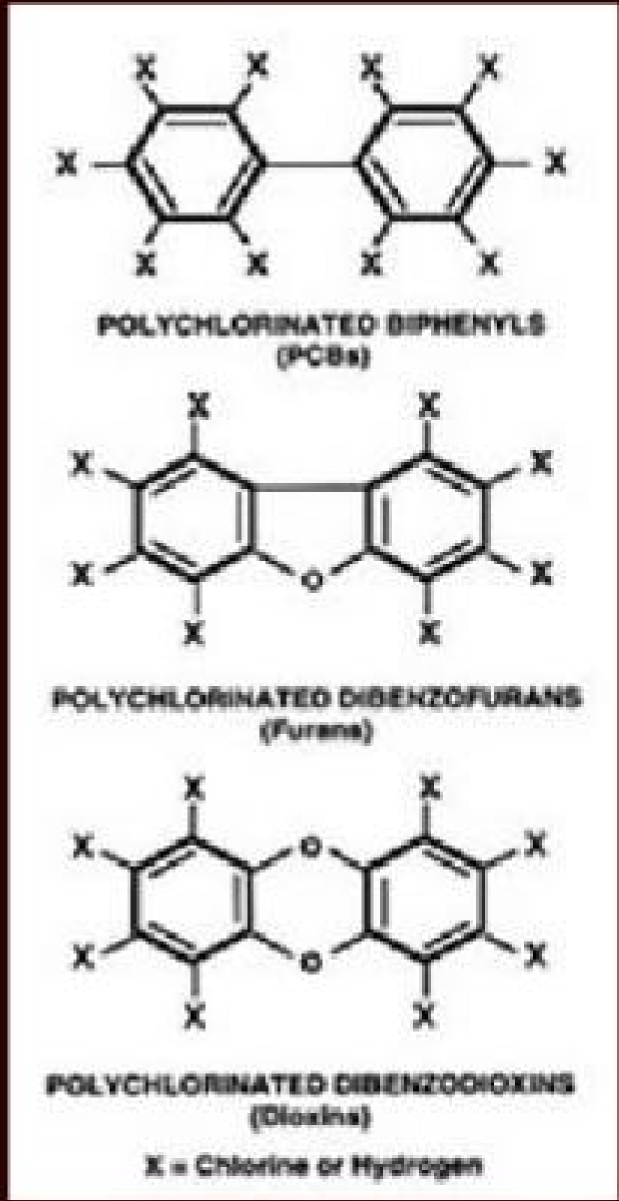
Clip slide

GAS CHROMATOGRAPHY- MASS SPECTROMETRY (GC-MS)


Gas chromatograp hy
+
Mass spectrometry
=
GC-MS
Separates mixture of components into individual
Identifies molecules based on their mass
A chemical analysis technique combining two instruments to provide for powerful separation & identification.

PCBs

- No known natural sources
- Belong to class of halogenated aromatic hydrocarbons
- Family of chemicals with biphenyl nucleus and varying number of chlorine atoms (1 – 10)
- 209 different congeners – chemical and toxicologic properties vary
- Toxicity varies with degree of chlorination and position of chlorine atoms



Toxic Effects Noted

- PCBs
  - Wide ranging and varying with species!
    - Endocrine disruption (Brouwer et al. 1989; Subramanian et al. 1987; Boon et al. 1992)
    - Immune suppression (Lahvis et al. 1995; Jepson et al. 1999)
    - Reproductive failure (Reijnders 1986)

Table 1. The 51 Compounds Analyzed Using the GC/MS/MS Method

1,2,4-Trichlorobenzene	p,p'-DDE	PCB 28
Hexachlorobutadiene	Dieldrin	PCB 52
Dichlobenil	o,p'-TDE	PCB 101
alpha-HCH	Endrin	PCB 118
beta-HCH	beta-Endosulphan	PCB 153
Hexachlorobenzene	p,p'-TDE	PCB 138
gamma-HCH	o,p'-DDT	PCB 180
delta-HCH	p,p'DDT	Cyfluthrin
Chlorothalonil	Methoxychlor	Cypermethrin
Heptachlor	Captan	Fenvalerate
Aldrin	EPTC	Deltamethrin
Isodrin	Tecnazene	Phorate
cic-Heptachlor Epoxide	Trifluralin	Tri-allate
trans-Heptachlor Epoxide	Disulphoton	Chlorpyritos-methyl
o,p'-DDE	Fenitrothion	Parathion-ethyl
alpha-Chlordane	cis-Permethrin	Chlorpyrifos-ethyl
alpha-Endosulphan	trans-Permethrin	Carbophenothion

2016
GCMS-TQ8050

S/N ≥ 40,000
IDL ≤ 0.5 fg

2014
GCMS-TQ8040

S/N ≥ 8,000
IDL ≤ 4 fg

2012
GCMS-TQ8030

S/N ≥ 5,000
IDL ≤ 6 fg

24

Clip slide

INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs) are widely distributed and relocated in the environment as a result of the incomplete combustion of organic matter. Many PAHs and their epoxides are highly toxic, mutagenic and/or carcinogenic to microorganisms as well as to higher systems including humans. Although various physicochemical methods have been used to remove these compounds from our environment, they have many limitations.

Trihalomethane

Trihalomethanes (THM) are a group of four chemicals that are formed along with other disinfection by products when chlorine or other disinfectants used to control microbial contaminants in **drinking water** react with naturally occurring organic and inorganic matter in **water**.

Chlorination

- the process of adding chlorine (Cl_2) or hypochlorite to water. This method is used to kill certain bacteria and other microbes in tap water as chlorine is highly toxic. In particular, chlorination is used to prevent the spread of waterborne diseases such as cholera, dysentery, and typhoid.

Chlorination

1- The process is economical and cheap .

2- It is harmless to human beings
.

3- It is reliable and effective .

4- Residual chlorine can be maintained in the water.

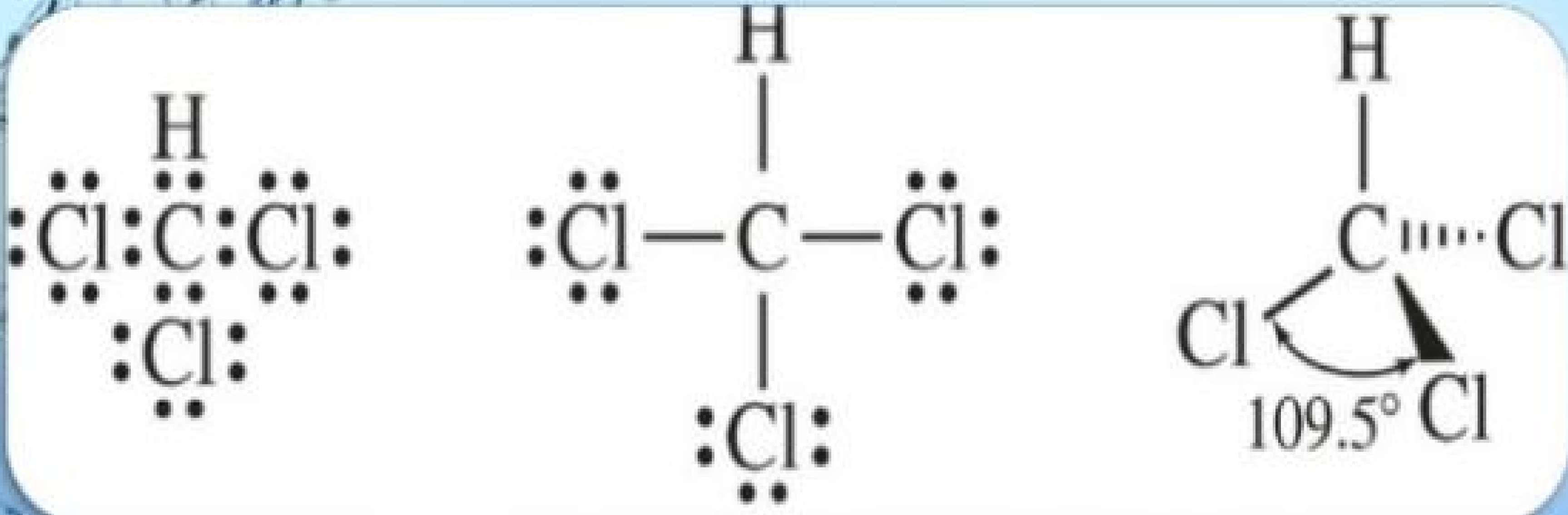
5- Easy to apply and ease to measure .

