NIKOLOZ SHAKULASHVILI

# Introduction in Biomedical Laboratory Work and Equipment

**Purpose**
**Description**
**Use**
**Operating principle**

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*To Ekaterina, Sophia and Alexander*

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# Annotation

The book is designed to give readers information on the pieces of most important modern general equipment for laboratories, describe their purpose, scope, and operational principles and provide technical specifications.

This publication aims to strengthen competences and form both theoretical knowledge and practical skills of how to use, maintenance, service and carrying out minor repairs of laboratory instruments for qualified and accurate sample preparation, as well as for precise analyses and to provide valid measurement procedures. Studying the structure of the equipment, the principle of operation, application and the tasks they perform is also an important goal of this publication. The devices discussed are essential components of equipment for various types of laboratories, including medical, biomedical, diagnostic, dentistry, pharmacy and forensic laboratories and institutions, research centers, veterinary clinics, chemical, biological, cosmetic, and pharmaceutical facilities, blood centers, mining and processing enterprises, testing and calibration laboratories, certification and supervisory authorities, food industry companies, universities, colleges, and so forth.

This publication is intended for students of universities, higher education institutions, and colleges in the fields such as medicine, biomedicine, pharmacy, dentistry, chemistry, biology, biochemistry, microbiology, biotechnology, chemical technology, petrochemistry, laboratory work. It may also be useful for students in other disciplines, particularly in ecology, geology, new materials, modern technologies and related areas. Additionally, it will be of interest to postgraduate students, residents, teachers and laboratory assistants, including those in laboratory medicine.

Many laboratories utilize multiple types of equipment, so before ordering and purchasing a device, it is important to consider the specific tasks laboratory research involves.  Selecting the appropriate laboratory instruments for specific applications is crucial for ensuring accurate results and reliable operations. I think, the present book can be helpful for proper choice.

# Preface

The idea behind this collection of works was to collect information on the pieces of most important modern general equipment for laboratories, describe their purpose, scope, and operational principles and provide technical specifications. The book is designed to give readers an understanding of the general equipment that a laboratory in a specific field and for a particular purpose may be equipped with. Naturally, it is impossible to cover all pieces of such equipment and devices in a single publication, but those included here are among the most commonly used and I believe, will capture readers' interest.

This publication aims to strengthen competences and form both theoretical knowledge and practical skills of how to use, maintenance, service and carrying out minor repairs of laboratory instruments for qualified and accurate sample preparation, as well as for precise analyses and to provide valid measurement procedures. Studying the structure of the equipment, the principle of operation, application and the tasks they perform is also an important goal of this publication. The devices discussed are essential components of equipment for various types of laboratories, including medical, biomedical, diagnostic, dentistry, pharmacy and forensic laboratories and institutions, research centers, veterinary clinics, chemical, biological, cosmetic, and pharmaceutical facilities, blood centers, mining and processing enterprises, testing and calibration laboratories, certification and supervisory authorities, food industry companies, universities, colleges, and so forth.

Many laboratories utilize multiple types of equipment, so before ordering and purchasing a device, it is important to consider the specific tasks laboratory research involves and to consult manufacturers or distributors. Selecting the appropriate laboratory instruments for specific applications is crucial for ensuring accurate results and reliable operations. Before installing or operating any devices, it is mandatory to read the "operational manual" and accompanying documents. First of all, you should familiarize yourself with the safety rules.

This publication is intended for students of universities, higher education institutions, and colleges in the fields such as medicine, biomedicine, pharmacy, dentistry, chemistry, biology, biochemistry, microbiology, biotechnology, chemical technology, petrochemistry, laboratory work. It may also be useful for students in other disciplines, particularly in ecology, geology, new materials, modern technologies and related areas. Additionally, it will be of interest to postgraduate students, residents, teachers and laboratory assistants, including those in laboratory medicine.

The book is richly illustrated. The illustrations are selected based on the principle of analogy to the devices described in the book. The author thanks the equipment manufacturing companies **OLIS** (Ukraine, https://olis.com.ua), **RADWAG** (Poland, https://radwag.com), **Biosan** (Latvia, https://biosan.lv), **BOECO** (Germany, https://www.boeco.com), **Witeg** (Germany, https://www.witeg.de), **C. Gerhardt GmbH & Co. KG** (Germany, https://www.gerhardt.de), **Retsch** (Germany, https://www.retsch.com), **Berghof** (Germany, https://www.berghof.com), **Martin Christ Gefriertrocknungsanlagen GmbH** (Germany, https://www.martinchrist.de), **Hercuvan Lab. Systems** (UK, Malaysia, https://hercuvan.com/), **Microlit** (USA, www.microlit.com), **HOMMAK** (Turkey, www.hommak.com) and **AHN Biotechnologie GmbH** (Germany, www.ahn-bio.com) for kindly granting permission to include images of their products and other schemes in this book. Some diagrams and photos were sourced from freely available online sources.

