World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(REVIEW ARTICLE)

Check for updates

Monoclonal antibodies: Pioneering the future of medicine

Deepika Rajput, Mohammad Khalid *, Shubham Pratap Singh, Megha Gupta and Ankit Kumar

Krishna Pharmacy College, Bijnor, Uttar Pradesh, India – 246701.

World Journal of Biology Pharmacy and Health Sciences, 2025, 21(01), 083-087

Publication history: Received on 15 November 2024; revised on 29 December 2024; accepted on 31 December 2024

Article DOI: https://doi.org/10.30574/wjbphs.2025.21.1.1074

Abstract

Large-scale manufacturing procedures have been developed in response to the growing demand for monoclonal antibodies (mAbs) utilized in therapeutic and diagnostic applications. Continuous optimization of the underlying systems has improved product. Numerous enhancements and changes to monoclonal antibodies have been devion. In response to mAb limitations and side effects, the number of monoclonal antibodies (mAbs) that have previously been approved for use in clinical trials and therapeutic applications has expanded dramatically in recent years. These changes have made it easier to employ mAbs in a variety of therapeutic applications, including the management of infectious disorders brought on by parasitic, bacterial, viral, and fungal organisms. Additionally Monoclonal antibodies have been utilized to treat Non-infectious diseases such as cancer, immunological problems, and arthritis, , and problems caused by organ donation. This review looks at cutting-edge technology related to the potential application of mAbs in biomedicine.

Keywords: Monoclonal antibodies (mAbs); Antibody engineering; Humanized MAbs (HMAs); Target antigen; Radiolabeled antibodies

1. Introduction

The introduction of hybridoma technology in the 1970s led to the manufacture of huge volumes of monoclonal antibodies (mAbs) in a variety of forms, including murine, chimeric, humanized, and completely human antibodies. And, more recently, the utilization of recombinant DNA technologies. These antibodies are available for clinical use as highly homogeneous specific reagents (1-3). Some clinical studies have examined pharmacokinetics by quantifying activity levels in normal tissues, monitoring Blood activity clearance curves and the rate of activity excretion in urine, as well as, most importantly, examination of plasma samples to detect the molecular kinds of radioactivity present (4-6).Because of their special qualities, scientists use them to shield people from disease [7]. Because of this method, an antibody may tag an infection or microorganism, making it possible for other immune system components to target it and kill it directly [8]. Changes to the Fab and Fc sections influence the specificity, length, and outcome of the antibody-dependent response [9]. When Kohler and Milstein created monoclonal antibodies (MAbs) in 1975, they transformed immunology. The first Mab was fully licensed in 1986 [10].One significant achievement has been the development of MAbs in transgenic plants and animals [11]. The US Food and Drug Administration authorized the first human monoclonal antibody for clinical use in 2002. The industry that produces mAbs has grown rapidly since then [12]. Recently, some 30 mAbs were approved for use as treatments in clinical settings, and several more were in various phases of study [13].

*Corresponding author: Mohammad Khalid

Copyright © 2025 Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution Liscense 4.0.

1.1. Types of therapeutic MAbs

Advances in antibody engineering have produced a variety of mAbs for use in biomedicine and life sciences. Despite having different targets and uses, these antibodies may share similar concepts. Additionally, a number of considerations, such as the application's goal, accessibility, and efficacy, may influence the decision to use one approach over another.

1.2. Murine Mab

Because humans and rats have different immune systems, murine antibodies made using hybridoma technology have limited uses in clinical medicine or human therapy. Except in extremely rare circumstances, this usually leads to treatment failure [14]. Murine immunogenic components are more successfully eliminated when a variety of techniques are used to reduce the immunogenic effects of murine monoclonal antibodies in human therapy [15]. As a result, the mAb's overall immunogenicity is reduced without affecting the original antibody's detection ability [16]. Humanization-derived antibodies are becoming increasingly important in the treatment of cancer and inflammatory illnesses, with many already on the market and more in clinical trials[17].Chimeric antibodies are unique therapeutic antibody types created by combining genetic components from nonhuman animals (mice) and humans. They are created by changing mouse variable areas and human constant regions [18]. Chimeric monoclonal antibodies are known by the suffix "ximab," such as Infliximab, Rituximab, and Abciximab [19].