The THMs forming

When chlorine is added to water with organic material, such as algae, river weeds, and decaying leaves, THMs are formed. Residual chlorine molecules react with this harmless organic material to form a group of chlorinated chemical compounds, THMs. They are tasteless and odorless, but harmful and potentially toxic. The quantity of byproducts formed is determined by several factors, such as the amount and type of organic material present in water, temperature, pH, chlorine dosage, contact time available for chlorine, and bromide concentration in the water.

Trihalomethanes (THMs)

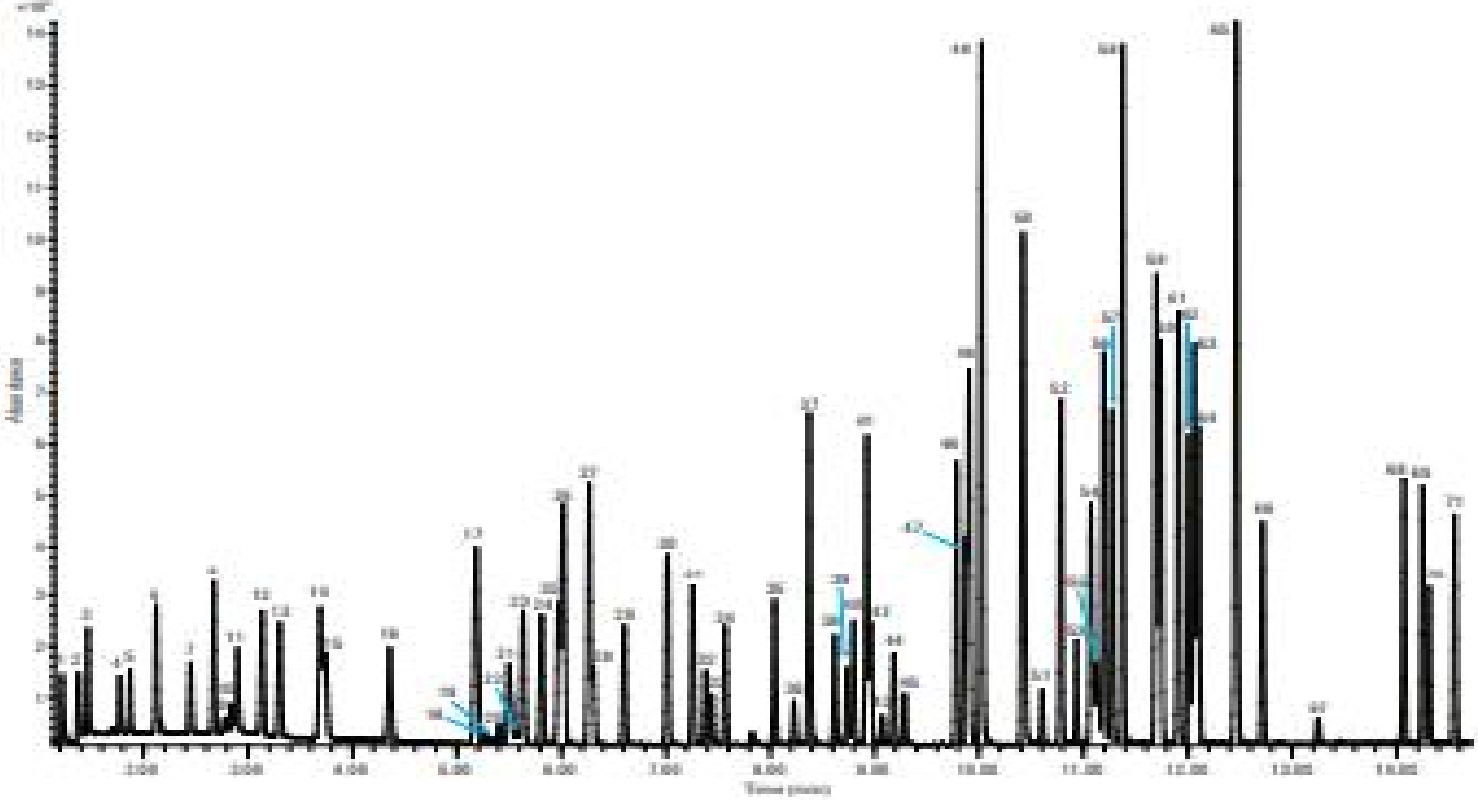
THMs are a class of chemical compounds derived from methane (CH_4) in which 3 of the 4 H atoms have been replaced by halogens Possibilities in drinking water include $CHCl_2Br$, $CHClBr_2$ and $CHBr_3$. But the most prevalent is chloroform, $CHCl_3$.



The Health Effects of THMs

	Compound	Adverse effects
THMS	$CHCL_3$	Cancer, liver, kidney and adversely affect the process of reproduction.
	$CHCLBr_2$	The kidney affects the nervous system, liver, kidney and reproduction.
	$CHCL_2Br$	Cancer, liver, kidney and affects the process of reproduction
	$CHBr_2$	Cancer, nervous system, liver, kidney


AQUATek
LVA
LUMIN
TO CONCENTRATOR
1
2
SYSTEM PRESSURE



1. Dichlorodifluoromethane
2. Chloromethane
3. Vinyl chloride
4. Bromomethane
5. Chloroethane
6. Trichlorofluoromethane
7. Diethyl Ether
8. 1,1-Dichloroethene
9. Acetone
10. Iodomethane
11. Carbon disulfide
12. Allyl chloride
13. Methylene chloride
14. Acrylonitrile, trans-1,2-dichloroethene
15. Methyl-tert-butyl ether (MTBE)
16. 1,1-Dichloroethane
17. 2,2-Dichloropropane, cis-1,2-Dichloroethene
18. 2-Butanone (MEK)
19. Propionitrile
20. Methyl acrylate
21. Bromochloromethane, Methacrylonitrile
22. THF
23. Chloroform
24. 1,1,1-Trichloroethane
25. 1-Chlorobutane
26. Carbon tetrachloride, 1,1-Dichloro-1-propene
27. Benzene
28. 1,2-Dichloroethane
29. Fluorobenzene
30. Trichloroethene
31. 1,2-Dichloropropane
32. Dibromomethane
33. Methyl methacrylate
34. Bromodichloromethane
35. cis-1,3-Dichloropropene
36. 1,1-Dichloropropanone, 2-Nitropropane, 4-methyl-2-pentanone (MIBK)
37. Toluene
38. trans-1,3-Dichloropropene
39. Ethyl methacrylate
40. 1,1,2-Trichloroethane
41. Tetrachloroethene
42. 1,3-Dichloropropane
43. 2-Hexanone
44. Dibromochloromethane
45. 1,2-Dibromoethane
46. Chlorobenzene
47. 1,1,1,2-Tetrachloroethane
48. Ethylbenzene
49. m+p-Xylene
50. o-Xylene, Styrene
51. Bromoform
52. Isopropylbenzene
53. Bromofluorobenzene
54. Bromobenzene, 1,1,2,2-Tetrachloroethane
55. 1,2,3-Trichloropropane, trans-1,4-Dichloro-2-butene
56. n-Propylbenzene
57. 2-Chlorotoluene
58. 1,3,5-Trimethylbenzene, 4-Chlorotoluene
59. tert-Butylbenzene
60. 1,2,4-Trimethylbenzene
61. sec-Butylbenzene
62. 1,3-Dichlorobenzene
63. p-Isopropyltoluene
64. 1,4-Dichlorobenzene
65. 1,2-Dichlorobenzene-d4, 1,2-Dichlorobenzene, n-Butylbenzene
66. Hexachloroethane
67. 1,2-Dibromo-3-chloropropane (DBCP)
68. 1,2,4-Trichlorobenzene
69. Hexachlorobutadiene
70. Naphthalene
71. 1,2,3-Trichlorobenzene

