

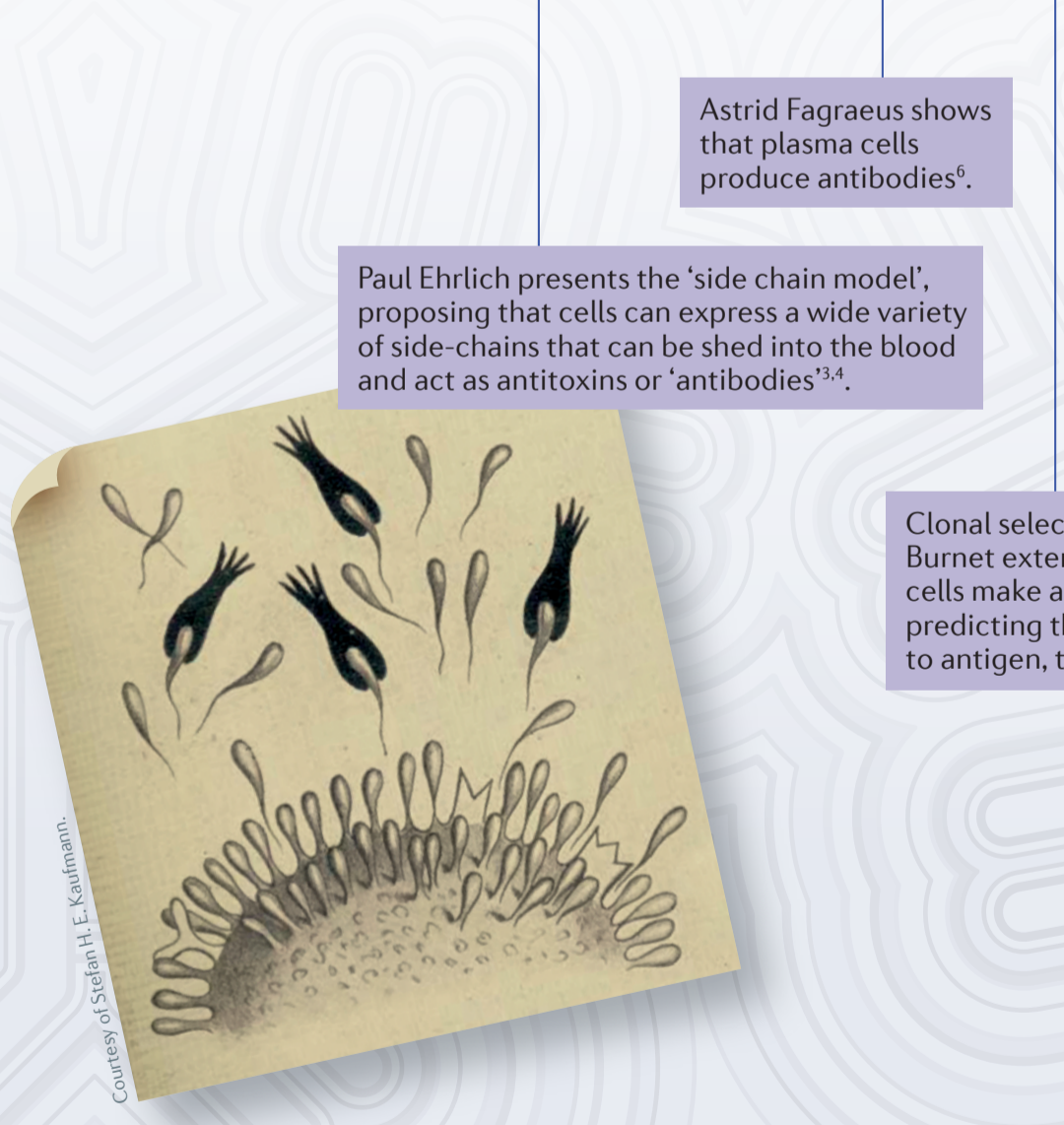
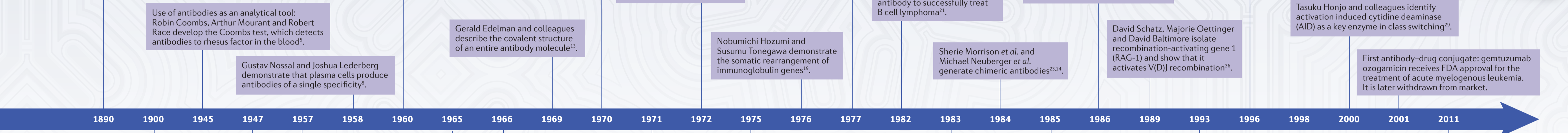
# The History of Antibodies

