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Engineering and Technology of Antibodies

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Introduction

Since the development of antibody production techniques, a number of immunoglobulins have been developed on a large scale using conventional methods. Hybridoma technology opened a new horizon in the production of antibodies against target antigens of infectious pathogens, malignant diseases including autoimmune disorders, and numerous potent toxins. However, these clinical humanized or chimeric murine antibodies have several limitations and complexities. Therefore, to overcome these difficulties, recent advances in genetic engineering techniques and phage display technique have allowed the production of highly specific recombinant antibodies. These engineered antibodies have been constructed in the hunt for novel therapeutic drugs equipped with enhanced immunoprotective abilities, such as engaging immune effector functions, effective development of fusion proteins, efficient tumor and tissue penetration, and high affinity antibodies directed against conserved targets. Advanced antibody engineering techniques have extensive applications in the fields of immunology, biotechnology, diagnostics, and therapeutic medicines. However, there is limited knowledge regarding dynamic antibody development approaches. Therefore, this review extends beyond our understanding of conventional polyclonal and monoclonal antibodies. Furthermore, recent advances in antibody engineering techniques together with antibody fragments, display technologies, immunomodulation, and broad applications of antibodies are discussed to enhance innovative antibody production in pursuit of a healthier future for humans [1,2].

Description

In recent years, the development of polyclonal and monoclonal antibody by means of laboratory animals has become a vital approach to protect against a number of pathogenic contagions. These immunoprotective molecules provide defense against transmissible diseases and can eliminate the infection. Their prophylactic and therapeutic protection ability was first discovered in the late nineteenth century by the passive transmission of antibodies from a diseased animal that provided immunity against diphtheria. Subsequently, immune sera from various herbivores and humans were obtained, pooled, and used as therapeutics. Since then, the management of infectious diseases such as diphtheria, tetanus, pneumococcal pneumonia, meningococcal meningitis, and toxin-mediated diseases has considerably improved patient survival [3].

Antibodies consist of two heavy chains Variable (VH), Joining (JH), Diversity (D), and Constant (C) region and two light chains Variable (VH), Joining (JH), and Constant (C) region, that are linked by non-covalent bonding and disulfide (s-s) bridges. Antibodies bind antigen with the help of a VHH fragment that can identify specific and unique conformational epitopes by the presence of its long Complementary Determining Regions (CDR3). *Escherichia coli* expression systems are unique for the validation of the correct functioning of antibody fragments in the periplasmic space or cytoplasm. Conversely, periplasmic expression systems help VH and VL pairing by providing optimal conditions to allow the production of functional molecules [4].

Polyclonal antibodies contain large and diverse concentrations of different antibodies with unknown specificities. They are broadly used for the detection of different antigens in research and diagnostics. However, non-human polyclonal antibodies induce immune responses in humans that impede their clinical use such as treating snake bites. Monoclonal antibodies have revolutionized scientific research. Production of these molecules is based on the fusion of antibody generating spleen cells from immunized mice, rats, or rabbits with immortal myeloma cell lines. These monoclonal antibodies are a highly specific class of biological reagents that facilitate enhanced clinical diagnostics in the medical arena. Subsequently, various antibodies are used clinically as prophylactic or therapeutic agents.

Polyclonal antibody

Antigen interactions are essential for the normal functions of antibodies that are widely used in research or therapeutics. The antigen specific and membrane associated receptor antibody response is mediated by T and/or B cells. Consequently, upon binding with a suitable antigen, B lymphocytes are induced to proliferate, and divide by a number of activating signals, thus increasing the numbers of B cells. These B cells are then differentiated into specific antibody producing plasma cell clones that recognize specific antigen epitopes via the antigen receptor. B cells are activated after recognizing their specific antigen. Some antigens are highly multifarious and exhibit abundant epitopes recognized by several lymphocytes. Consequently,

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lymphocytes multiply and differentiate by activation of these multifarious antigens into plasma cells that produce polyclonal antibody responses [5].

Monoclonal antibody

Monoclonal antibodies (mAbs) are clinically significant homogeneous and mono-specific scientific biomolecules produced from hybridoma cells by hybridoma technology. mAbs arise from single cell clone compared to multiple cell clones for pAbs. Since their discovery, these molecules have been used as research tools and have revolutionized the fields of biotechnology, immunology, diagnostics, and medicine.

Hybridoma technology has been a significant and essential platform for producing high quality mAbs. It permits generation of therapeutic antibodies in a native form. However, technical difficulties in hybridoma production have updated the mainstream antibody production into new ways like display and transgenic mice techniques. Nevertheless, hybridoma technology is a classical and established route of generating specific antibodies all around the globe.

Conclusion

ELISA is enzyme based colorimetric assay, requires large sample volumes, several incubation steps and has low detection sensitivity. Conversely, nanotechnology and Nanoparticles (NPs) use nanomaterials with length scale of 1–100 nanometers (nm). Nanomaterials have unique biological properties such as small size, large surface to volume ratio, sharp melting temperature, magnetic properties, unusual target binding properties, and size based multi-coloring.

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Conflict of Interest

The author shows no conflict of interest towards this manuscript.

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