Radiological aspects:

Radioactivity should be as low as possible

Guideline values-

Gross alpha activity-0.5 Bq /L

Gross beta activity- 1.0 Bq /L

1Bq= 1 disintegration per second

Effects of radioactivity on water

Risks

- Damage to tissues
- Cells
- DNA and other vital molecules
- Cancer
- birth defects
- Abnormalities
- Death

NaturalNews.com

Natural radioactivity

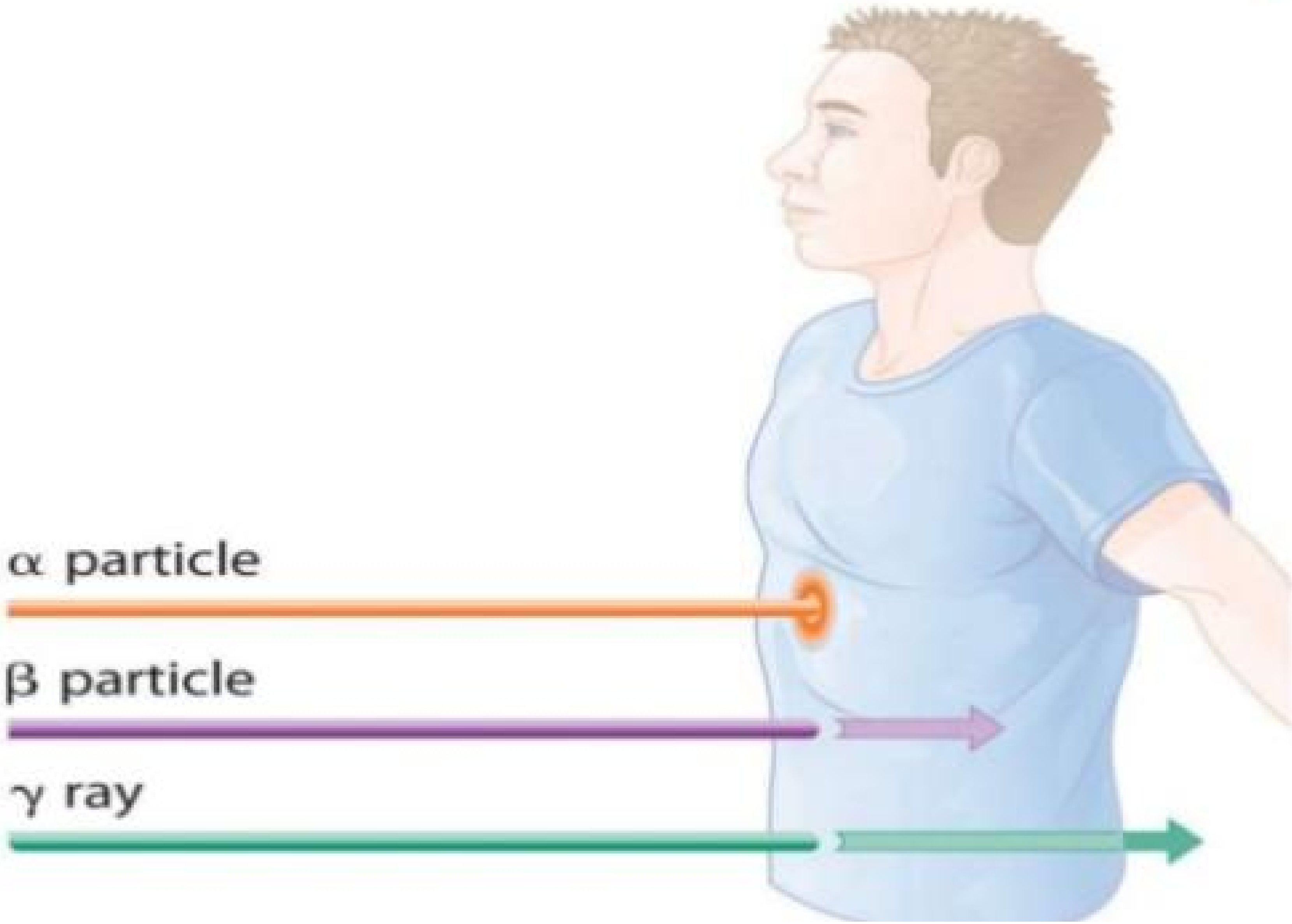
- The element whose nuclei spontaneous disintegrate are called *radioactive element*.
- Example of natural radioactivity are:-

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

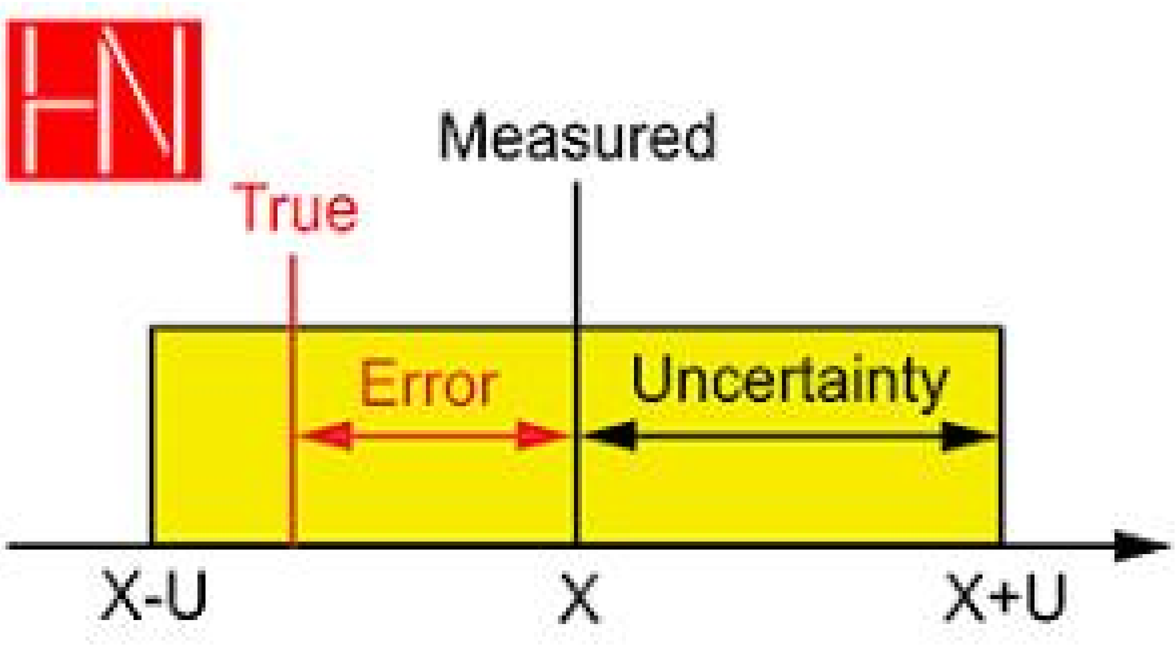
$$^{234}_{90}Th \longrightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e$$