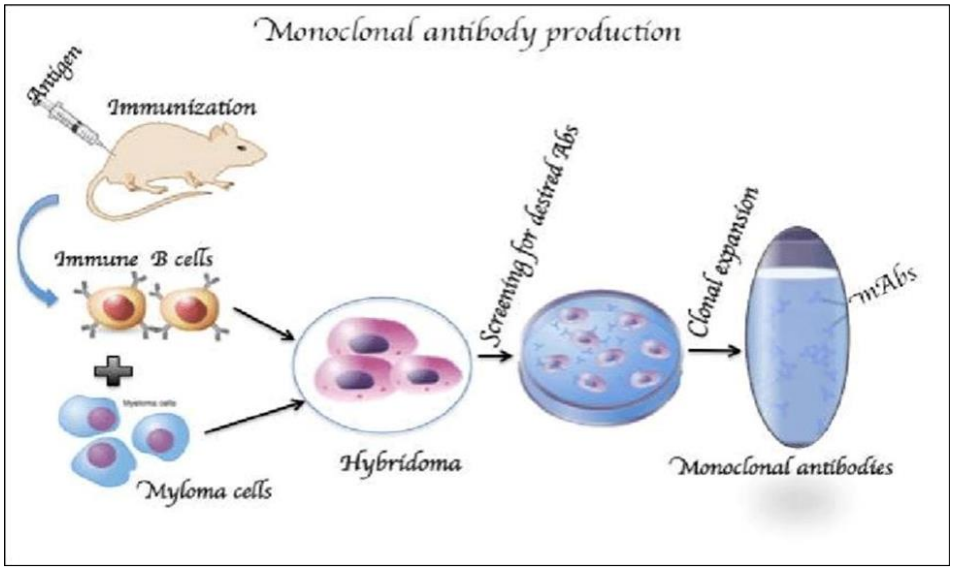

Figure 1 depicts the steps involved in Mab manufacturing

Humanized MAbs (HMAs) are considered natural pharmaceuticals due to their safety in vivo actions. Human mAbs are now widely employed for disease therapy and immunodiagnostics thanks to developments in mAb technology. There are approximately 20 mAb medications, including humanized mice mAbs.

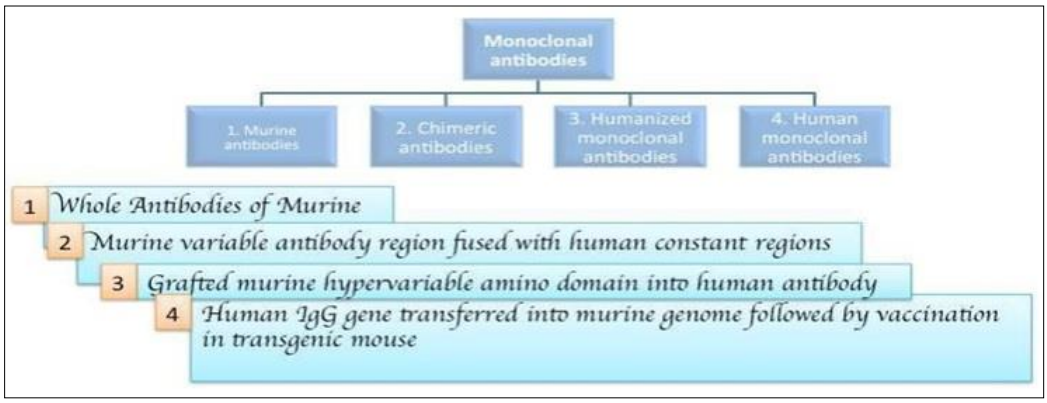

Figure 2 Therapeutic Mab types and production methods

They have grown in popularity as medicinal reagents in recent decades. Other monoclonal antibodies are in various phases of clinical trials, under the supervision of different academic institutions and/or in collaboration with pharmaceutical companies. Human mAb technologies are extremely useful in health economics, in addition to strategic research [20]. In terms of antigen binding, they can be less potent than the parent murine monoclonal antibodies [21].Daclizumab, omalizumab, and alemtuzumab are examples of humanized antibodies approved by the FDA [22].

1.3. Fully human MAbs

In addition, compared to using animal models, it is not practical to immunize humans in vivo with a wide variety of antigens [23]. Similarly, to screen antibody libraries, antibody fragments can be shown on filamentous bacteriophages [24, 25]. The most popular and well-established approach for creating novel human antibodies is the phage display technique [26].These consist of phage display platforms and transgenic mice [27].

1.4. Factors Affecting Pharmacokinetics Parameters

Pharmacokinetics is still poorly understood, which makes it difficult to create logical mAb therapy plans. A specific mAb's pharmacokinetic profile might be influenced by a number of things. Rapid clearance may result from circulating target antigens (28). Internalization of antigen-antibody Cells has an impact on half-life and serum clearance. Pharmacokinetics can also be significantly influenced by antibody size and domains in the Fc region. Compared to their full-sized parental forms, mab fragments usually have faster clearance rates and shorter half-lives. The ideal dosage and timing of antibody delivery will also depend on the quantity of target antigens that are available and the binding avidity of the mAb. It is important to take into account additional factors pertaining to the modified carbohydrate side chains, antibody glycosylation, and antibody catabolism.

