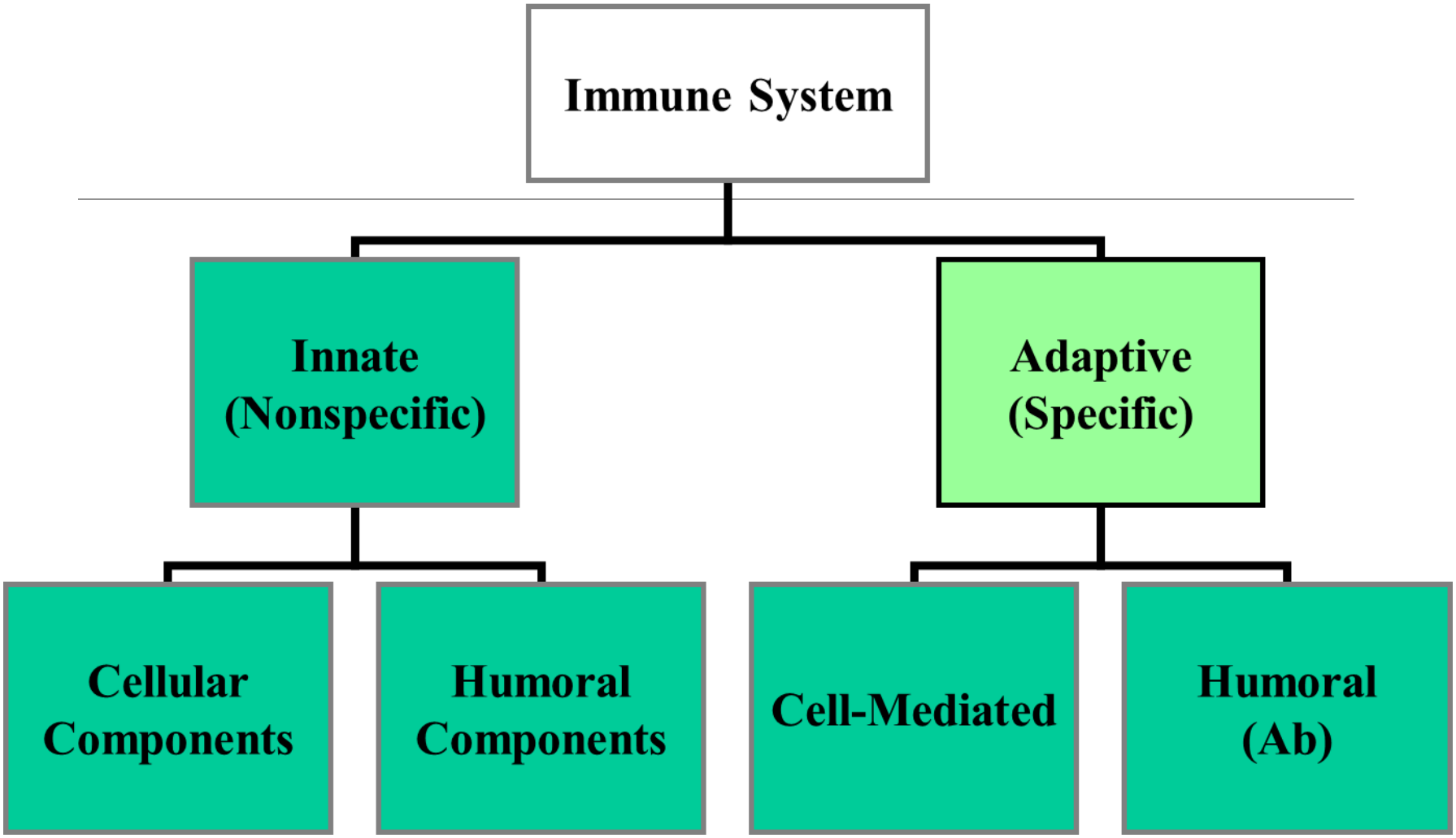
Basic Immunology III

Dr.Roongtawan Muangmoon

Learning Objectives for Immunology Overview

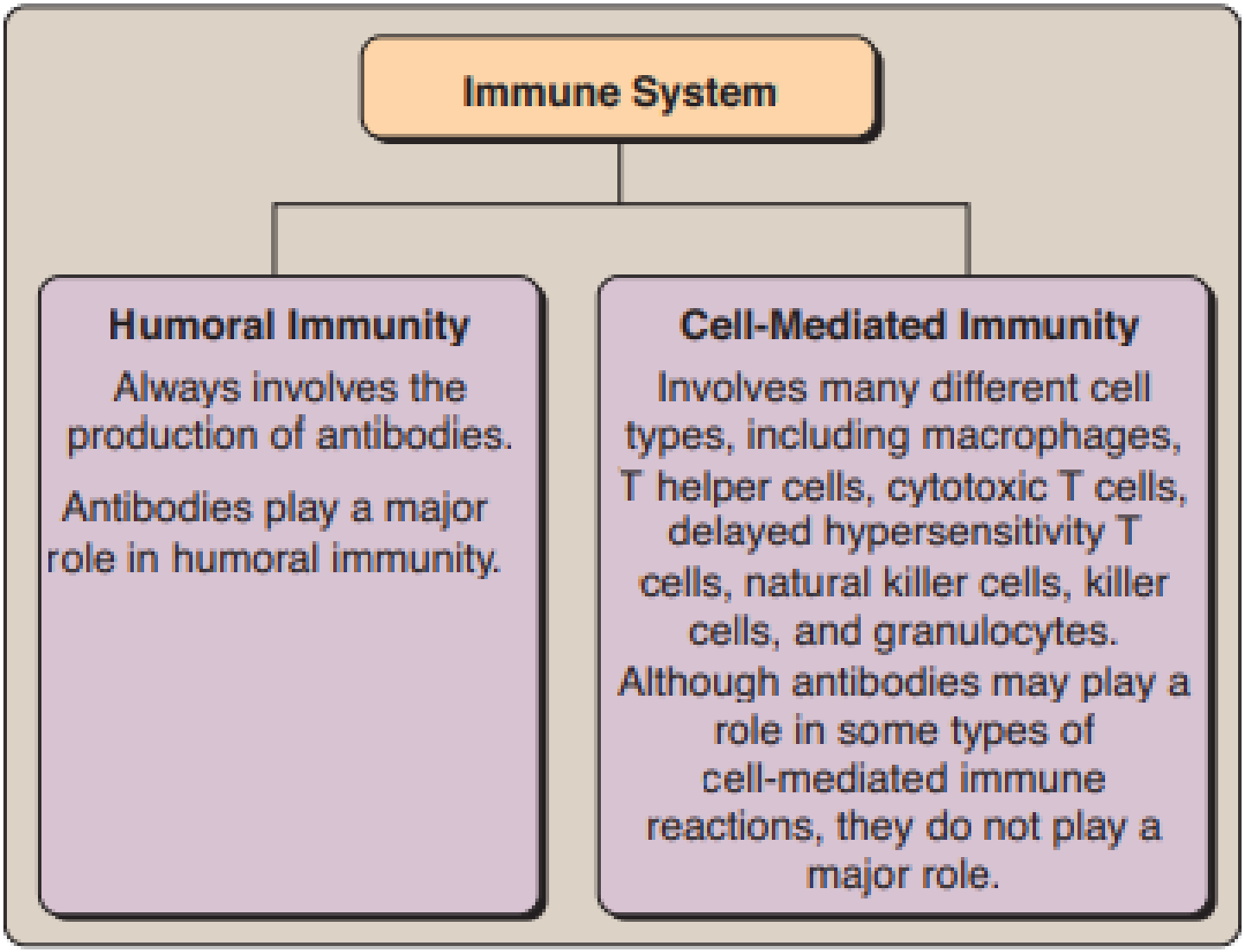
Upon completion of this lecture and exercises the student will be able to:

- Define the terms immunity, immunology
- Describe major historical events in the development of immunology
- Differentiate innate and adaptive immunity in terms of components and type of immune response.
- Explain the major defenses of innate immunity
- Describe the mechanisms used by the body to defend itself in an innate response.


Immune System
Innate (Nonspecific)
Adaptive (Specific)
Cellular Components
Humoral Components
Cell-Mediated
Humoral (Ab)

The immune system is considered to be a specific host defense mechanism and the third line of defense.