$$^{226}_{88}Ra \longrightarrow {}^{222}_{86}Th + {}^{4}_{2}He$$

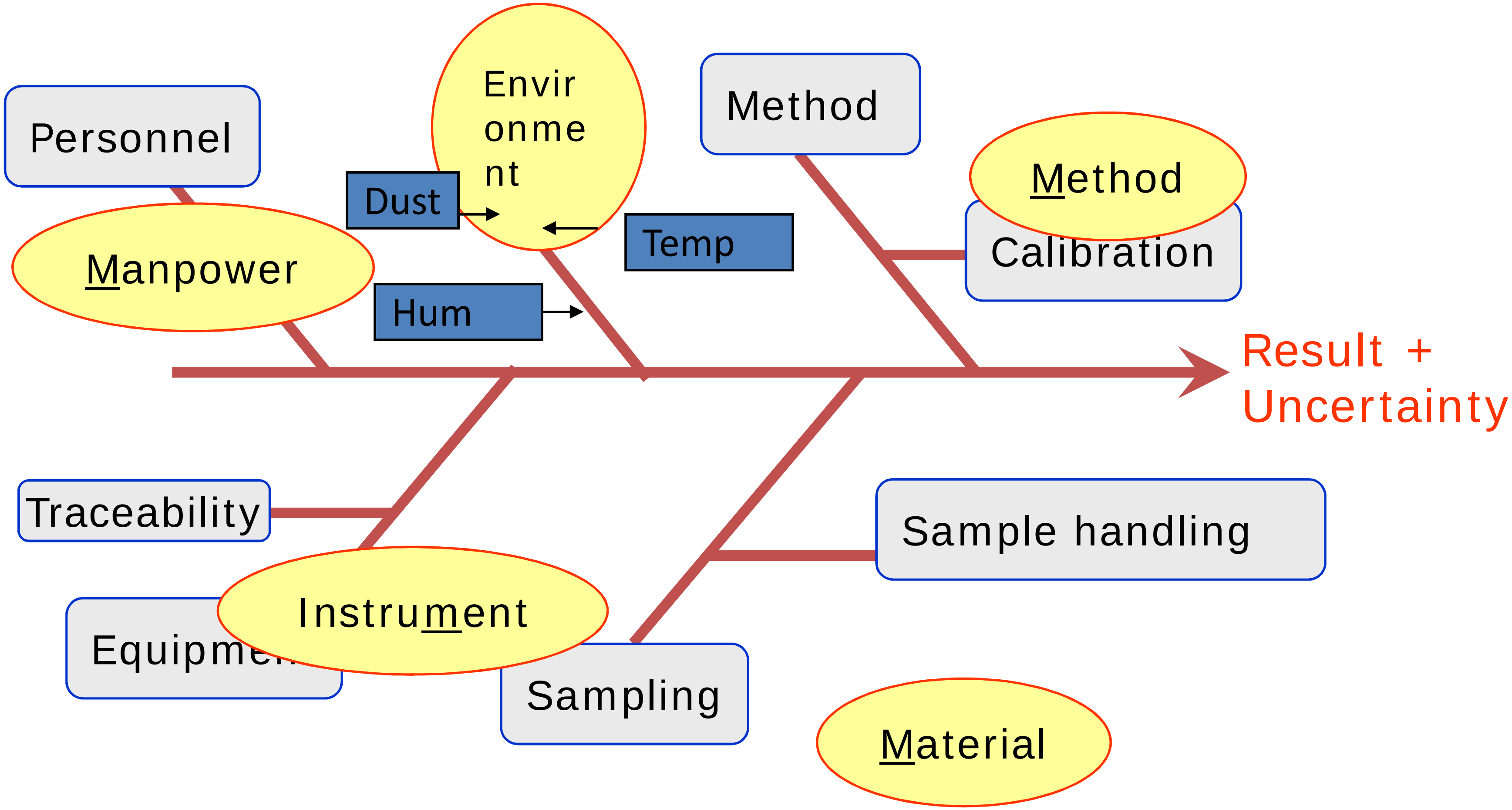
Radiation Penetration Ability



Evaluation of measurement uncertainty



Sources of uncertainty in analysis



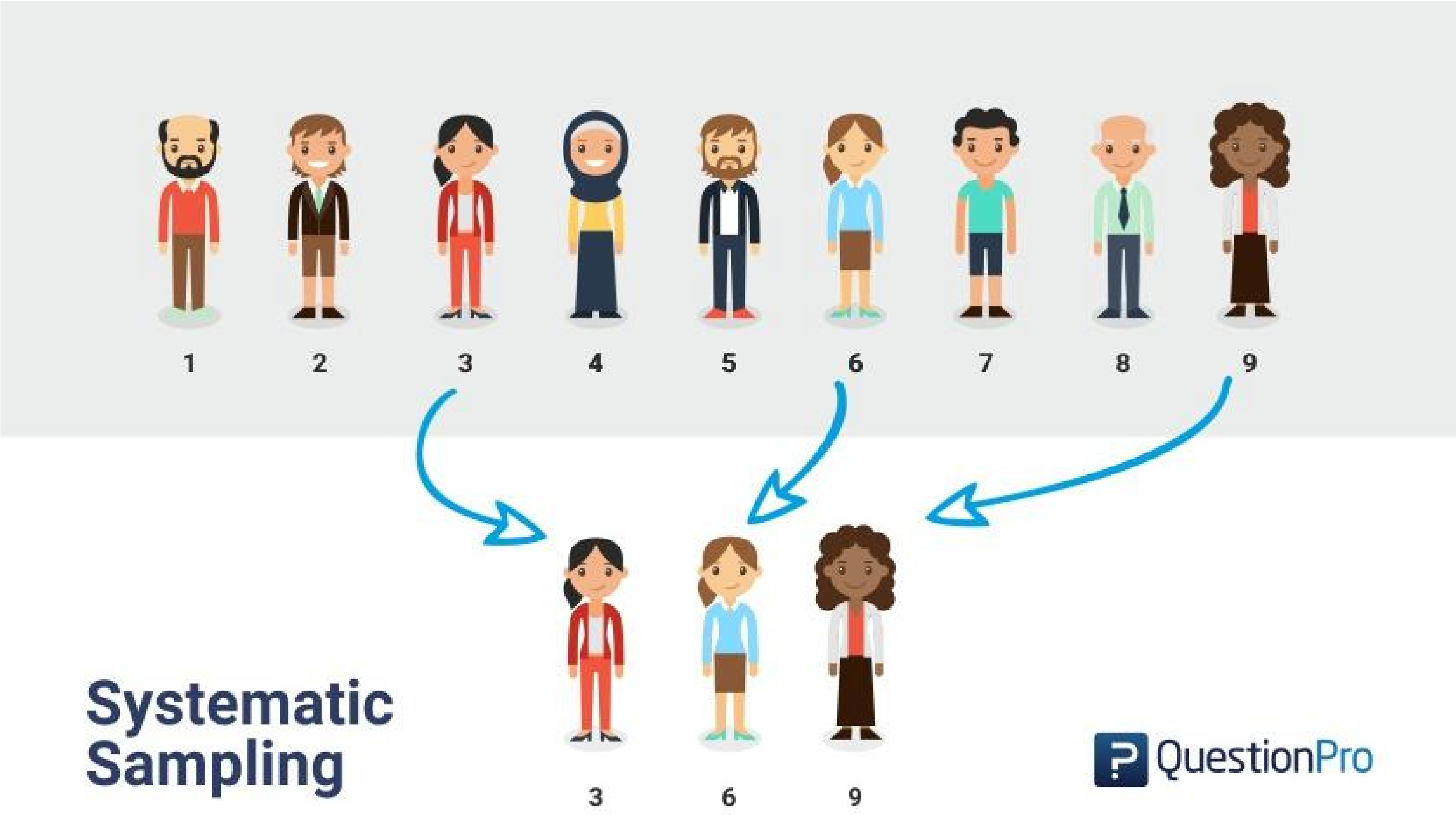
ii) MICROBIOLGICAL ASPECTS

- Bacteriological indicators
- Virological aspects
- Biological aspects

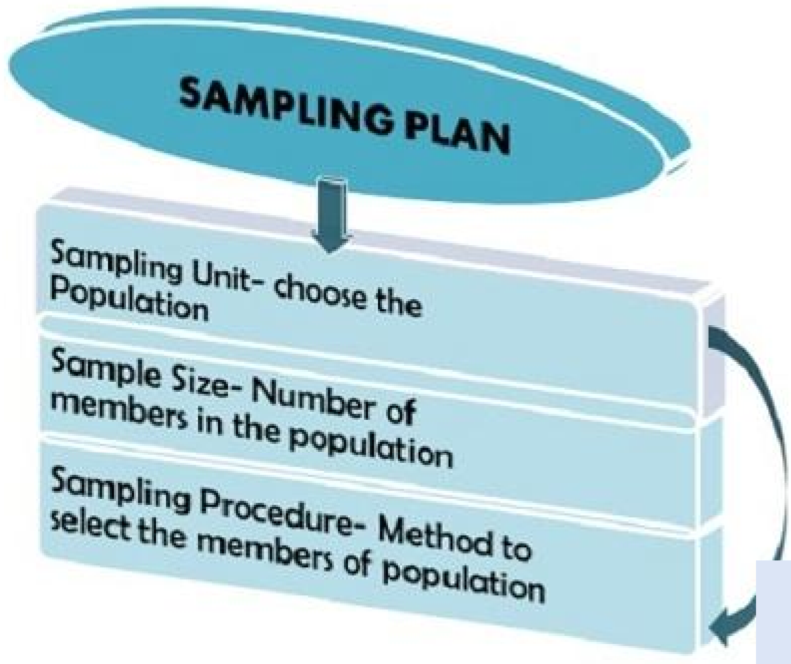
Bacteriological quality of drinking water