The reader should bear in mind that the equipment discussed and displayed in this book may vary visually and in design depending on the manufacturer. This is the first book in the series and covers general laboratory equipment. The next volume will focus on measuring instruments and analyzers for performing a wide range of tasks. The idea for this book's publication was proposed on behalf of the laboratory of biomedicine, where the author works, and was supported by the School of Medicine at the University of Georgia. The book partially reflects the materials of lectures given to students of the School of Medicine.

*Tbilisi, 2025*

*Nikoloz Shakulashvili*

# Symbols, Abbreviation List and Unit Convertor

*(to be found in present issue)*

| | | | | |
|---|---|---|---|---|
| °C | – | grad Celsius | – | unit of temperature on the Celsius temperature scale in the International System of Units (SI) |
| cm | – | centimeter | – | unit of length in the International System of Units (SI) |
| g | – | gram | – | unit of mass in the International System of Units (SI) |
| kHz | – | kilohertz | – | unit of frequency equal to $10^3$ Hertz |
| kW | – | kilowatt | – | unit of power or radiant flux equal to $10^3$ Watt |
| l | – | liter | – | unit of volume in the International System of Units (SI) |
| $m^3/h$ | – | cubic meter in 1 hour | – | volumetric flow rate |
| $\mu$l | – | microliter | – | unit of volume equal to $10^{-6}$ liter |
| $\mu$S/cm | – | microsiemens per centimeter | – | unit in the category of electric conductivity |
| mbar | – | millibar | – | metric unit of pressure equal to $10^{-3}$ bar |
| mg | – | milligram | – | unit of mass equal to $10^{-3}$ gram |
| ml | – | milliliter | – | unit of volume equal to $10^{-3}$ liter |
| mm | – | millimeter | – | unit of length equal to $10^{-3}$ meter |
| MPa | – | megapascal | – | unit of pressure equal to $10^6$ Pascal |
| m/S | – | meter per second | – | unit of both speed and velocity |

| | | | | |
|---|---|---|---|---|
| MΩ/cm | – | MΩ per centimeter | – | (a MΩ, or Mho, or Megohm is the multiplicative inverse of an ohm).<br>unit of electrical resistivity (water quality indicator for the concentration of ions) |
| Pa | – | Pascal | – | unit of pressure in the International System of Units (SI) |
| psi | – | Pound per square inch | – | unit of pressure |
| rpm | – | rpm | – | unit of rotational speed (or rotational frequency) |
| ω/min | – | oscillation/min | – | repeated movement from one position to another per min |

| | | |
|---|---|---|
| DNA | – | Deoxyribonucleic acid |
| GC | – | Gas Chromatography |
| HEPA | – | High-efficiency particulate air (type of filter) |
| HPLC | – | High-performance liquid chromatography |
| PCR | – | Polymerase chain reaction |
| PTFE | – | Polytetrafluoroethylene |
| RNA | – | Ribonucleic acid |
| SPE | – | Solid-phase extraction |
| TLC | – | Thin-layer chromatography |
| ULPA | – | Ultra-low particulate air (type of filter) |
| UV | – | Ultraviolet |

## Unit convertor

1 $\mu$S/cm = $10^{-6}$ MΩ/cm

1 bar = 0.9869 atm = 100000 Pa = 14.5031 psi

# Introduction

### *Classification and Categories of Laboratory Equipment*

Laboratory equipment encompasses devices, instruments, and tools used in laboratory work for sampling and sample preparation, testing and research, and qualitative and quantitative analyses. This is a general term for a variety of tools used in different types of laboratories.

### *Classification*

Laboratory equipment can be divided into the following main categories, which can then be further divided into subcategories:

- General laboratory equipment;
- Special equipment;
- Measuring equipment;
- Analytical equipment;
- Testing equipment.

**General laboratory equipment** as described in this edition is used in the process of sample preparation, during intermediate tasks before the study, and for analysis. For example, this includes equipment used for grinding, filtering, sieving, mixing, separation, thermal or ultrasonic treatment, temperature maintenance, extraction, and so forth.

General laboratory equipment can be divided into the following subcategories:

- Heating, cooling, and thermostatting equipment;
- Mixing and separation equipment;
- Equipment for component isolation.

**Special laboratory equipment** refers to devices necessary for solving specific problems typical of a particular laboratory. For example, this category includes equipment designed to create sterile conditions.