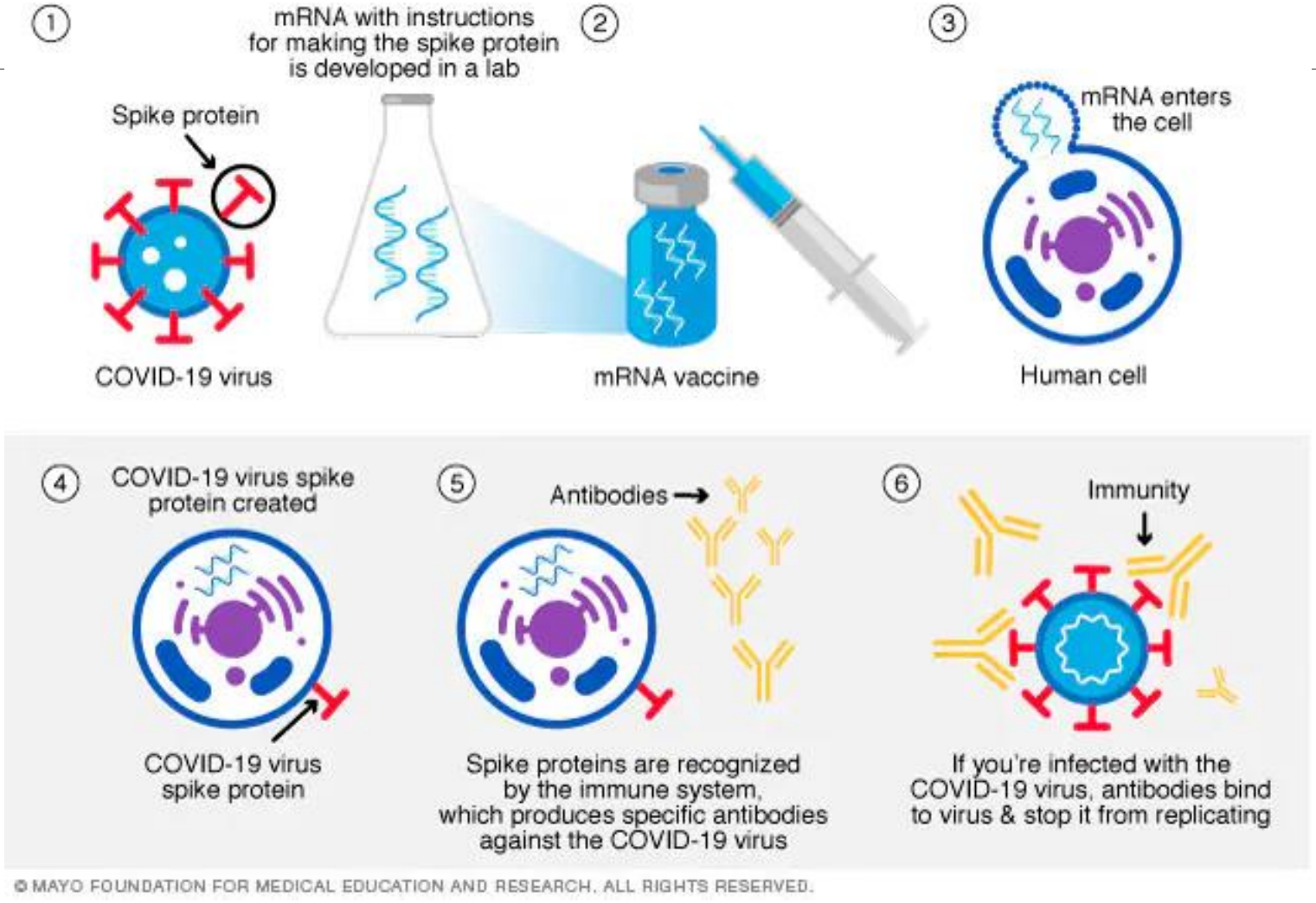
The two major arms of the immune system



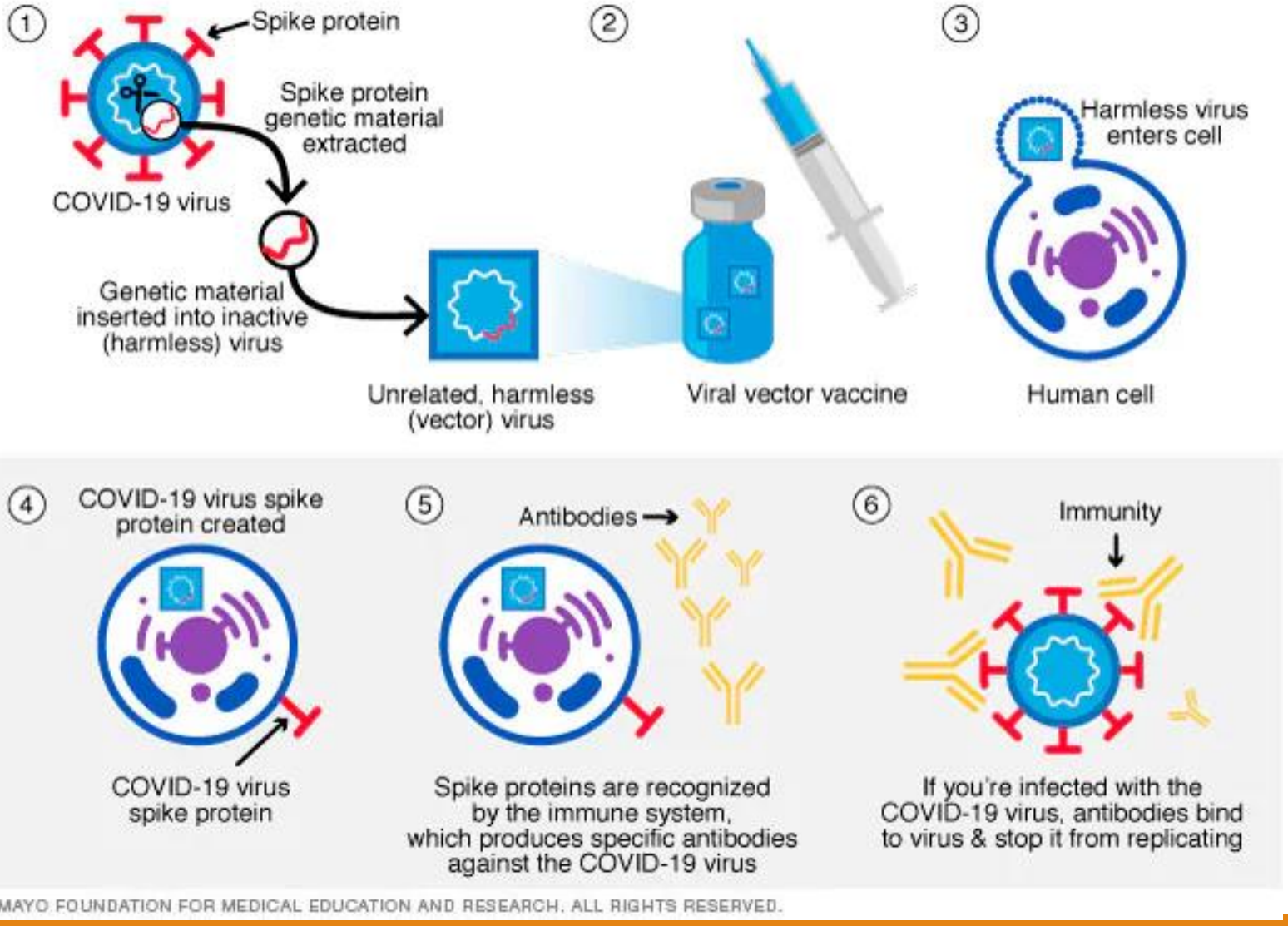

Bumrungrad
International
HOSPITAL
COVID
19
VACCINE
BOOSTER
0.5
1
1.5
2
2.5
3ml

Child receiving a vaccine. (Courtesy of Judy Schmidt, James Gathany, and the CDC.)