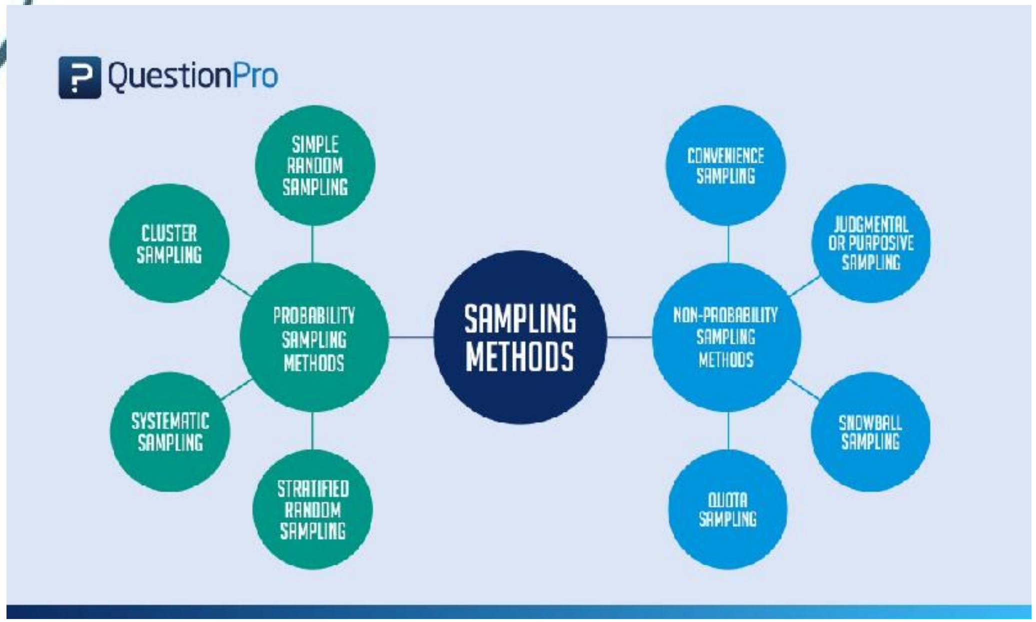
ORGANISMS	GUIDELINE VALUE
All water intended for drinking	Must not be detectable in any 100ml sample
Treated water entering distribution system (E.coli ,total coliform count)	Must not be detectable in any 100ml sample
Treated water entering distribution system (E.coli ,total coliform count)	Must not be detectable in any 100ml sample In c/o large supplies, must not be present in 95% of samples taken throughout any 12month period

6.Sampling



Sampling plan & methods





Laboratory involved in sampling must have:

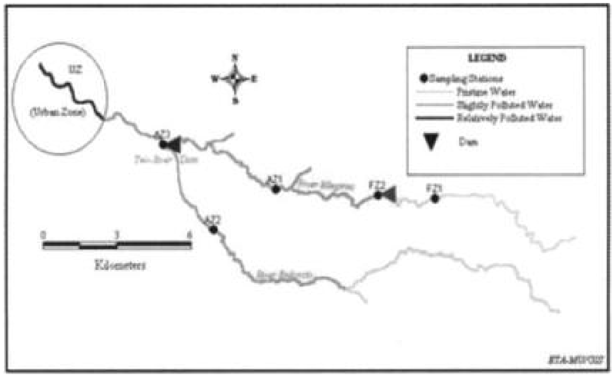
- ❖Sampling Plan.
- ❖SOP for sampling.
- ❖Work instruction for sampling.
- ❖Field data sheets.
- ❖Necessary PPE.
- ❖Sampling tools.
- ❖Specific pre washed Containers.
- ❖Preservatives.
- ❖Equipments and chemical for on site testing.
- ❖Sample storage facility.
- ❖Vehichle for transport of samples to the laboratory.

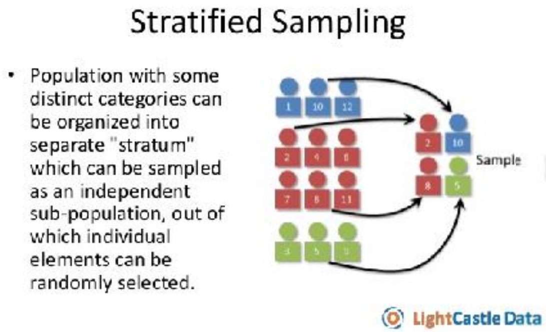
sampling method

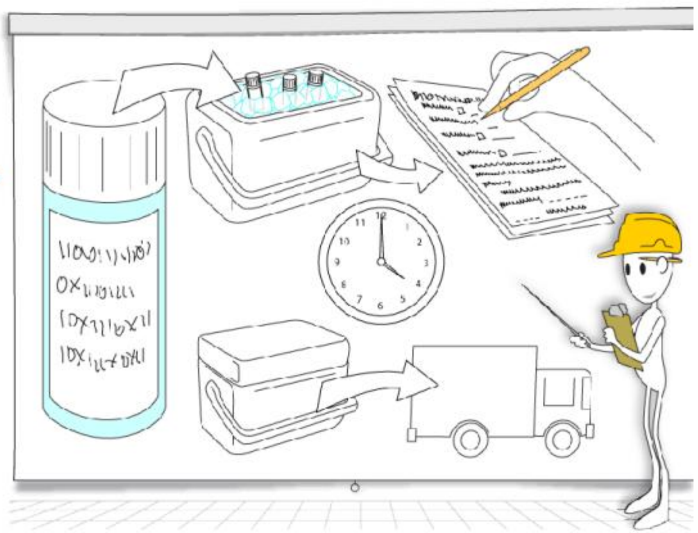
a) selection of samples or sites

b) sampling plan

c) preparation & treatment of samples







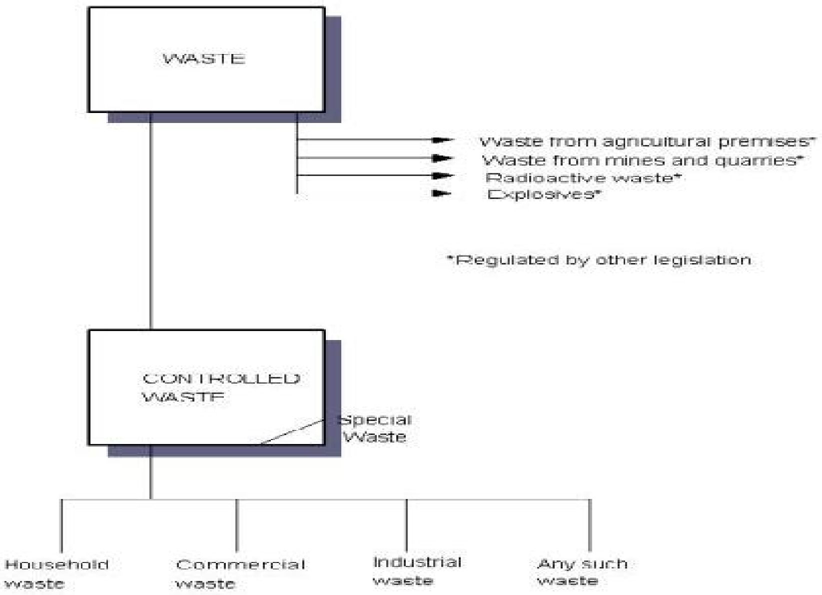
The laboratory shall retain records of sampling data that forms part of the testing or calibration that is undertaken. These records shall include, where relevant:

a	reference to the sampling method used;
b	date and time of sampling;
c	data to identify and describe the sample (e.g. number, amount, name);
d	identification of the personnel performing sampling;
e	identification of the equipment used;
f	environmental or transport conditions;
g	diagrams or other equivalent means to identify the sampling location, when appropriate;
h	deviations, additions to or exclusions from the sampling method and sampling plan.

