

Untapped Potential...

Maximize Your Life Science Results by
Selecting the Optimal Water Grade



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Introduction

Water is one of the most important and essential components in many chemical reactions, biological processes, and scientific research. Water's unique properties and its ability to dissolve a wide range of compounds, make it a valuable tool for scientific studies, including biochemistry, material science, and environmental sciences. Understanding the behavior of water is crucial for many areas of research such as protein folding, biomolecular interactions, and climate change.

Water is an essential component in the laboratory. Selecting the wrong grade of water can affect experimental results, contaminate reagent preparation, and may even damage equipment. Impurities and inconsistencies in the water quality can affect the outcome of an experiment and effect your reproducibility. Contaminants, variations in the pH, and even the temperature of the water can affect your experimental outcomes. This makes selecting the proper grade of water extremely important.

This report will focus on water used for life science and bioprocessing applications. It is important to understand the different grades of water available and how to go about choosing the most appropriate grade for your application. This guide will provide an overview of the key principles and steps for making that selection.

Ultra-Pure Water – What is it and why is it important?

When considering the type of water to use for life science and bioprocessing applications, you want to start with ultra-pure water. But what exactly is ultra-pure water?

Ultra-pure water can be defined as water where the impurities are removed to the ppb (parts-per-billion) level or even the ppt (parts-per-trillion) level. Low levels of impurities can interfere with certain scientific experiments or manufacturing processes. This leads to inaccurate results or poor product quality.

The preparation of ultra-pure water may involve several steps. These can include distillation, deionization, reverse osmosis, and filtration. The number of steps needed will depend on the application. Additional steps, such as UV light exposure or ozonation, may also be necessary.

What impurities removed during water purification? These can include dissolved minerals, organic compounds, bacteria, and viruses.

Ultra-pure water is critical for ensuring accurate, reliable, and reproducible scientific results and high-quality standards in many industries and applications.

What Defines Water Quality?

Understanding the factors that define water quality will help in the selection of the best grade of water for a specific application.

Criteria That Define Water Quality

- **Purity** – Impurities, such as dissolved solids, organic compound, and microorganisms can interfere with experimental results. Therefore, water should be free of these components.
- **pH** – Certain chemicals and biological processes like enzyme activity in biochemistry or microbiology are pH dependent. For the best results, the pH of the water should be consistent and appropriate for a specific experiment.
- **Conductivity** – Dissolved ions and impurities can affect the electrical conductivity of water. Conductivity, the reciprocal of resistivity, provides a non-specific indication of the level of ions in the water. High conductivity can affect the accuracy of analytical measurements. For most experiments, low conductivity is preferred.
- **Microbial Content** – Water should be free of bacteria and other microbes that could interfere and contaminate an experiment. Filtration, UV treatment, and sterilization techniques are used to keep these values low.
- **Endotoxins** – These are toxins found in gram-negative bacteria that can contaminate laboratory experiments. Limulus Amebocyte Lysate activity testing is used to assess the level of endotoxin. Endotoxins can affect the accuracy of immunological assays or cell-based assays in molecular biology or biotechnology.
- **Trace Metals & Organic Compounds** – Some experiments are sensitive to the presence of trace metals and organic compounds. Using water that is free of these contaminants will improve results. Measuring all the organic compounds in water can be impractical, so total organic carbon or TOC is typically measured as an indicator of organic impurities.



Water Selection

Life Science experiments require water with a high degree of purity to avoid contamination and increase accuracy and reproducibility. Different research experiments may require different grades of water.

For example, molecular biology experiments such as DNA sequencing, PCR, and mRNA studies, require water that is free of DNase, RNase, and proteases. Similarly, cell culture experiments require water that is free from endotoxins and other contaminants that might interfere with cell growth and viability.

Selecting the Proper Grade of Water

1. Identify your specific application. Different applications require different grades of water. It is important to understand the requirements of your application to select the appropriate water.
2. Determine your purity requirements.
3. Select the appropriate grade of water.

What Are the Different Grades of Water?