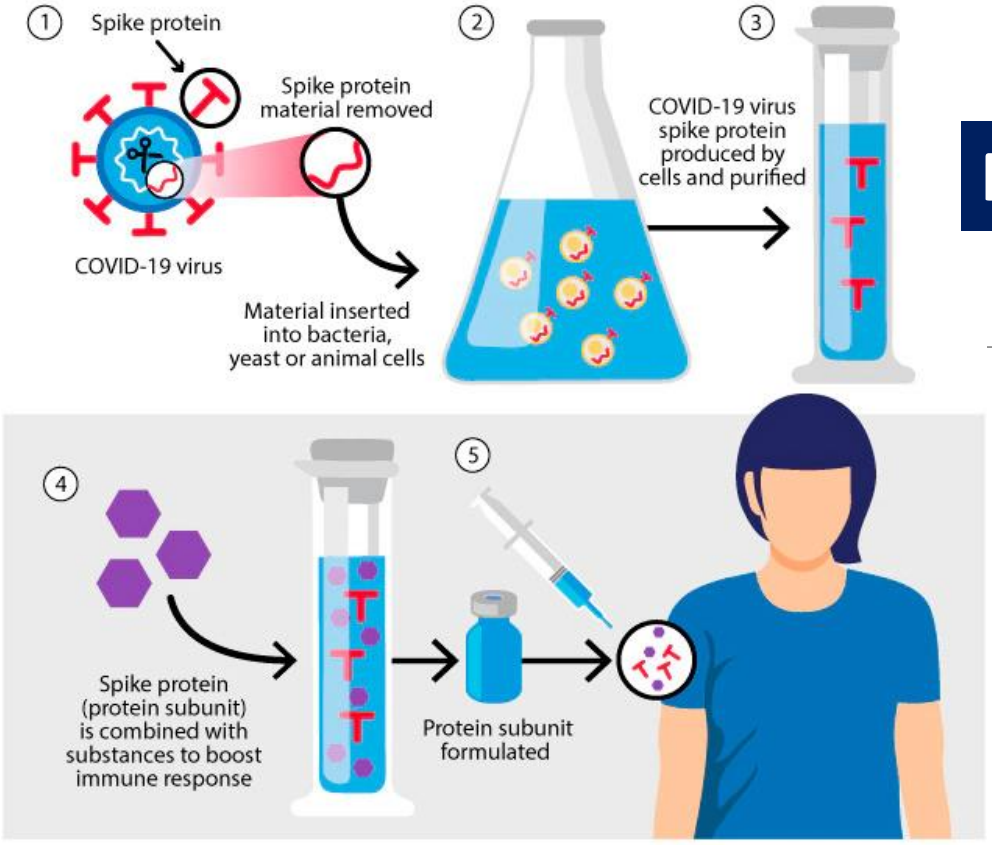
mRNA vaccine

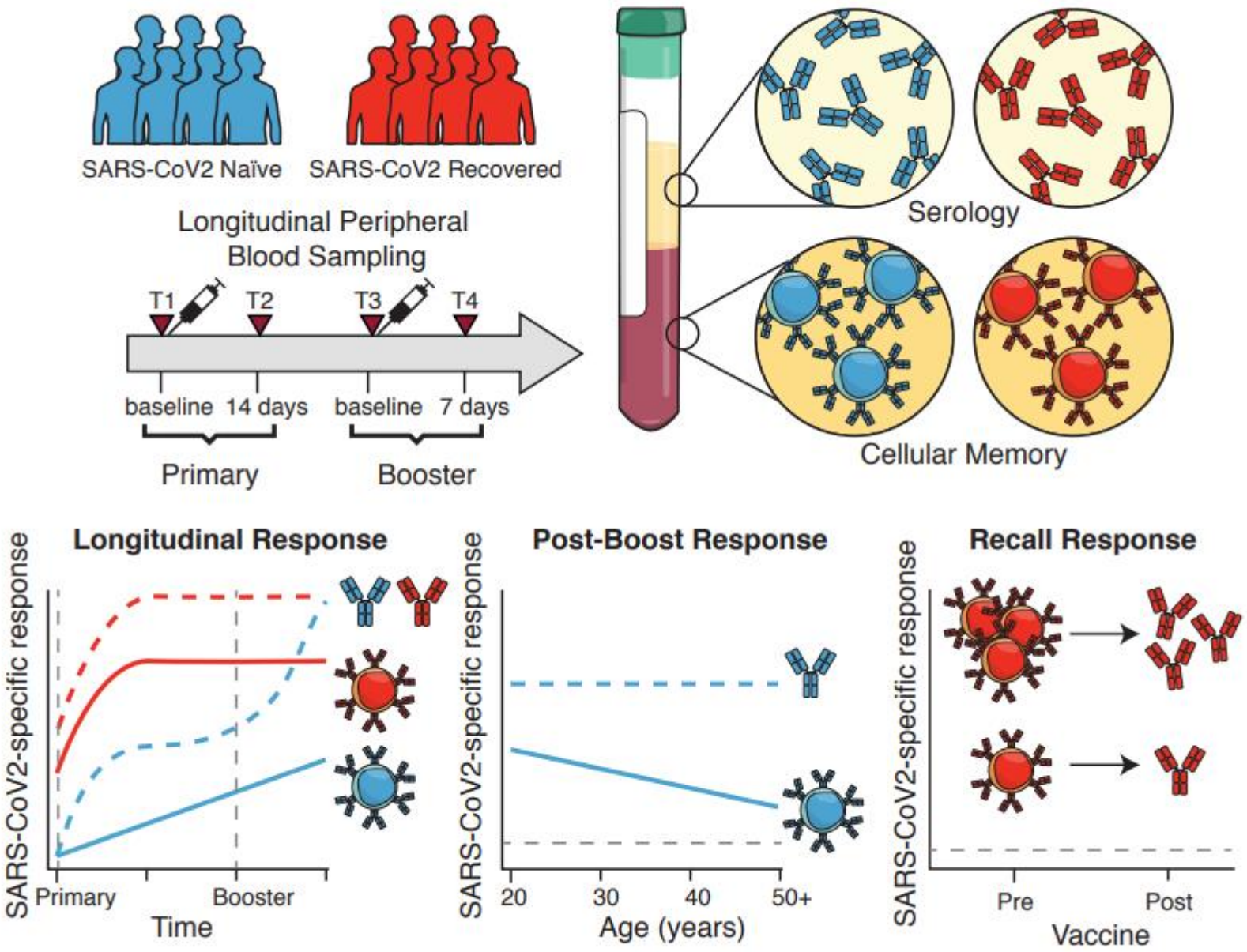


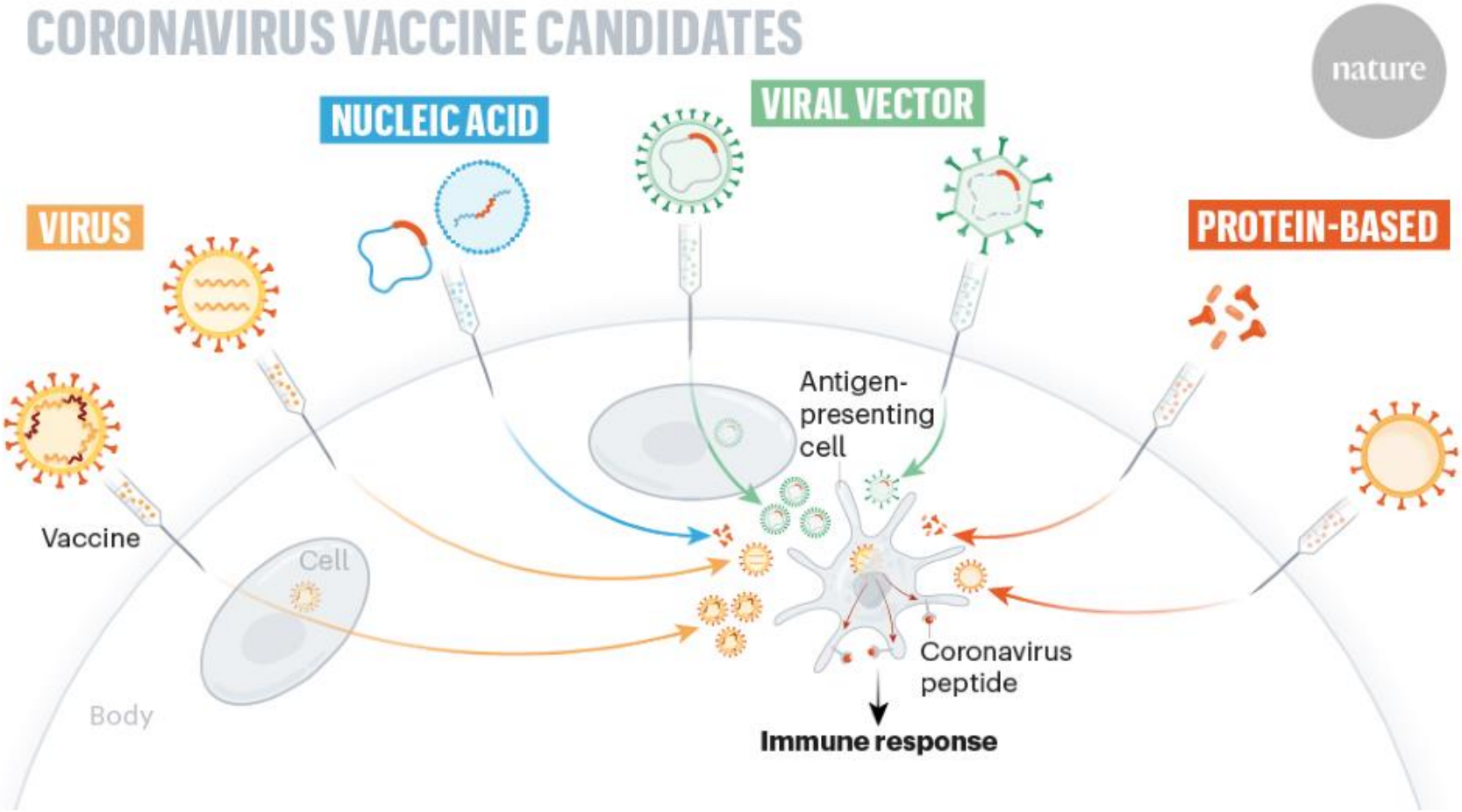
Viral vector vaccine

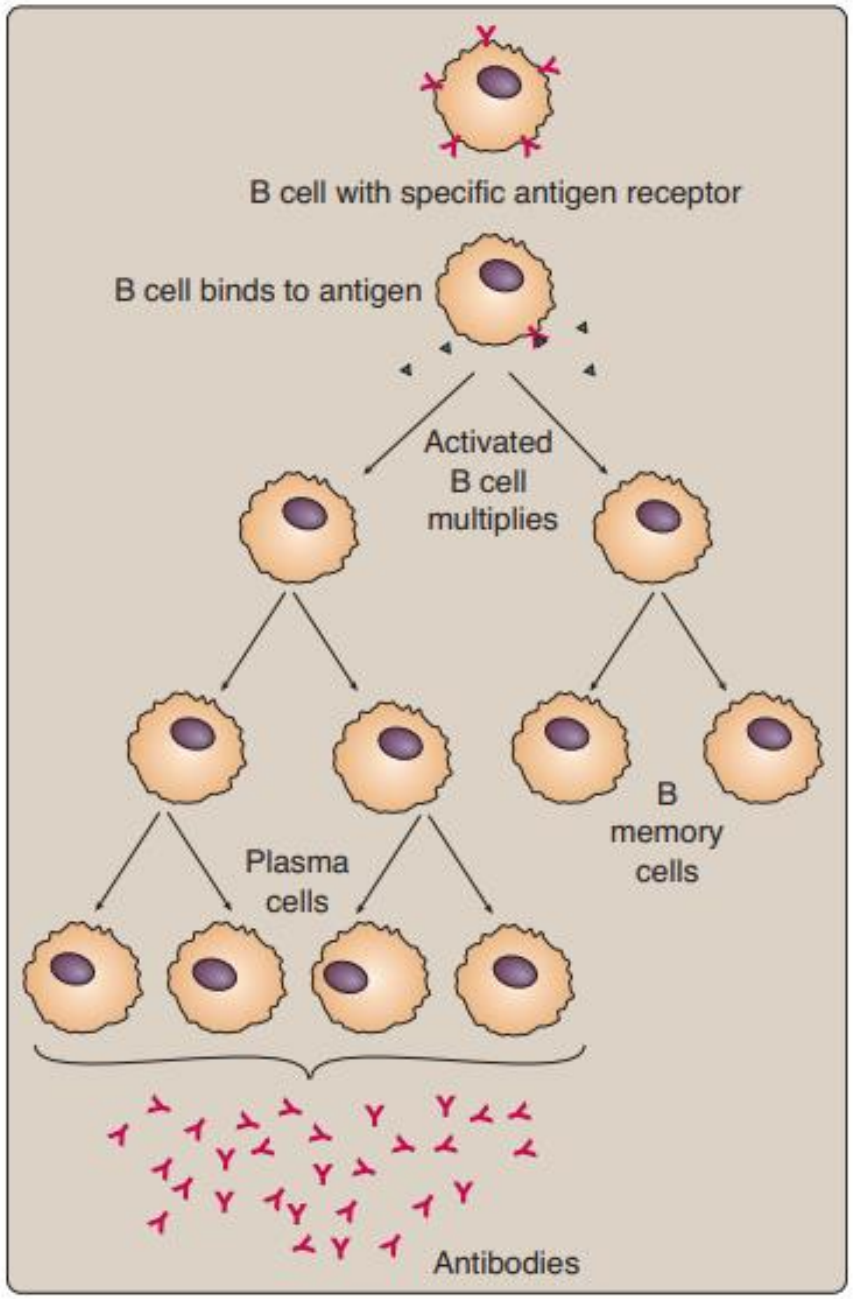


Protein subunit vaccine



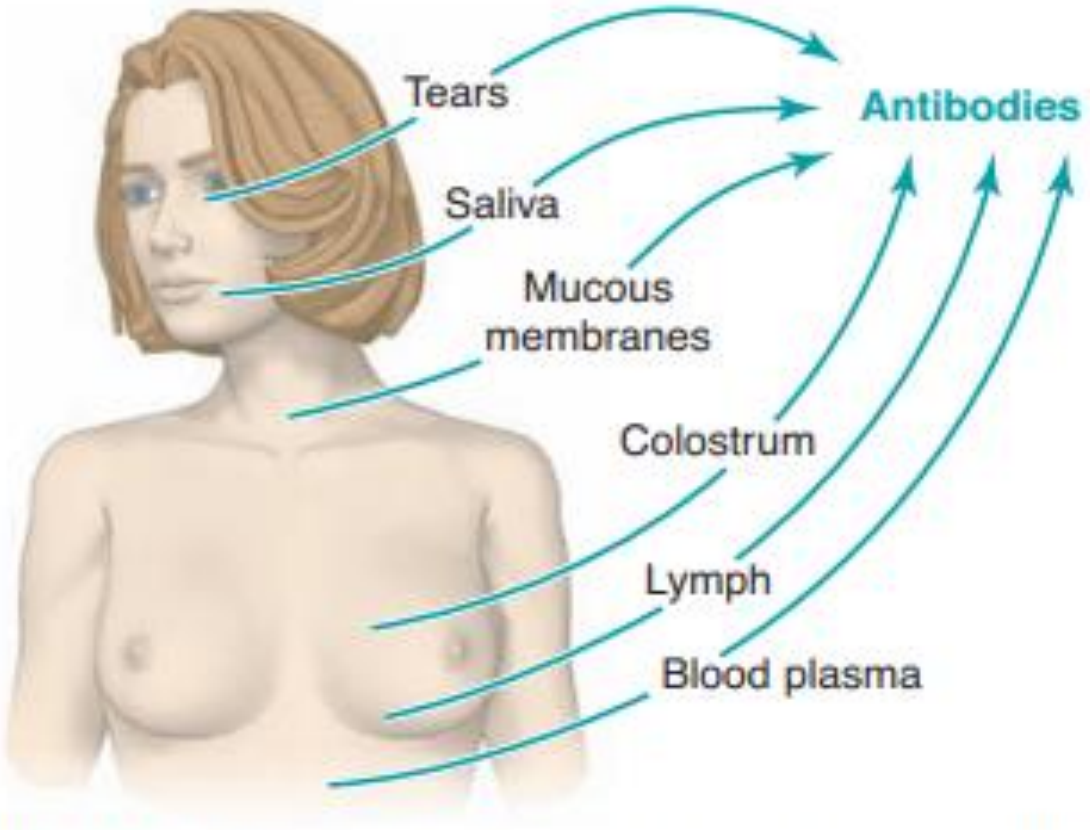

SARS-CoV2 Naïve
SARS-CoV2 Recovered
Longitudinal Peripheral Blood Sampling
T1
T2
T3
T4
baseline
14 days
baseline
7 days
Primary
Booster
Serology
Cellular Memory
Longitudinal Response
SARS-CoV2-specific response
Primary
Booster
Time
Post-Boost Response
SARS-CoV2-specific response
20
30
40
50+
Age (years)
Recall Response
SARS-CoV2-specific response
Pre
Post
Vaccine