7.Handling of Test Items

The laboratory shall have a procedure for the transportation, receipt, handling, protection, storage, retention, and disposal or return of test or calibration items, including all provisions necessary to protect the integrity of the test or calibration item,

Types of waste. A detailed explanation of the definition of waste can be found in Annex 2 of The Scottish Office Environment Department Circular 10/94



Source: The Scottish Office Statistical Bulletin, Waste Collection, Disposal and Regulation Statistics 1993 ISBN 0-7480-4936-3

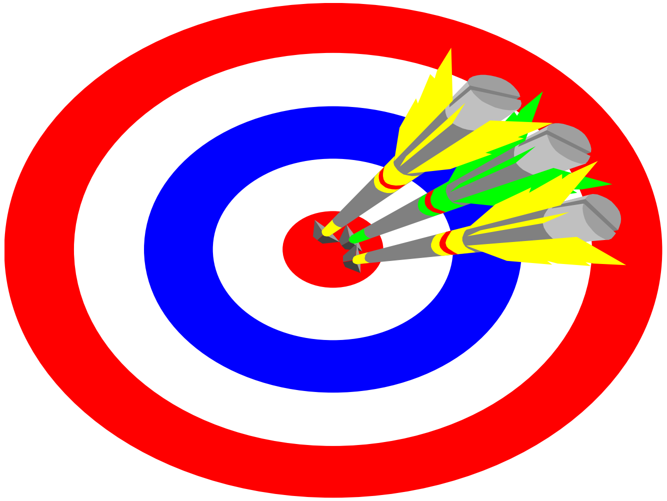
8.Ensuring the validity of results

Everyone makes mistakes!!


WHAT IS QUALITY CONTROL?
quality control
a process that helps a company make sure it creates quality products and that staff and management alike make minimal mistakes
Study.com

Quality ?

- Consistency
  - Accuracy
  - Precision
- Right result
  - First time
  - Every time

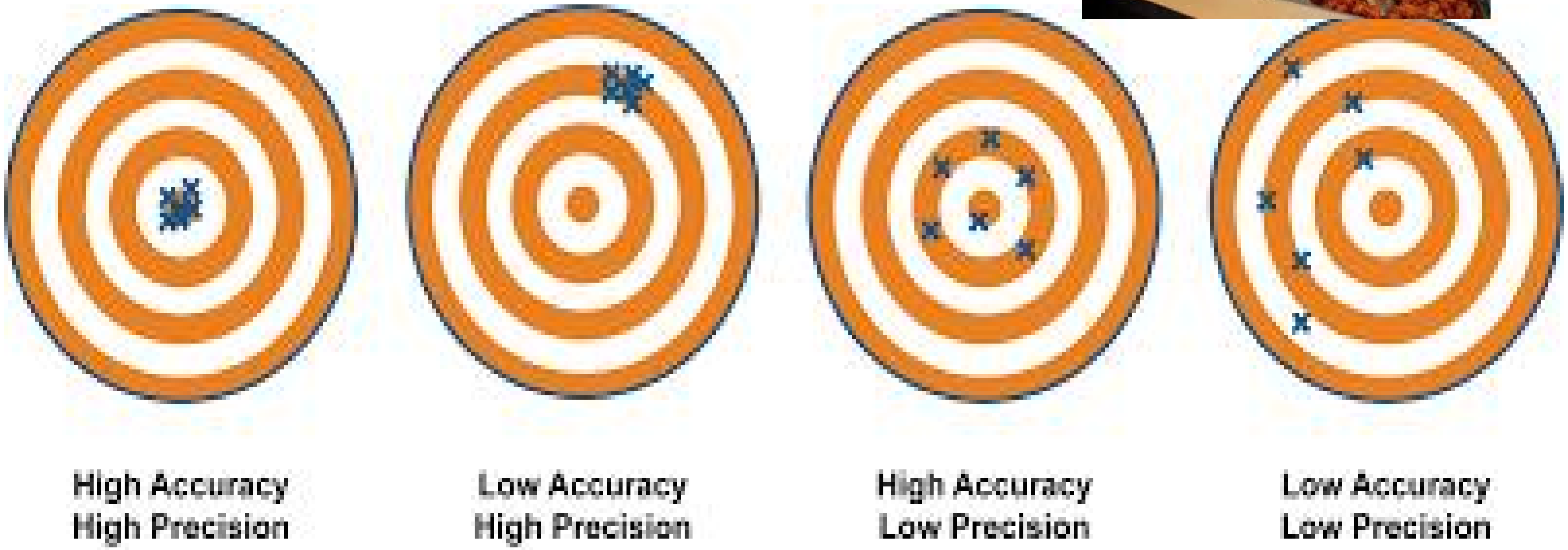


For getting confidence (Repeatability, retesting, recovery)

Home Examination of one section(Intra –Laboratory Comparison)

Examination of all sections of a class (ILC)

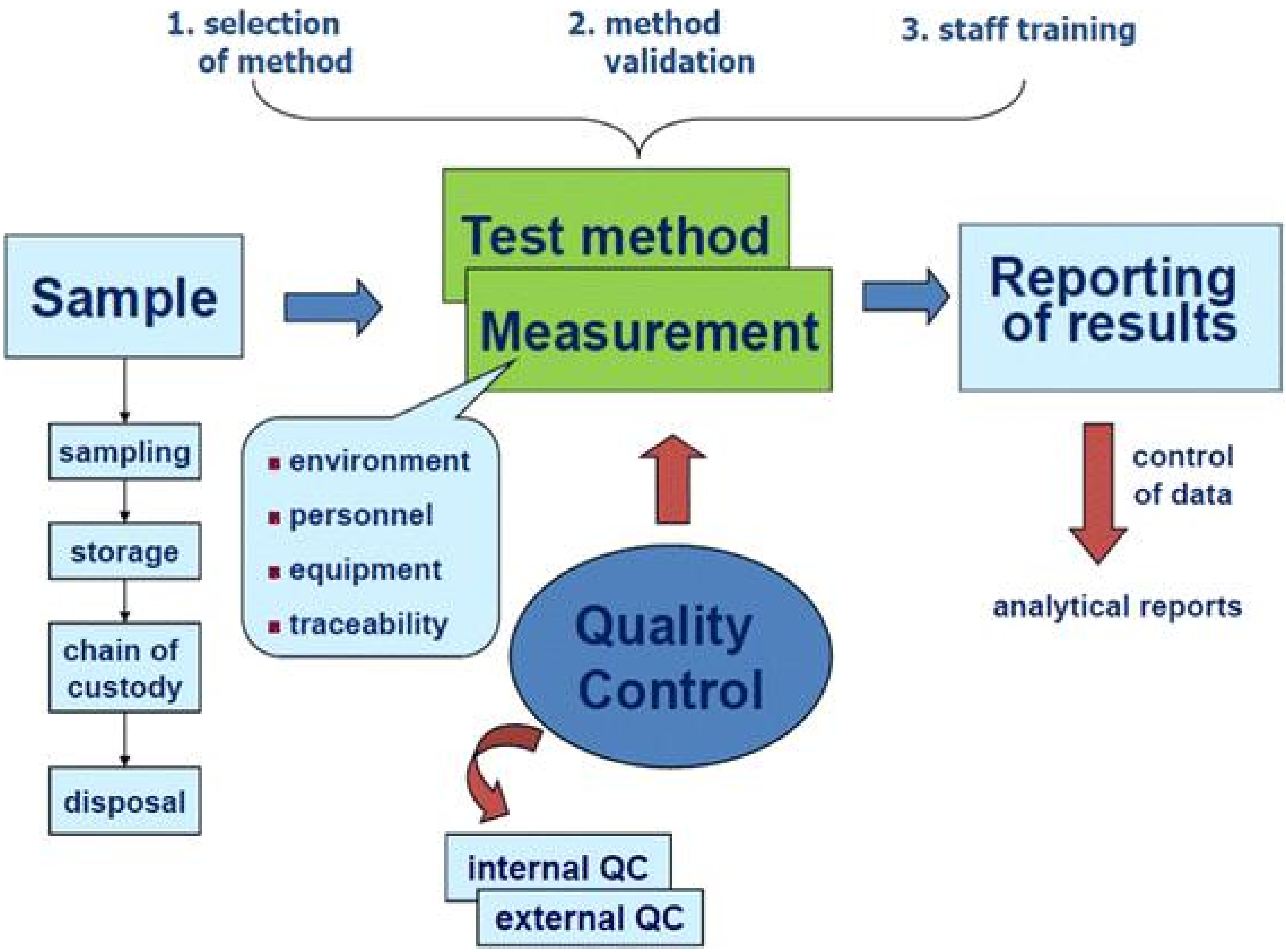
CBSE Board Examination (PT Participation)