1.5. Target antigen

When developing mAb-based treatments, target antigen distribution is still a critical factor to take into account (29, 32). The therapeutic potential of mAbs against many antigens is compromised because the majority of mAbs against human tumor antigens bind not only to tumors but also to normal tissues that express The antigen to target. Some of the shed antigens seen in serum are CA125 and CA19-9, carcinoembryonic antigen (CEA), prostate specific antigen (PSA), TAG 72, and epidermal growth factor receptor (EGF-R). Circulating antigens can be identified in serum (29-32) Circulating tumor antigens that can bind to antibodies in the bloodstream would negatively impact therapy by preventing the targeting antibody from reaching tumor cells, as well as diagnostic tests using radiolabeled antibodies (33).Additionally, as seen in patients with B-cell lymphoma treated with radio labeled anti idiotypicmAbs, antigen shedding from the tumor cells' surface can result in the creation of circulating immune complexes and quick removal of the mAb from blood (21).The ideal dosage and delivery schedule for chimeric monoclonal antibodies will also depend on the quantity of target antigens that are available and the mAb's binding activity.

2. Conclusion

Monoclonal antibodies are transforming medicine. The precision they offer in diagnosing and treating many diseases is unmatched. These antibodies have a unique ability. They can specifically target antigens.

These antibodies are proving vital in oncology. They also show promise in autoimmune disorders. Additionally they are indispensable in managing infectious diseases. Biotechnology continues to evolve at a rapid pace. This evolution is increasing their efficacy. It is also reducing side effects. It's also broadening their therapeutic use.

There are stumbling blocks. These include high production costs. Potential for resistance is another obstacle. Yet there are ongoing advancements in antibody engineering. There are also innovations in delivery systems. These have the potential to surmount these difficulties.

We are on the cusp of a new era. Personalized medicine is on the horizon. Monoclonal antibodies are leading the way. They are a model of how treatments can be customized. They can improve patient outcomes. They can make healthcare more focused and effective.

Compliance with ethical standards

Acknowledgements

Sincerest thanks go to the administration and faculty of Krishna Pharmacy College. Their continued support was instrumental. They also contributed great encouragement throughout this manuscript. Special thanks are extended to our colleagues. We are grateful for their invaluable insights. Their guidance was truly beneficial. We acknowledge the contributions of all researchers and of all authors, their work has been referenced. It is a key part of this review.

Disclosure of conflict of interest

No conflict of interest to be disclosed

References

[1] Kohler, G., Milstein, C. Continuous cultures of fused cells secreting antibody of predefined specificity. Nature 1975, 256: 495-7.

[2] Goldstein, N.I., Prewett, M., Zuklys, K., Rockwell, P., Mendelsohn, J. Biological efficacy of a chimeric antibody to the epidermal Growth factor receptor in a human tumor xenograft model. Clin Cancer Res 1995, 1: 1311-8.

[3] Yang, X.D., Jia, X.C.J., Corvalan, J.R.F., Wang, P., Davis, C.G. Development of ABX-EGF, a fully human anti-EGF-R monoclonal Antibody, for cancer therapy. Critical Reviews In Oncol And Hemat 2001, 38: 17-23.

[4] Crombet, T., Torres, L., Neninger, E. et al. Pharmacological evaluation of humanized anti-epidermal growth factor receptor, monoclonal antibody h-R3, in patients with advanced epithelial-derived Cancer. J Immunother 2003, 26: 139-48.

[5] Hnatowich, D.J., Gionet, M., Rusckowski, M. et al. Pharmacokinetics of 111In-labeled OC-125 antibody in cancer patients compared with the 19-9 antibody. Cancer Res 1987, 47: 6111-7.

[6] Hnatowich, D.J., Griffin, T.W., Kosciuczyk, C. et al. Pharmacokinetics of an indium-111-labeled monoclonal antibody in cancer Patients. J Nucl Med 1985, 26: 849-58.

[7] Poongodi V, Gopal KS, Raghunathan A. Monoclonal antibody an updated review in dentistry. International Journal of Current Research 2018;10:72408-72412.

[8] Ahmad ZA, Yeap SK, Ali AM, Ho WY, Alitheen NBM, Hamid M. scFv Antibody: Principles and Clinical Application. Clinical and Developmental Immunology 2012;2012:980250.

[9] Pecetta S, Finco O, Seubert A. Quantum leap of monoclonal antibody (mAb) discovery and Development in the COVID-19 era. Seminars in Immunology 2020;50:101427.

[10] Hudson AJ, Souriau C. Engineered antibodies. Nature Medicine 2003;9:124-132.

[11] Berger M, Shankar V, Vafai A. Therapeutic Applications of Monoclonal Antibodies. American Journal of the Medical Sciences 2002;324:14–30

[12] Nelson AL, Dhimolea E, Reichert JM. Development Trends for human monoclonal antibody therapeutics. Nat Rev Drug Discovery 2010; 9(10): 767–774.