CORONAVIRUS VACCINE CANDIDATES
nature
NUCLEIC ACID
VIRAL VECTOR
VIRUS
PROTEIN-BASED
Antigen-presenting cell
Vaccine
Cell
Body
Coronavirus peptide
Immune response

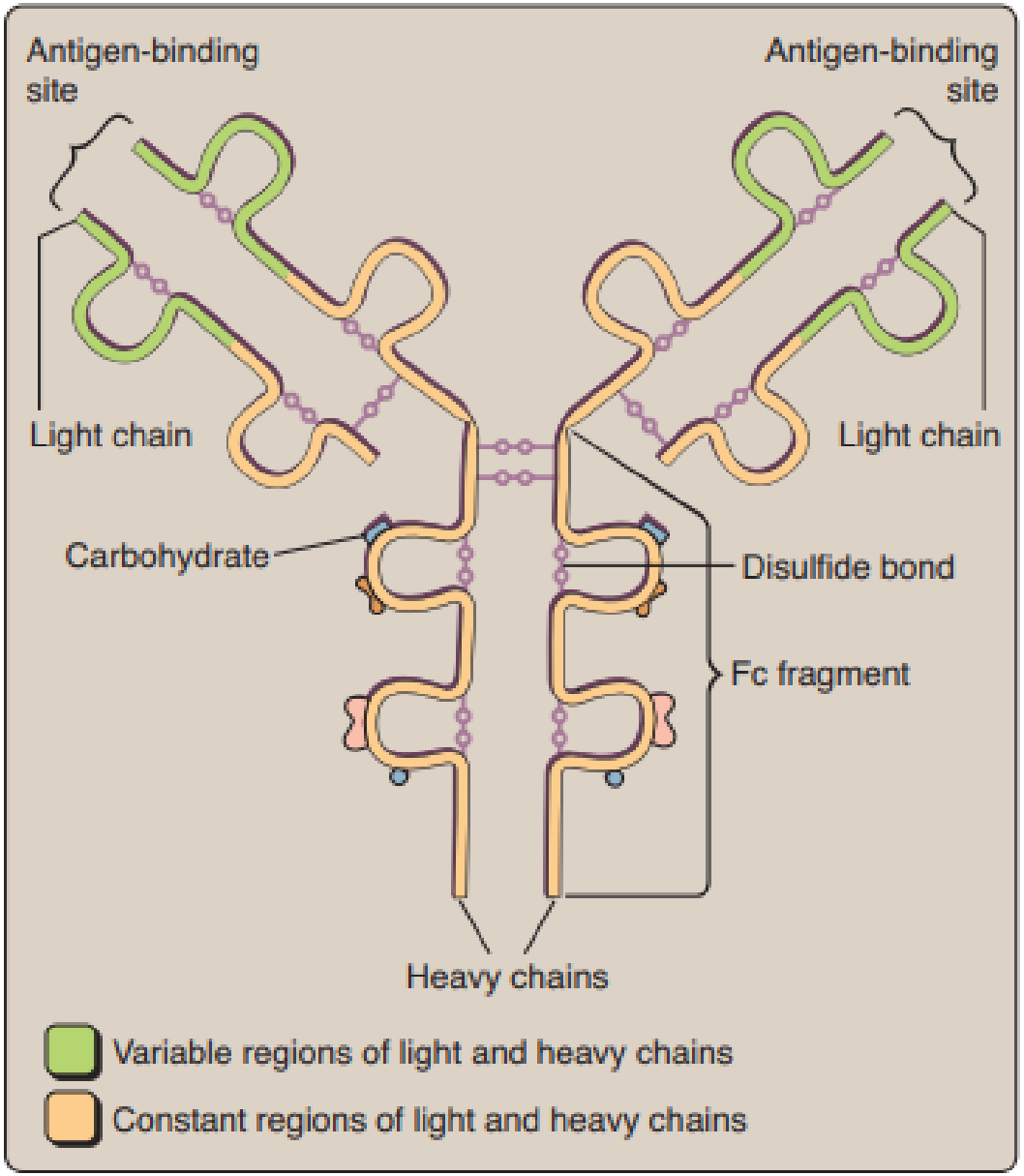


Processing of T-independent antigens.

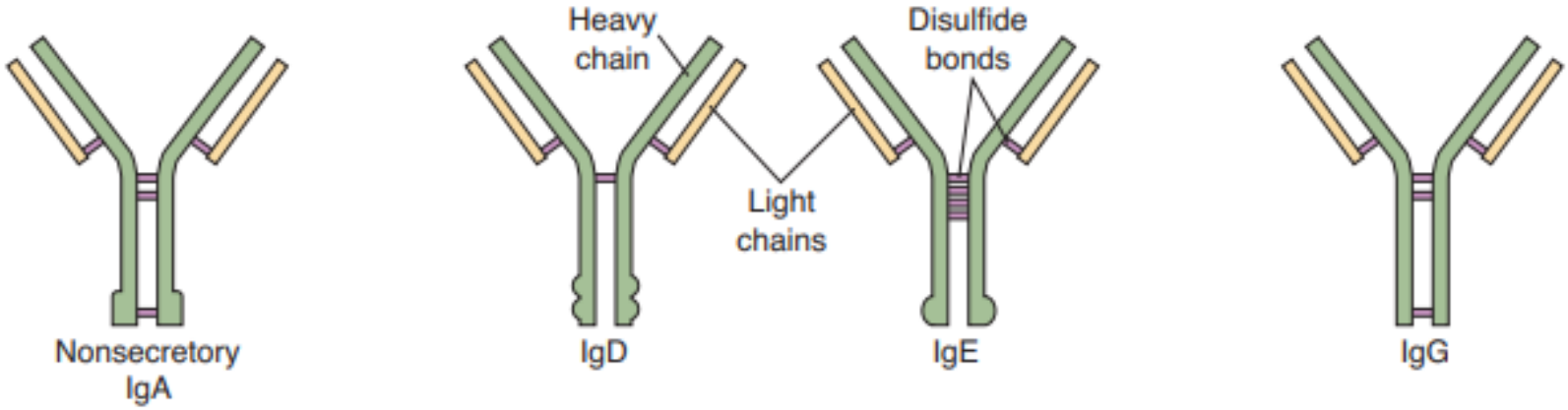
(From Cohen BJ. Memmler's The Human Body in Health and Disease, 11th ed. Philadelphia:Lippincott Williams & Wilkins, 2009.)



