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Handbook of Biochemistry Spotting



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Chapter 2

Laboratory Equipment

Laboratory equipment is generally used to either perform an investigation or to take measurements and gather data. Clinical biochemical tests comprise over one-third of all hospital laboratory investigations. Thousands of tests are carried out in clinical biochemistry laboratories varying from very simple tests such as urine analysis, to the highly complex, such as DNA analysis. It is therefore extremely essential for the students embarking on the journey of biochemistry to be well versed with the laboratory equipment.

The introduction offered in this chapter aided by the visuals, highlighting the principle, procedure and applications of various equipment would facilitate the pupils understand the core concepts of the biochemical and related clinical investigations.

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10. Automated analyzer
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12. Enzyme-linked immunosorbent assay (ELISA) microplate reader
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16. Magnetic stirrer
17. Laboratory tabletop centrifuge
18. Laboratory incubator
19. Compact random access automatic biochemistry analyzer
20. Alcohol sensor
21. Laboratory hot water bath
22. Respiratory rate sensor
23. Pulse oximeter
24. Polymerase chain reaction (PCR) machine
25. Urine test strips

COMMONLY USED LABORATORY EQUIPMENT

Instruments	Details
	**1. Blood gas analyzer-blood gas analysis (BGA)** test is used to determine the pH of the blood, the partial pressure of carbon dioxide (PCO_2) and oxygen (PO_2), and the bicarbonate level. Many blood gas analyzers also measure concentrations of lactate, hemoglobin, several electrolytes, oxyhemoglobin, Carboxyhemoglobin and methemoglobin. Arterial blood gas (ABG) testing is mainly used in pulmonology and critical care medicine to determine gas exchange across the alveolar-capillary membrane. The values obtained guide in determining the underlying acid base imbalance.
	**2. HPLC apparatus—**High-performance liquid chromatography (sometimes referred to as high-pressure liquid chromatography), HPLC, is a chromatographic technique used to separate a mixture of compounds in analytical chemistry and biochemistry with the purpose of identifying, quantifying or purifying the individual components of the mixture. HPLC has many uses including medical, legal, research (e.g. separating the components of a complex biological sample, or of similar synthetic chemicals from each other), and manufacturing (e.g. during the production process of pharmaceutical and biological products).

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3. Gamma counter — A Gamma counter is a machine to measure gamma radiation emitted by a radionuclide. Gamma counters are used in radiobinding assays and in radioimmunoassays (RIA).
RIA is a very sensitive in vitro assay technique used to measure concentrations of antigens (for example, hormone levels in the blood) by use of antibodies. As such, it can be seen as the inverse of a radiobinding assay, which quantifies an antibody by use of corresponding antigens.



4. Urine testing using the Clinitek 50 (Paper strips) — Quick way of analyzing the urine sample. Bedside procedure for the critically ill patients. The operator's time is only 10 seconds.



5. A glucose meter (or glucometer) is a medical device for determining the approximate concentration of glucose in the blood. It is a key element of home blood glucose monitoring (HBGM) by people with diabetes mellitus or hypoglycemia. A small drop of blood, obtained by pricking the skin with a lancet, is placed on a disposable test strip that the meter reads and uses to calculate the blood glucose level. The meter then displays the level in mg/dL or mmol/L. The benefits include a reduction in the occurrence rate and severity of longterm complications from hyperglycemia as well as a reduction in the short-term, potentially life-threatening complications of hypoglycemia.

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6. Digital pH meter is an electronic device used for measuring the pH (acidity or alkalinity) of a liquid. A typical pH meter consists of a special measuring probe (a glass electrode) connected to an electronic meter that measures and displays the pH reading.



7. Handheld pH meter for measurement of pH of biological fluids.



8. A colorimeter is a device used in colorimetric procedures; the word colorimeter refers to the device that measures the absorbance of particular wavelengths of light by a specific solution. This device is most commonly used to determine the concentration of a known solute in a given solution by the application of the Beer-Lambert law, which states that the concentration of a solute is proportional to the absorbance.



9. Semi-auto chemistry analyzer—The auto analyzer is an automated analyzer using a special flow technique named continuous flow analysis (CFA), The instrument is easy to use. It can store multiple tests parameters. Many programs, such as liver function determination, Kidney function determination, lipids, glucose and ion test, etc. can be tested on the machine to meet the clinics and hospitals' need.

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10. An automated analyzer is a medical laboratory instrument designed to measure different chemicals and other characteristics in a number of biological samples quickly, with minimal human assistance. Samples can be processed singly, in batches, or continuously. The testing time for many analytes is reduced to minutes. The chances of manual errors are reduced. The reagent volume used per test is less and they can be easily operated.



11. A spectrophotometer is commonly used for the measurement of transmittance or reflectance of solutions. The most common spectrophotometers are used in the UV and visible regions of the spectrum and some of these instruments also operate into the near-infrared region as well.
Visible region 400–700 nm spectrophotometery is used extensively in colorimetric procedures.