Antibodies are large, characteristic Y-shaped molecules and arguably one of the most iconic structures in all of science. They are produced by plasma cells of the immune system and have the ability to specifically bind an almost limitless variety of target molecules, which enables them to neutralize toxins and pathogens like bacteria or viruses. Antibodies were originally described in the late 1800s as the active component of antiserum and as such are a key component of most types of immune response. In ground-breaking work in the 1970s, scientists developed techniques to produce antibodies of a defined specificity artificially and in vast

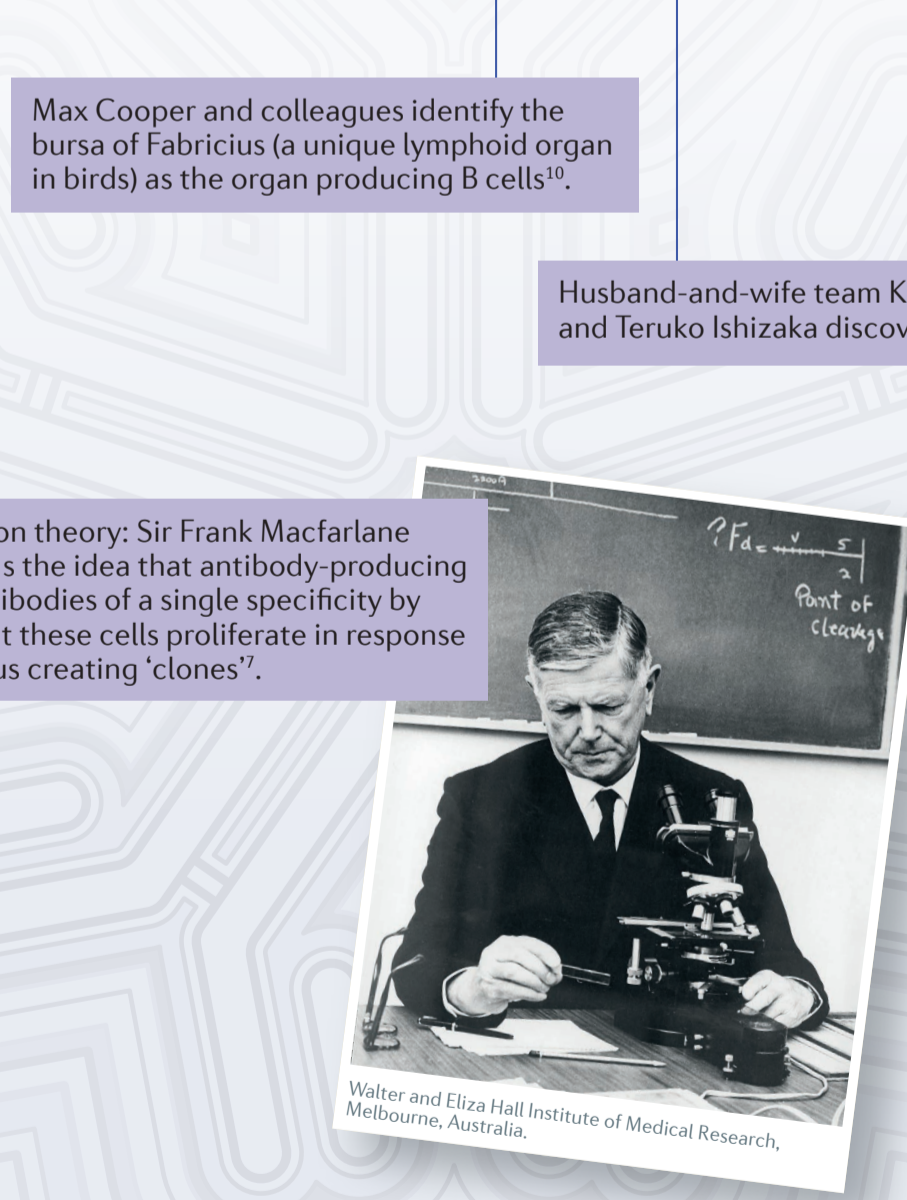
quantities outside of the body; these 'monoclonal antibodies' paved the way for the widespread use of antibodies as a research tool. More recently, monoclonal antibodies are proving themselves to be remarkably effective in the clinic, particularly for the treatment of certain types of cancer and autoimmune disease. As of 2015, the global monoclonal antibody market is estimated at US \$75 billion, and this figure is projected to increase substantially over the coming years. This poster provides an overview of important historical milestones in the discovery of antibodies and their development as therapeutics.