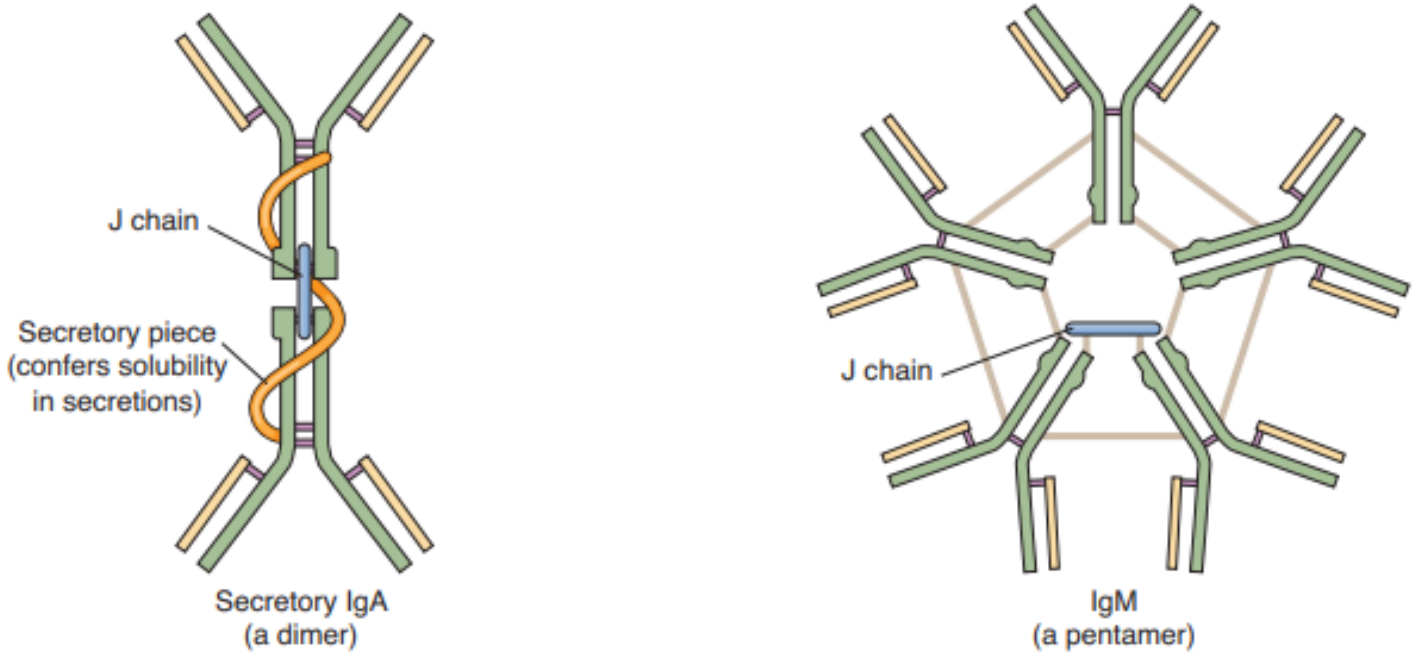
Body fluids and sites where antibodies are found.



Basic structure of a monomeric immunoglobulin molecule.

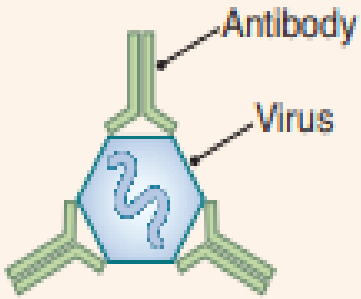
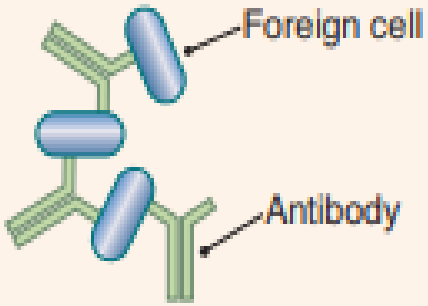
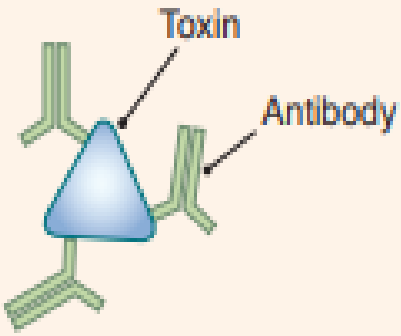


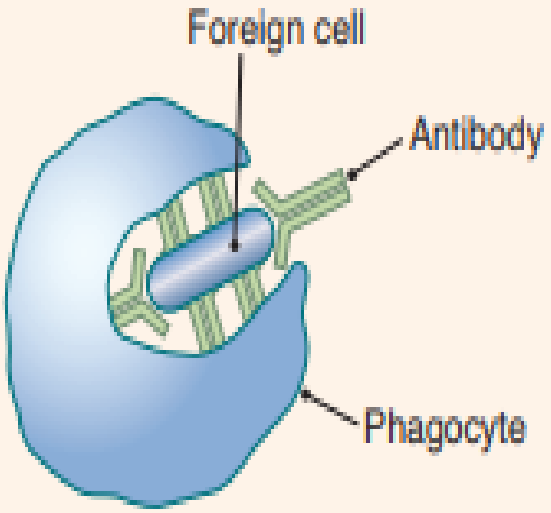
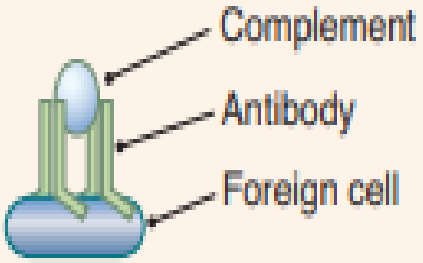
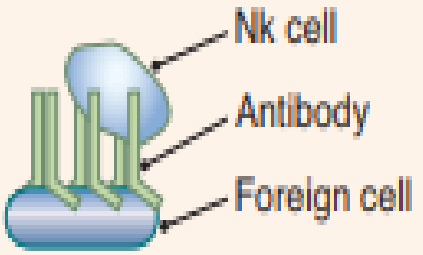
Structures of the different classes of antibodies



Structures of the different classes of antibodies

Antigen–Antibody Interactions and Their Effects

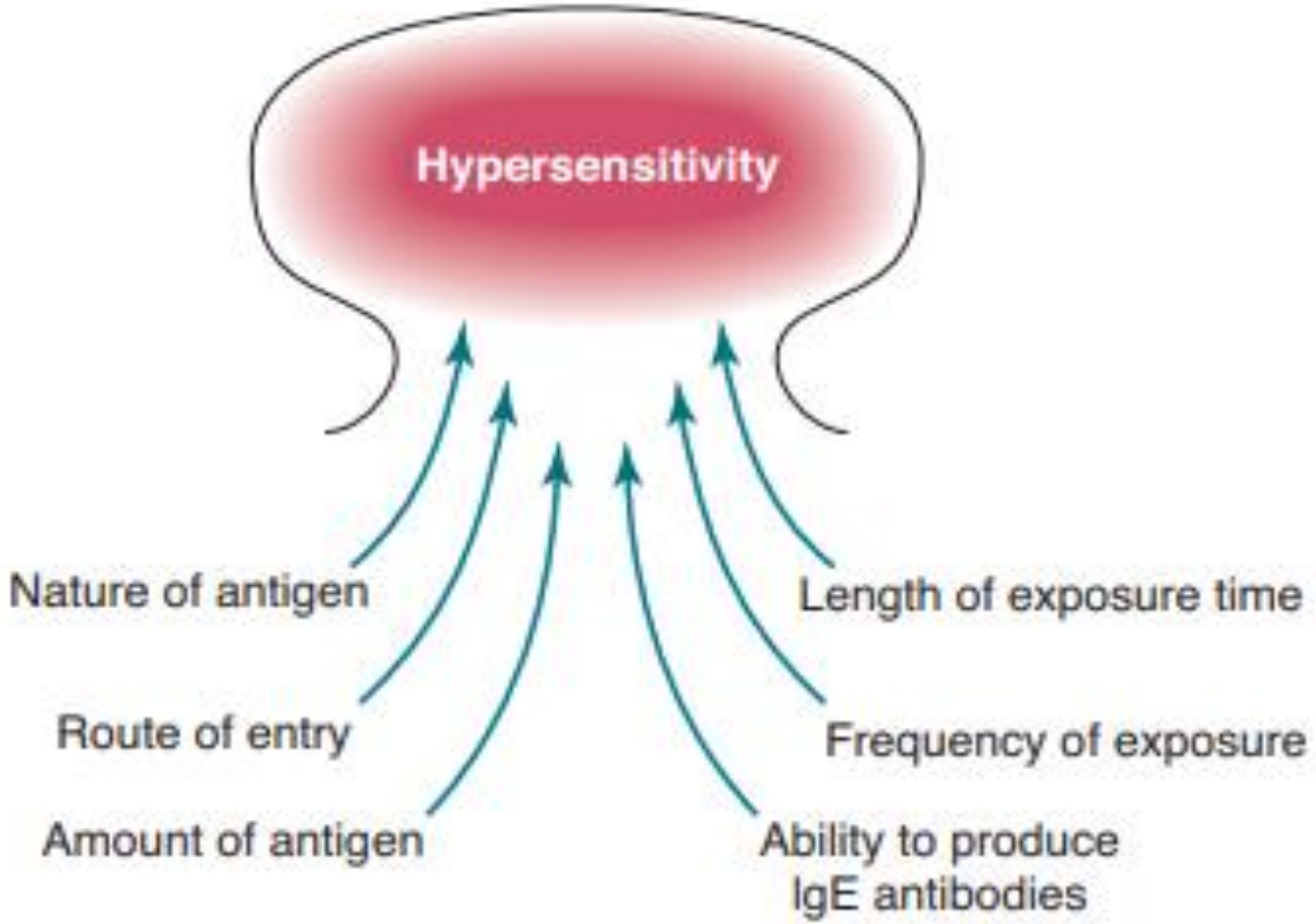
INTERACTION		EFFECTS
Prevention of attachment		A pathogen coated with antibody is prevented from attaching to a cell.
Clumping of antigen		Antibodies link antigens together, forming a cluster that phagocytes can ingest.
Neutralization of toxins		Antibodies bind to toxin molecules to prevent them from damaging cells.