Practice

Practice

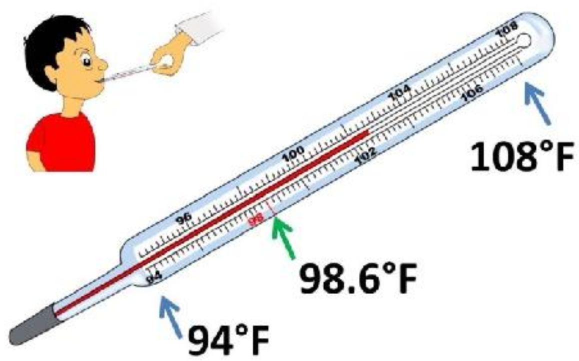
➢use of reference materials or quality control materials;
➢use of alternative instrumentation that has been calibrated to provide traceable results;
➢functional check(s) of measuring and testing equipment;
➢use of check or working standards with control charts, where applicable;
➢intermediate checks on measuring equipment;
➢replicate tests or calibrations using the same or different methods;
➢retesting or recalibration of retained items;
➢correlation of results for different characteristics of an item;
➢review of reported results;
➢intralaboratory comparisons;
➢testing of blind sample(s).


1. selection of method
2. method validation
3. staff training
Sample
Test method
Measurement
Reporting of results
sampling
storage
chain of custody
disposal
environment
personnel
equipment
traceability
Quality Control
internal QC
external QC
control of data
analytical reports

Day to day activities

Do you have fever?

Above 100°F IN 1940



100.6°F IN 1980

CALIBRATION CERTIFICATE OF

Digital Thermometer

Doctor Le Parco Medical Company

THE STANDARDS USED ARE TRACEABLE TO NATIONAL STANDARDS.

Calibration Results.

Value On UUC in °F	Actual Value Observed in °F	Correction in °F
98.6	98.44	-0.16
95.3	95.09	-0.21
100.1	99.68	-0.42
103.7	103.22	-0.48

Calibrated By :	Checked By :	Authorized By :
MANISHA CHAUBEY	JITENDER VERMA	SHAILESH UPADHYAY

100.6±0.005 °F IN 1990

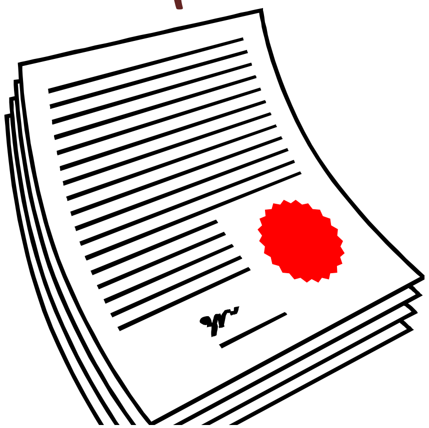
Quality Assurance vs. Quality Control

Quality Assurance

An overall management plan to guarantee the integrity of data (The "system")

Quality Control

A series of analytical measurements used to assess the quality of the analytical data (The "tools")



Factors influencing quality: Analytical

PROFICIENCY OF PERSONNEL:
Education, Training, Aptitude, Competence, Commitment, Adequate number, CME, Supervision, Motivation

REAGENTS STABILITY, INTEGRITY AND EFFICIENCY:
Stable, Efficient, Desired quality, Continuously available, Validated

EQUIPMENT RELIABILITY:
Meet technical needs, Compatible, User & maintenance friendly, Cost effective, Validated

USE OF APPROPRIATE CONTROLS:
- Internal: Labs, Calibrated against national
- External: Supplied by manufacturer, National, International

ANALYTICAL FACTORS

SPECIFICITY & SENSITIVITY OF SELECTED TEST:
Adequate ST, Sufficient SP, cost effective, compatible with, available infrastructure and expertise, interpretable, meets the needs/ objectives, validated

Procedural reliability using Standard Operating Procedures

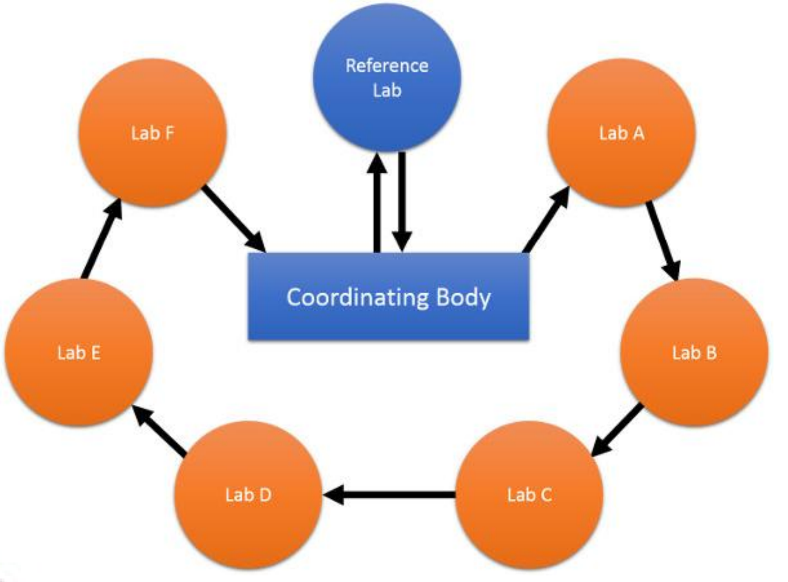
Assessment

DOCUMENTATION:
All the written policies, plans, procedures, instructions and records, quality control procedures and recorded test results involved in providing a service or the

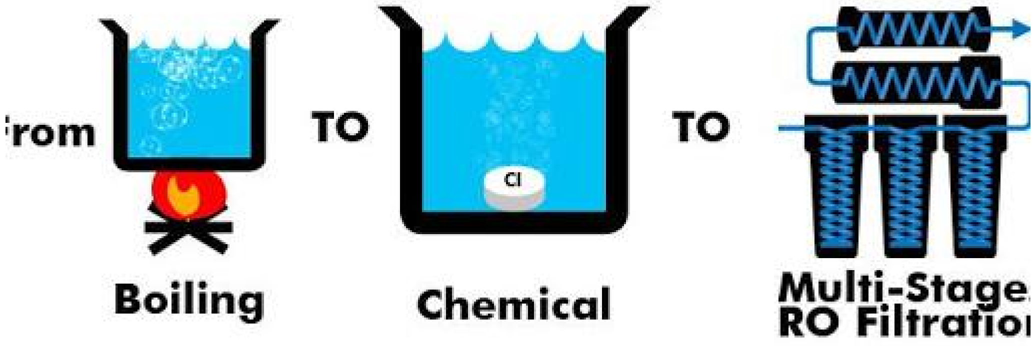
Monitor performance by comparison with other lab:

a) PT

b) Interlaboratory comparison



9.Reporting the Result



rom
TO
Cl
TO
Boiling
Chemical
Multi-Stage
RO Filtratio

Purification on Small Scale

BOILING: for 5-10 minutes kills almost all organisms & removes temporary Hardness.