Cell Culture Grade Water

Cell culture is a vital tool for biomedical research. In Cell Culture, cells are grown in a controlled environment. Water is an essential role in the makeup of cell culture medium. Bacteria and endotoxins in water can interfere with the growth and development of cells. Filtered, deionized, sterile water that is free of bacteria, endotoxins, and other impurities is the best water for cell culture applications.



Cell Culture applications:

1. Growth and maintenance of cells in culture
2. Cell Culture Medium preparation
3. Reagent and buffer preparation
4. Biotechnology research applications such as production of recombinant proteins and development of new cell-based therapies. This may also include drug development, microbiology and virology research and toxicology research.

DEPC-Treated Water

DEPC-treated water is used in molecular biology experiments to prevent the degradation of RNA molecules. Diethyl pyrocarbonate (DEPC) is a chemical reagent that inactivate RNases (ribonucleases). RNases can come from many sources, including water. Ribonucleases are very stable and difficult to inactivate. They can contaminate samples and interfere with results if they are not removed or inactivated. DEPC-treated water is also used in other laboratory applications such as DNA extraction and purification.

Preparation of DEPC-treated water starts with ultra-pure water. DEPC is mixed with water and allowed to react for a specific amount of time. The water is then autoclaved to inactivate any residual DEPC.

DEPC-Treated Water Applications:

1. RNA Isolation
2. Reverse transcription
3. Polymerase Chain Reaction (PCR)
4. Gel Electrophoresis
5. Antibody labeling



Endotoxin-Free Water

Endotoxins are bacterial membrane components found in most gram-negative bacteria. They can cause a range of symptoms including fever, inflammation, and shock. They are a significant contaminant in many laboratory experiments, including cell culture.

Endotoxin-free water has very low levels of endotoxins. It is prepared by passing ultrapure water through a series of filters to remove the endotoxins. The water is then tested to ensure that it meets the required endotoxin level for the application.

Endotoxins are measured using a Limulus amoebocyte lysate (LAL) assay. In this assay, horseshoe crab blood cells are used to detect the presence of endotoxins in the water.

Endotoxin-Free Water Applications:

Experiment Type	Examples	Why use Endotoxin-Free Water?
Molecular Biology	PCR, qPCR, DNA Sequencing	Avoid false positives and ensure accurate results
Microbiology	Bacterial Growth Studies, Antimicrobial Susceptibility Testing	Avoid interference with growth or activity of bacteria
Biochemistry	Enzyme Assays, Protein Expression, Purification	Ensure purity of samples and avoid interference with the activity of enzymes and proteins
Pharmaceutical and Medical Device	Drug Development, Medical Device Manufacturing	Ensure the safety and effectiveness of the products and comply with regulatory requirements
Animal Experiments	<i>In vivo</i> studies, Cell Culture with Animal Serum	Prevent inflammation and other immune responses in animals

Molecular Biology Grade Water

Molecular Biology Grade water is purified to remove contaminants that interfere with molecular biology applications. The water is treated and quality tested to ensure it is free of RNases, DNases and proteases that would degrade DNA or RNA and inhibit reactions.

This grade of water can be used in molecular biology techniques such as DNA and RNA purification, cloning, and protein purification.

Molecular Biology Grade Water Applications:

1. Polymerase chain reaction (PCR) and reverse transcription PCR (RT-PCR)
2. DNA and RNA gel electrophoresis
3. Cloning and gene expression analysis
4. Protein Purification

PCR-Qualified Water

PCR-qualified water or PCR-grade water, is a grade of water specifically produced for use in Polymerase Chain Reaction (PCR) experiments. Polymerase Chain Reaction (PCR) is used to amplify small quantities of DNA or RNA into larger quantities. Water used for PCR needs to be free of contaminating DNA, RNase, DNase, and other contaminants that may interfere with the reaction and results. PCR-qualified water is typically filtered, ultra-pure water that is then tested to ensure that functions in PCR reactions.