Help with phagocytosis		Phagocytes can attach more easily to antigens that are coated with antibody.
Activation of complement		When complement attaches to antibody on a cell surface, a series of reactions begins that activates complement to destroy cells.
Activation of NK cells		NK cells respond to antibody adhering to a cell surface and attack the cell.

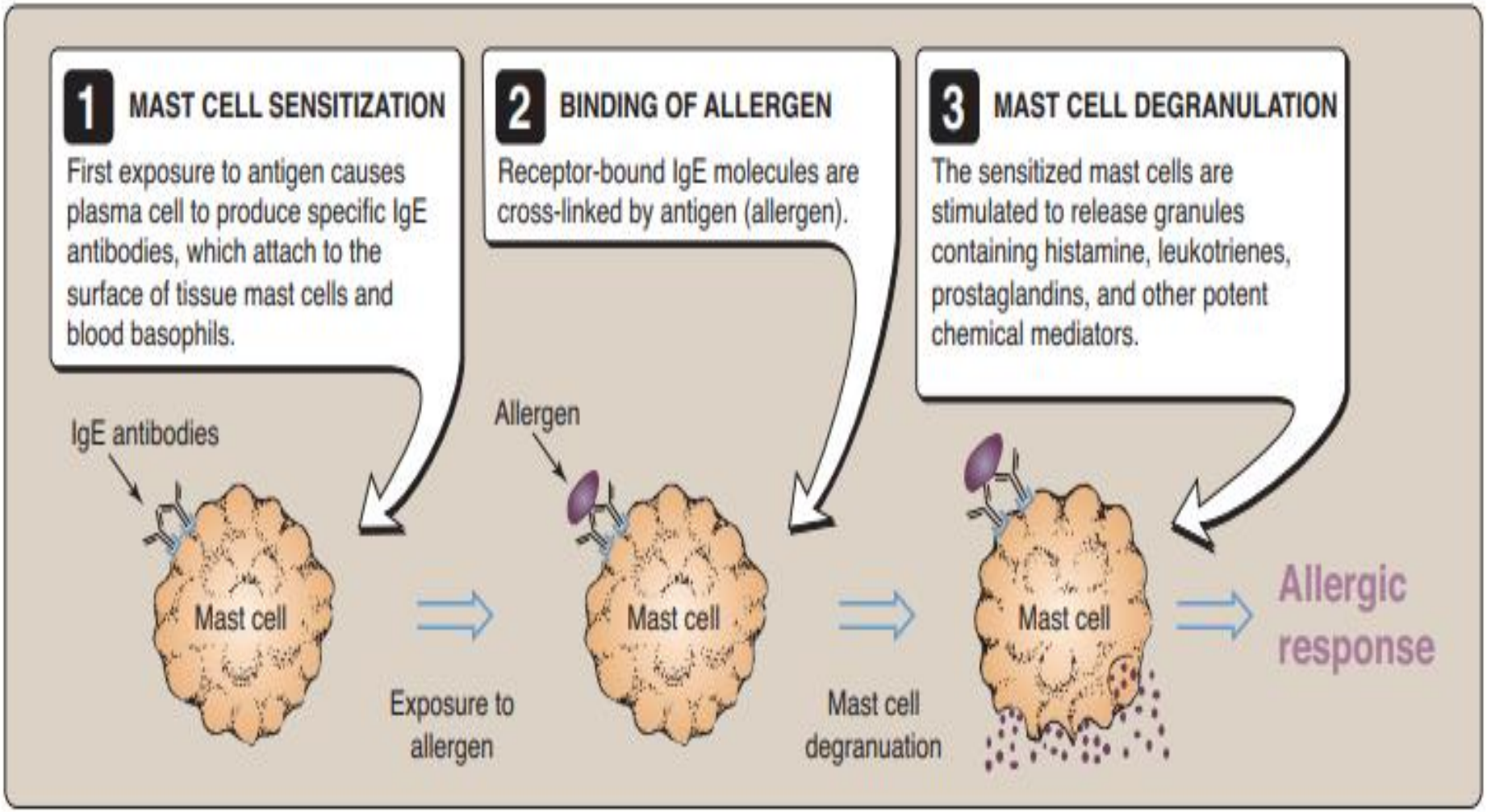
(Courtesy of Cohen BJ. Memmler's The Human Body in Health and Disease, 11th ed. Philadelphia: Lippincott Williams & Wilkins, 2009.)

Types of Hypersensitivity Reactions

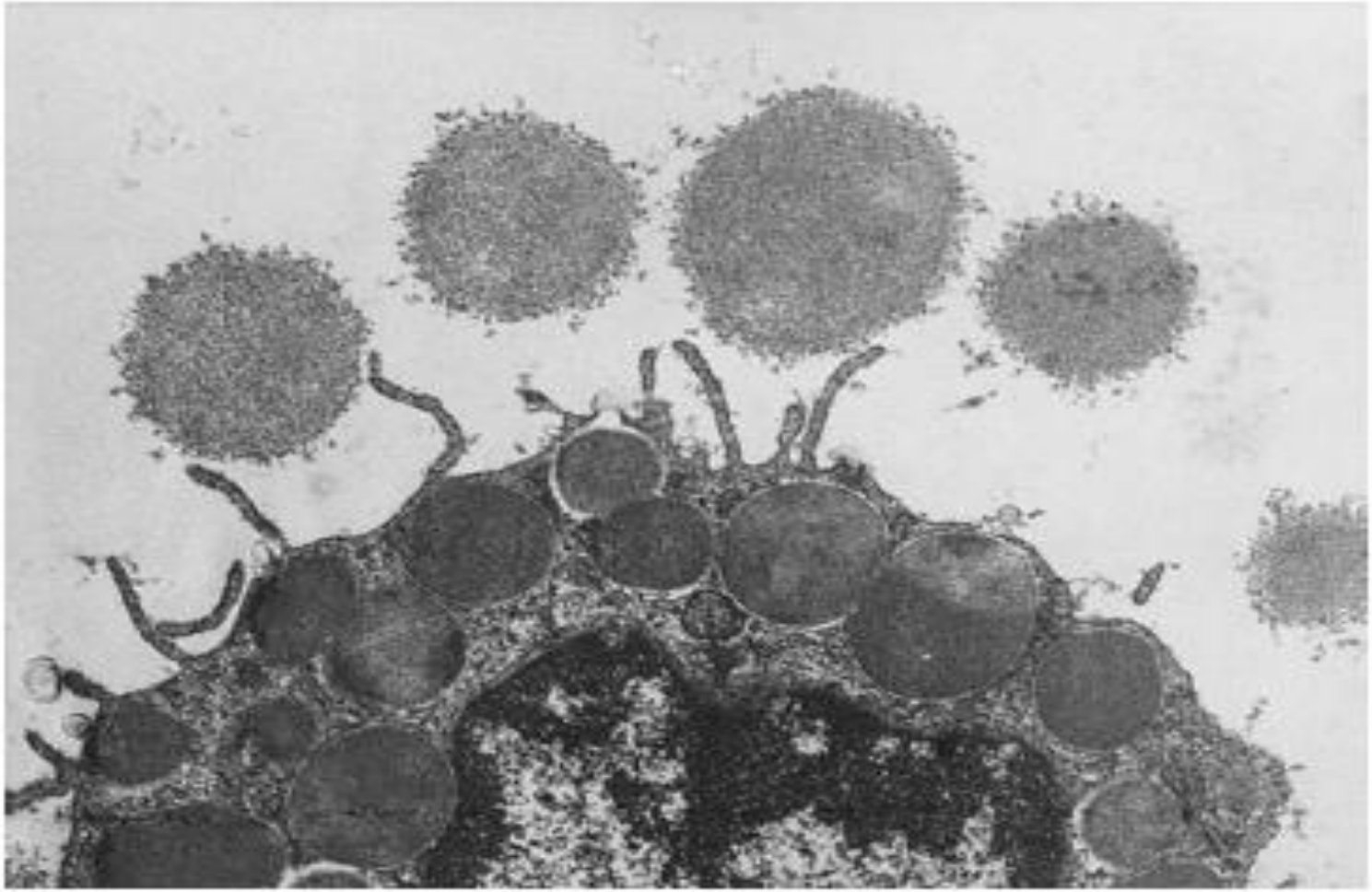
IMMEDIATE-TYPE HYPERSENSITIVITY REACTIONS (OCCUR FROM WITHIN A FEW MINUTES TO 24 HOURS AFTER CONTACT WITH A PARTICULAR ANTIGEN)	
Type I hypersensitivity reactions	Anaphylactic reactions (allergic reactions)
Type II hypersensitivity reactions	Cytotoxic reactions (involve damage to or death of body cells)
Type III hypersensitivity reactions	Immune complex reactions (damage to tissues and organs is initiated by antigen–antibody complexes)
DELAYED-TYPE HYPERSENSITIVITY (DTH) REACTIONS (USUALLY TAKE 24 TO 48 HOURS OR LONGER TO MANIFEST THEMSELVES)	
Type IV hypersensitivity reactions	Also known as cell-mediated reactions; antibodies play only a minor role, if any; an example is a positive TB skin test