DISTILLATION: not commonly used due to higher cost, used in Labs. etc.

ADDITION OF CHEMICALS

Bleaching Powder: 5% solution is used Dose: 3-6 drops/L contact time of ½ hour. Chlorine Tablets/Halazone Tablets. one tablet/litre.

Iodine Solution: 02 drops of 2% Soln./litre

$KMnO_4$: an amount that gives just pink coloration to the Water.

Alum: used for turbid water in a dose of 0.1-0.4 grains/5 litres of Water.

When sources of water are Rivers, Streams, Lakes etc. then water is Purified by

- Coagulation
- Sedimentation
- Filtration
- Disinfection
- Storage

When sources of water are wells, Springs, Tanks etc. Then water is purified by the addition of Bleaching powder/Chlorinated Lime as it is

- Cheep
- Easy to use
- Reliable and safe

. Filtration: ceramic filters –Pasteur Chamberland filter, Berkefeld filter, Katadyn filter.

Main part is candle (porcelin /infusorial earth)

In Katadyn: Surface covered with silver catalyst, bact. destroyed in contact with silver ion (oligodynamic action)

can remove bact. Not virues

4. <u>Ultraviolet irradiation</u>: can destroy bact. Viruses, yeast, fungi, algae, protozoa

- Mercury vapor arc lamps emitting UV rays at a wave length of 254 nano mt
- Water should be free from turbidity/ colloidal suspended constituents
- Short exposure required, no foreign matter added, no taste /odour change
- No residual effect

. <u>Multistage Reverse osmosis purification of water</u>:

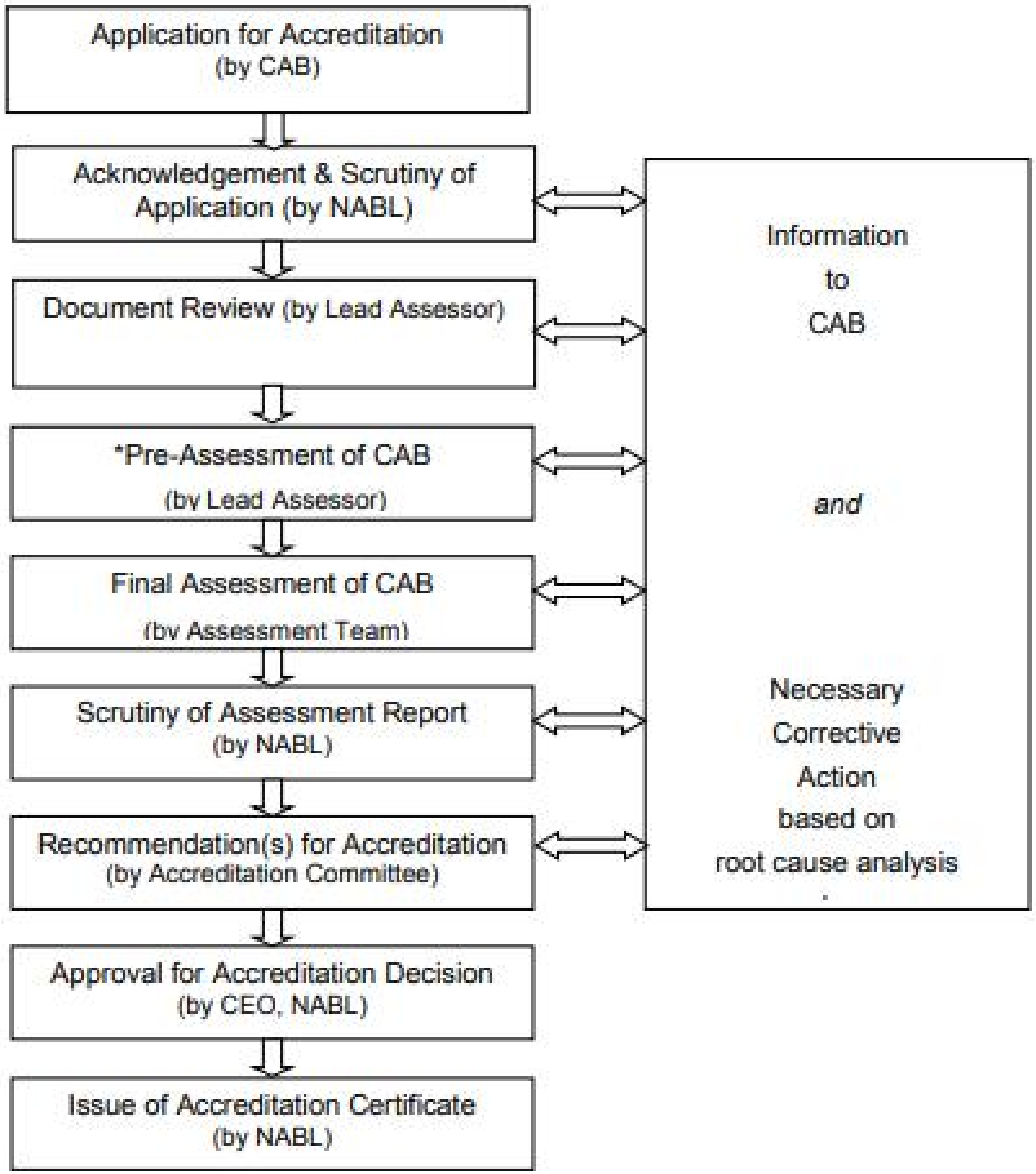
Remove total dissolved solid, hardness, heavy metals, bacteria, viruses, protozoa, cysts.

Clarity cartridge removes suspended particles (dust/mud/sand)

The reverse osmosis cartridge removes dissolved solid/hardness/heavy metals/ micro organism.

For biological impurities like bacteria or viruses in the **water**, then an ultra violet (UV) **filter** can be used. If only chemical properties are bad — like the presence of TDS — then an **RO** is **necessary**,”

ACCREDITATION PROCESS



National Accreditation Board for Testing and Calibration Laboratories
(A Constituent Board of Quality Council of India)

CERTIFICATE OF ACCREDITATION

CHENNAI METTEX LAB PVT. LTD.

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

'General Requirements for the Competence of Testing & Calibration Laboratories'
and fulfills the requirements of EIC, FSSAI, APEDA, Tea Board & IOPEPC
for its facilities at

Jothi Complex, No. 83, MKN Road, Guindy, Chennai,
Tamil Nadu

in the field of

TESTING

Certificate Number TC-5589 (Integrated)
Issue Date 27/08/2019 Valid Until 15/06/2021

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Signed for and on behalf of NABL

N. Venkateswaran
Chief Executive Officer

Without a Laboratory Quality System -

too many mistakes can make analysis very costly; due to

costs of analysis

expenses caused by wrong decisions, or

- repeating analysis of samples
- investigation of problems
- revision of procedures
- loss of good reputation

Prevention is Better than cure!

'It costs less to prevent a problem than it does to correct it'

A formal quality system in the laboratory should prevent mistakes by means of:

- quality assurance measures
- quality control of the analytical results
- thorough documentation of the system
- efficient maintenance of records
- regular audits of all aspects of the system

House wife has solution of problems

Analyst has solution of chemicals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Thank you...

-----For your Kind attention