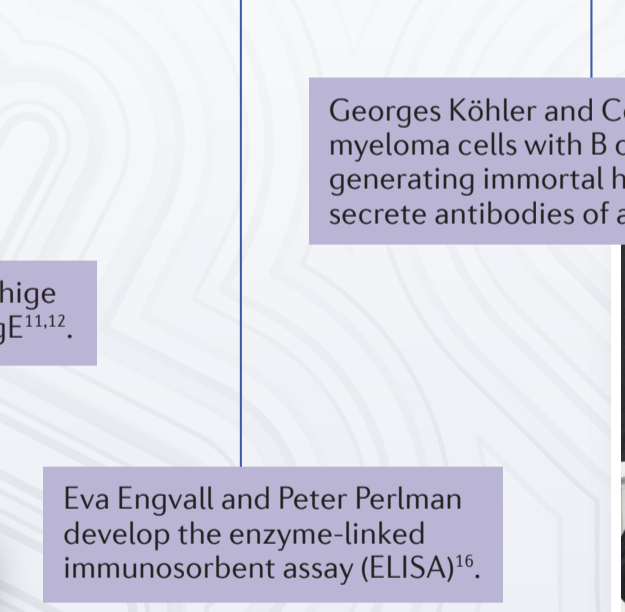
Diphtheria anti-serum: Emil von Behring and Shibasaburo Kitasato demonstrate that serum from infected animals can be used to treat and prevent infection in other animals<sup>1,2</sup>.



Paul Ehrlich presents the 'side chain model', proposing that cells can express a wide variety of side-chains that can be shed into the blood and act as antitoxins or 'antibodies'<sup>3,4</sup>.



Clonal selection theory: Sir Frank Macfarlane Burnet extends the idea that antibody-producing cells make antibodies of a single specificity by predicting that these cells proliferate in response to antigen, thus creating 'clones'<sup>5</sup>.



Husband-and-wife team Kimishige and Teruko Ishizaka discover IgE<sup>11,12</sup>.