[13] Li J, Zhu Z. Research and development of next Generation of antibody-based therapeutics. ActaPharmacol Sin 2010; 31(9): 1198–1207.

[14] Bernett MJ, Karki S, G Moore GL, Leung IWL, Chen H, Pong E, Nguyen DHT, Jacinto J, Zalevsky J, Muchhal US, et al. Engineering Fully Human Monoclonal Antibodies from Murine Variable Regions. J Mol Biol 2010; 396(5):1474–1490

[15] Rodrigues ME, Costa AR, Henrique M, Azeredo J, Oliveira R. Technological progresses in monoclonal Antibody production systems. BiotechnolProg 2010; 26(2): 332–351.

[16] Brezski RJ, Almagro JC. Application of Antibody Engineering in the Development of Next Generation Antibody-Based Therapeutics. In Dev Antibody-Based Therap 2012; 4(29): 65-93

[17] O'Brien LM, Goodchild SA, Phillpotts RJ, Perkins SD. A Humanised murine monoclonal antibody protects mice From Venezuelan equine encephalitis virus, Everglades Virus and Mucambo virus when administered up to 48h After airborne challenge. Virology 2012; 426(2): 100–105.

[18] Lin W, Kurosawa K, Murayama A, Kagaya E, Ohta K. Bcell display-based one-step method to generate chimeric human IgG monoclonal antibodies. Nucleic Acids Res 2011; 39(3): 1–10

[19] Mak TM, Hanson BJ, Tan YJ. Chimerization and Characterization of a monoclonal antibody with potent Neutralizing activity across multiple influenza A H5N1 Clades. Antiviral Res 2014; 107(1): 76–83

[20] Wang S. Advances in the production of human Monoclonal antibodies. AntibTechnol J 2011; 1: 1–4.

[21] Chandel P, Harikumar SL. Pharmaceutical monoclonal Antibodies: Production, guidelines to cell engineering And applications. Int J Pharm Pharma Sci 2013; 5(2):13–20

[22] Harding FA, Stickler MM, Razo J, DuBridge RB. The Immunogenicity of humanized and fully human Antibodies: Residual immunogenicity resides in the CDR Regions. MAbs 2010; 2(3): 256–265.

[23] Bernett MJ, Karki S, G Moore GL, Leung IWL, Chen H, Pong E, Nguyen DHT, Jacinto J, Zalevsky J, Muchhal US, et al. Engineering Fully Human Monoclonal Antibodies from Murine Variable Regions. J Mol Biol 2010; 396(5):1474–1490.

[24] Steinitz M. Human Monoclonal Antibodies. In Methods in Molecular biology (Clifton, N.J.), 2014; 1060: 111–22.

[25] Medecigo M, Manoutcharian K, Vasilevko V, Govezensky T, Munguia ME, Becerril B, Luz-Madrigal A, Vaca L, Cribbs DH, Gevorkian G. Novel amyloid-beta specific scFv and VH antibody fragments from human and mouse phage display antibody libraries. J Neuroimmunol 2010; 223(1): 104–114.

[26] Solforosi L, Mancini N, Canducci F, Clementi N, Sautto GA, Diotti RA, Clementi M, Burioni R. A phage display Vector optimized for the generation of human antibody Combinatorial libraries and the molecular cloning of Monoclonal antibody fragments. New Microbiol 2012; 35(3):289–294.

[27] Chandel P, Harikumar SL. Pharmaceutical monoclonal Antibodies: Production, guidelines to cell engineering And applications. Int J Pharm Pharma Sci 2013; 5(2):13–20.

[28] Carrasquillo, J.A., Colcher, D., Sugarbaker, P. et al. Radioimmunoscintigraphy of colon cancer with Iodine-131 labeled B72.3 monoclonal antibody. J Nucl Med 1988, 29: 1022-30.

[29] 17. Carrasquillo, J.A., Colcher, D., Sugarbaker, P. et al. Radioimmunoscintigraphy of colon cancer with Iodine-131 labeled B72.3 monoclonal antibody. J Nucl Med 1988, 29: 1022-30.

[30] Baselga, J., Pfister, D., Cooper, M.R. et al. Phase I studies of antiepidermal growth factor receptor chimeric antibody C225 aloneand in combination with cisplatin. J Clin Oncol 2000, 18: 904-14.

[31] Iznaga-Escobar, N., Torres, L., Morales, A. et al. 99mTc-labeled antiEGF-receptor antibody in patients with tumor of epithelial origin:I. Biodistribution and dosimetry for radioimmunotherapy. J Nucl Med 1998, 39: 15-23.

[32] Goldenberg, D.M., Deland, F.H. History and Status of tumor imaging with radiolabeled antibodies. J Biol Response Modif 1983, 1:121-36.