12. ELISA microplate reader — ELISA is a test that uses antibodies and color change to identify a substance. ELISA uses a solid-phase enzyme immunoassay (EIA) to detect the presence of a substance, usually an antigen, or an antibody in a sample; it is a useful tool for determining serum antibody concentrations such as in the HIV test and in many other viral infections. It has also found applications in the food industry in detecting potential food allergens. ELISA can also be used in toxicology as a rapid presumptive screen for certain classes of drugs and for the estimation of biomolecules in the biological fluids which are present in very small concentration.

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13. A photoelectric flame photometer is a device used in inorganic chemical analysis to determine the concentration of certain metal ions, among them sodium, potassium, lithium, and calcium.
In principle, it is a controlled flame test with the intensity of the flame color quantified by photoelectric circuitry. The intensity of the color will depend on the energy that had been absorbed by the atoms that was sufficient to vaporize them. The sample is introduced to the flame at a constant rate. Filters select which colors the photometer detects and exclude the influence of other ions.



14. The insulin pump is a medical device used for the administration of insulin in the treatment of diabetes mellitus, also known as continuous subcutaneous insulin infusion therapy.
An insulin pump is an alternative to multiple daily injections of insulin by insulin syringe or an insulin pen and allows for intensive insulin therapy when used in conjunction with blood glucose monitoring.



15. Digital weighing scale is a measuring instrument for determining the weight or mass of an object.

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16. A magnetic stirrer or magnetic mixer is a laboratory device that employs a rotating magnetic field to cause a stir bar immersed in a liquid to spin very quickly, thus stirring it. The rotating field may be created either by a rotating magnet or a set of stationary electromagnets, placed beneath the vessel with the liquid. Since glass does not affect a magnetic field appreciably (it is transparent to magnetism), and most chemical reactions take place in glass vessels, magnetic stir bars work well in glass vessels. Magnetic stirrers may also include a hot plate or some other means for heating the liquid.



17. A laboratory tabletop centrifuge — A centrifuge is a piece of equipment, generally driven by an electric motor that puts an object in rotation around a fixed axis, applying a force perpendicular to the axis. The centrifuge works using the sedimentation principle, where the centripetal acceleration causes denser substances to separate out along the radial direction (the bottom of the tube).
Simple centrifuges are used in chemistry, biology, and biochemistry for isolating and separating suspensions. They vary widely in speed and capacity.



18. Laboratory Incubator — The incubator maintains optimal temperature, humidity and other conditions such as the carbon dioxide (CO_2) and oxygen content of the atmosphere inside. Incubators are essential for a lot of experimental work in cell biology, microbiology and molecular biology and are used to culture both bacterial as well as eukaryotic cells.
The simplest incubators are insulated boxes with an adjustable heater, typically going up to 60 to 65°C (140 to 150°F), though some can go slightly higher (generally to no more than 100°C).

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19. Compact random access automatic biochemistry analyzer — Random access analyzer conceived to fill the gap existing between the semi-automatic analyzers and the fully automatic instruments. Suitable for the small and medium size laboratory, and is also cost effective.
Allows 120 tests/hour, tray for loading of 80 samples and a refrigerated compartment for storage of 20 reagents.



20. Alcohol Sensor — Digital breath alcohol detector displays blood alcohol concentration (BAC) percentage in seconds.
It is used to detect hidden alcoholics.
It is basically a breathalyzer.



21. Laboratory hot water bath — Laboratory, utility water baths are used for maintaining a temperature set points over a long period of time. Different size and depth of the bath chamber are available to meet most requirements. They provide digital temperature control with a ranges from ambient to 100°C.

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22. Respiratory rate sensor — To measure the breath rate in accordance with the respiratory airflow and pressure changes.



23. Pulse oximeter — To measure pulse rate and the percentage of hemoglobin saturated with O_2.



24. PCR Machine — The thermal cycler (also known as a thermocycler, PCR machine or DNA amplifier) is a laboratory apparatus used to amplify segments of DNA via the polymerase chain reaction (PCR) process.

The PCR is a biochemical technology in molecular biology to amplify a single or a few copies of a piece of DNA across several orders of magnitude, generating thousands to millions of copies of a particular DNA sequence.

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25. Urine test strips — 10 different substances in urine can be detected. Easy, quick and bed side procedure.

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Namrata Chhabra MD is a specialist of medical biochemistry with a work experience of around 31 years. She has worked at Government Medical College, Amritsar, Punjab, India; with the Ministry of Health and Medical Education, Iran, and is currently working as a Principal-in-charge, Professor and Head, Department of Biochemistry at Sir Seewoosagur Ramgoolam (SSR) Medical College, Mauritius. She has to her credit a multitude of research publications, award-winning presentations and professional laurels. She is a life member of various professional organizations and is also a faculty, editor, scholarly reviewer and member advisory board of various peer-reviewed journals. She has carved a niche with her simplified yet thought-provoking teaching by virtue of her expertise in teaching field. Serving the adjective of a kind teacher with stern principles, she is heard from her students as a strict scheduler when it comes to academic excellence. She prides herself on skillful diligent planning and cares deeply about the student's conceptual understanding and learning experience. Her first book: *A Case Oriented Approach Towards Biochemistry*, published by M/s Jaypee Brothers Medical Publishers, New Delhi, India, has received huge accolades from the students and faculty all over the world. She is moving with a mission to make biochemistry simple, interesting and meaningful.



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