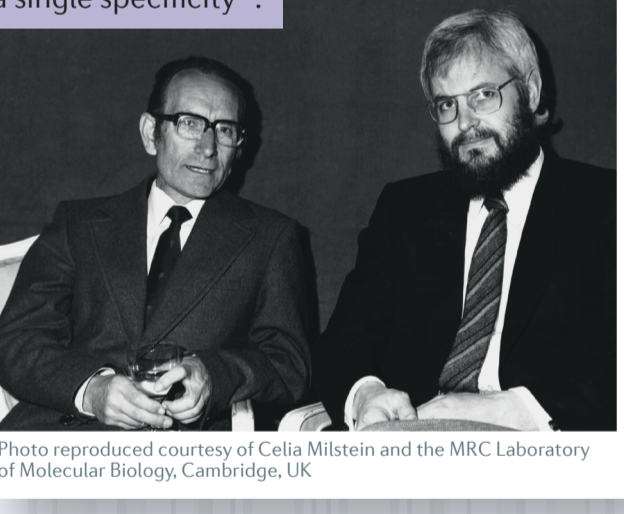
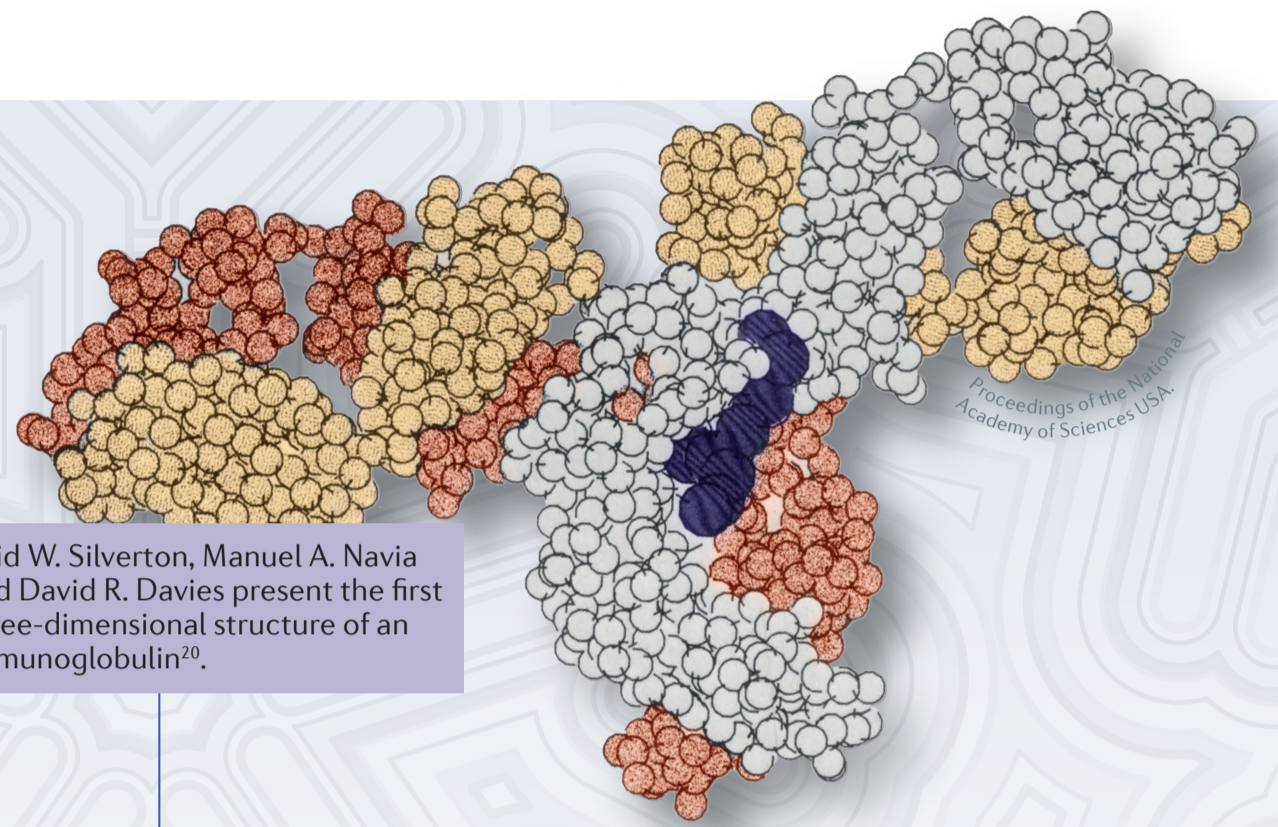