PCR- Qualified Grade Water Applications:

1. PCR
2. RT-PCR
3. qPCR
4. Molecular Biology techniques, such as cloning and sequencing



WFI Quality Water

WFI Water or Water for injection is an extremely high purity water used in the pharmaceutical industry for the preparation of injectable drugs. WFI water meets strict quality standards that are set by regulatory agencies including the USP (United States Pharmacopeia), the EP (European Pharmacopeia), or the JP (Japanese Pharmacopeia). Water used in drug manufacturing must be free from contaminants that might be harmful to patients.

WFI Quality Water is purified to the same strict regulatory standards as WFI water. Using this grade water for in scientific experiments can help ensure the quality, accuracy, and reproducibility of results that require high sensitivity and precision.

WFI Quality Water Applications:

1. Cell Culture and Tissue Engineering

WFI Quality Water provides a sterile and controlled environment for cell growth and development. It is free from impurities and contaminants that may negatively affect cell growth, differentiation, and viability. Preparing cell culture media, buffers, and other solutions with WFI Quality Water reduces the risk of contamination and improves the reliability and reproducibility of experimental results.

2. Biotech production

Production of biotech products such as vaccines, recombinant proteins, and monoclonal antibodies with WFI Quality Water imparts benefit that include reducing the risk of contamination, ensure product consistency, and improved quality. WFI Quality Water helps reduce variability as products are scaled from Research Use Only (RUO) to GMP production.

3. Diluent for Sterile Concentrates and Cleaning Equipment

The high purity, non-reactive nature, and lack of impurities and contaminants in WFI Quality Water makes it excellent for cleaning and rinsing research and biotech production equipment. Rinsing equipment with WFI Quality Water will not leave behind any residues that could potentially interact with product being produced or tested.

Conclusion

Individual laboratories may use different grades of water for different experimental applications. Producing ultra-pure water in different grades can be time-consuming and costly for an individual lab. The Water will also require quality control testing to ensure it meets the purity requirements for its specific application. Therefore, many researchers purchase the specific grade of water they need for their application.

This guide provides an overview of the key considerations for selecting the proper grade of water. By understanding the requirements of your specific application and selecting the appropriate grade of water, you can improve the accuracy and reproducibility of your experimental results.



Resources

Nabulsi, R. and Al-Abbadi, M., *Laboratory Medicine*, Volume 45, Issue 4, November 2014, Pages e159-e165, "Review of The Impact of Water Quality on Reliable Laboratory Testing and Correlation with Purification Techniques", <https://doi.org/10.1309/LMLXNDOWNRJJ6U7X>

Laboratory Water, NIH, March 2013

https://orf.od.nih.gov/TechnicalResources/Documents/DTR%20White%20Papers/Laboratory%20Water-Its%20Importance%20and%20Application-March-2013_508.pdf

Long J Mabic S., Water quality in patient testing, *Clinical Lab Prod*, 2007, 22-23,

<http://www.clpmag.com/2007/04/water-quality-in-patient-testing/>

Wiemer, K.E., Anderson, A., and Stewart, B., *Human Reproduction*, Volume 13, Supplement 4, 1998, pages 166 -172, "The importance of water quality for media preparation",

https://doi.org/10.1093/humrep/13.suppl_4.166

Quality Biological...Ultra-pure water is at the base of all our solutions

Do you need help scaling your process? Is your manufacturing capacity strained due to increasing demands? Looking to speed your time to market?

Quality Biological is here to help with liquid solutions custom manufactured with unparalleled flexibility and the personalized service you need to meet your unique needs.

Ultra-pure water is the foundation of everything we do. Since 1983, we have been manufacturing products in our ISO certified manufacturing facility, providing you with the highest quality solutions and personalized service you need to achieve your goals.

Whether you need a few liters of ultra-pure water, cell culture media, buffer, or a custom solution for your research, or need to scale your formulation for preclinical or Phase 1 trials or need hundreds of liters for commercialization...we have your solutions.

How can we assist you in achieving your goals faster? Contact us at QualityBiological.com to discuss your unique needs.



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