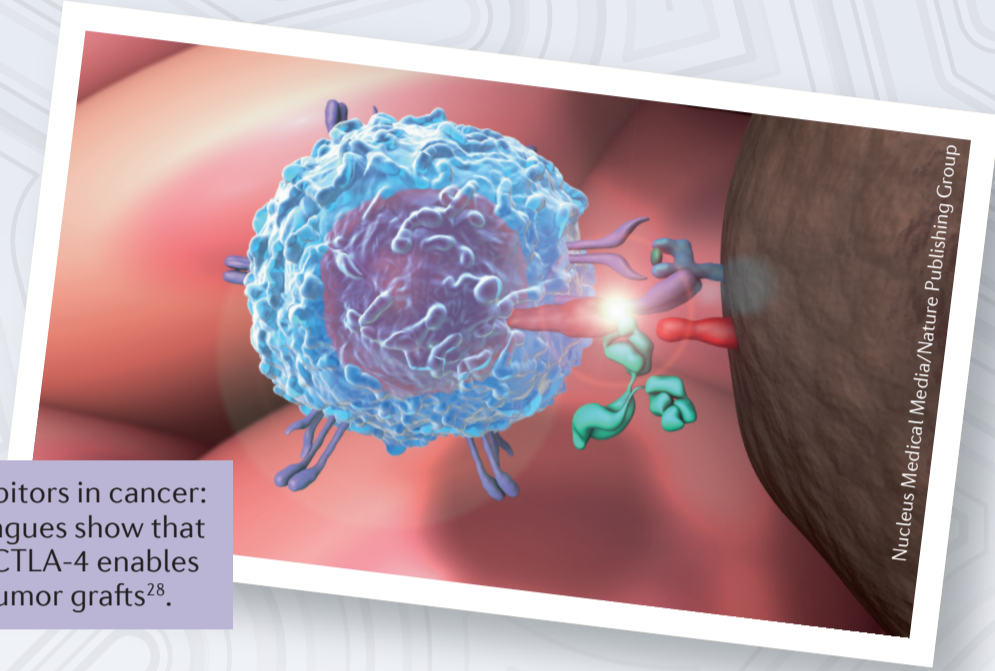
Photo reproduced courtesy of Celia Milstein and the MRC Laboratory of Molecular Biology, Cambridge, UK

First description of a potentially lytic therapeutic monoclonal antibody: Herman Waldmann and colleagues show that CAMPATH-1 (later registered as alemtuzumab) can fix human complement and eliminate lymphocytes<sup>22</sup>.



Enid W. Silvertown, Manuel A. Navia and David R. Davies present the first three-dimensional structure of an immunoglobulin<sup>20</sup>.

Proceedings of the National Academy of Sciences USA



First checkpoint inhibitors in cancer: Jim Allison and colleagues show that an antibody against CTLA-4 enables mice to reject solid tumor grafts<sup>29</sup>.

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- Antibody-related Nobel prizes**
- 1901 **Emil von Behring** for 'the development of serum therapy'.
  - 1908 **Paul Ehrlich** 'in recognition of ... work on immunity'.
  - 1972 **Gerald Edelman** and **Rodney Porter** 'for their discoveries concerning the chemical structure of antibodies'.
  - 1977 **Rosalyn Yalow** '...for the development of radioimmunoassays of peptide hormones'.
  - 1984 **Niels K. Jerne**, **Georges J. F. Köhler** and **César Milstein** 'for theories concerning the specificity in development and control of the immune system and the discovery of the principle for production of monoclonal antibodies'.
  - 1987 **Susumu Tonegawa** 'for his discovery of the genetic principle for generation of antibody diversity'.

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