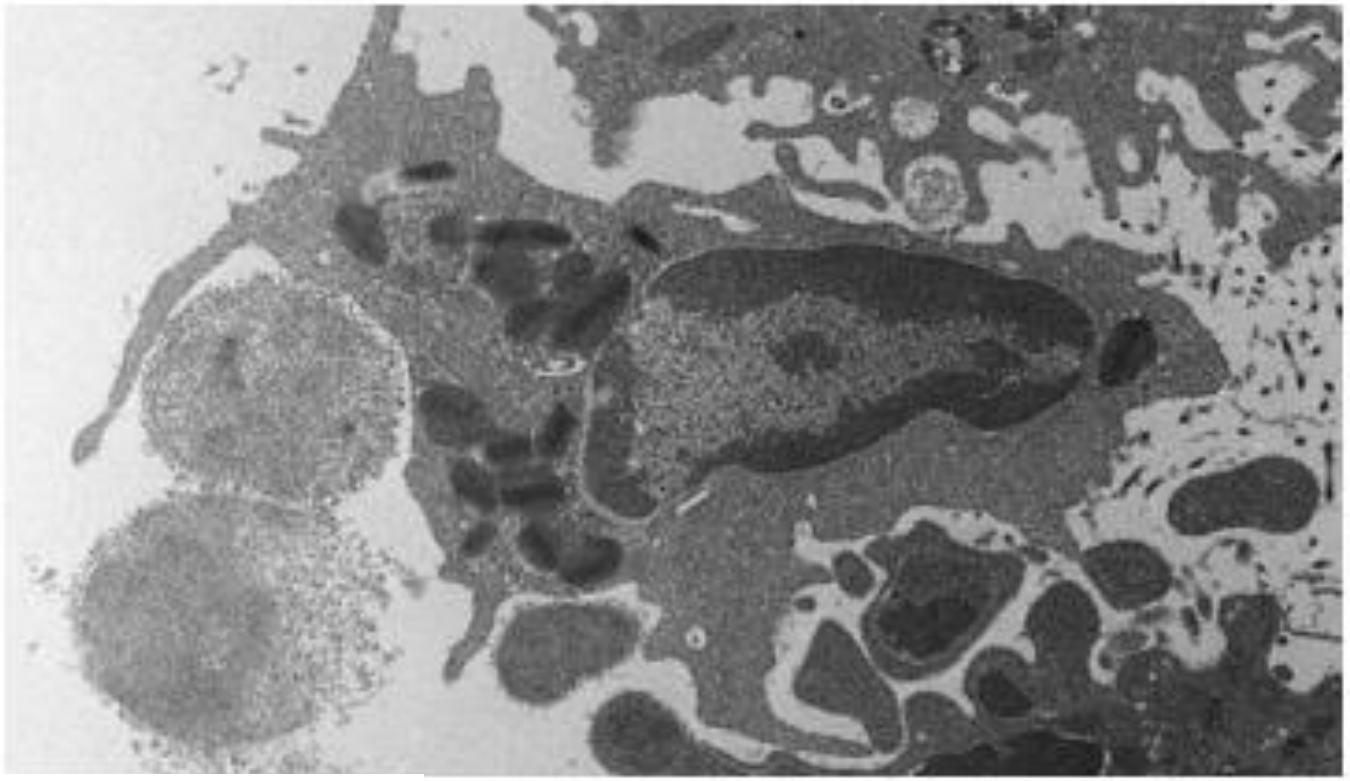
Factors in the development of type I hypersensitivity (allergies).



Events that occur in type I hypersensitivity reactions. (From Harvey RA, Champe PA, eds. Lippincott Illustrated Reviews: Microbiology. Philadelphia: Lippincott Williams & Wilkins, 2001.)

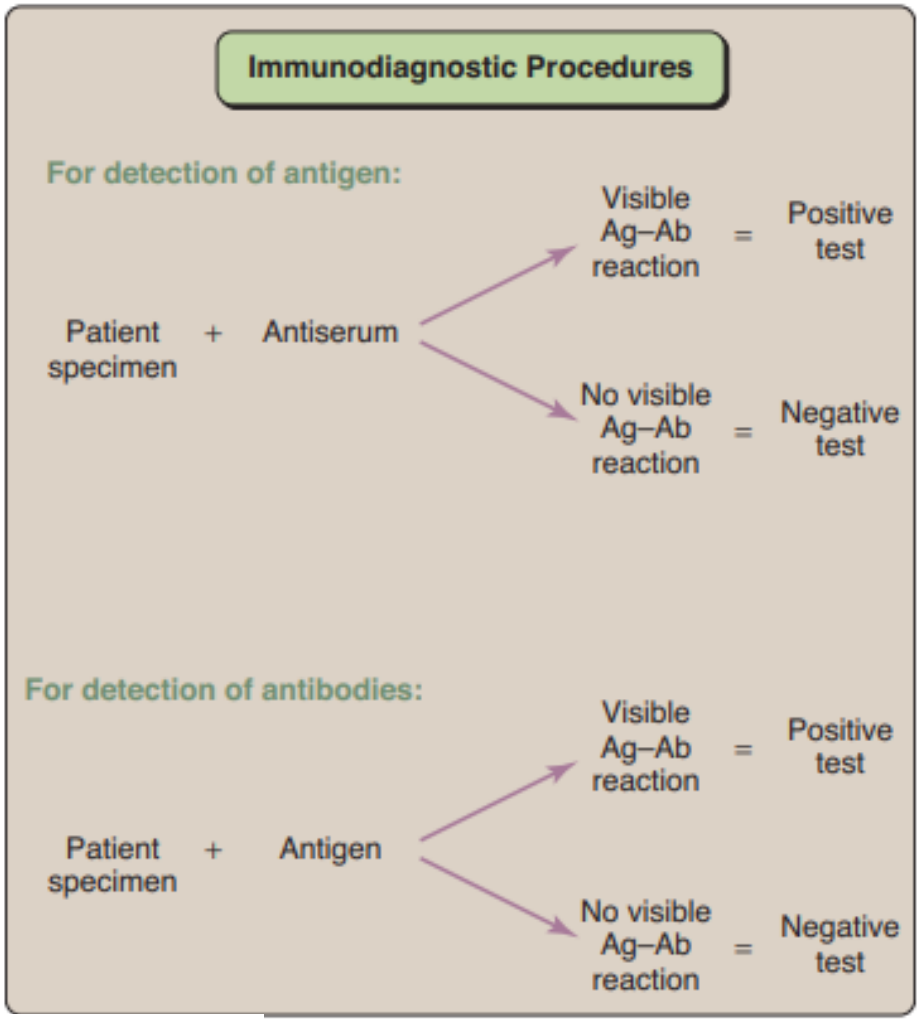


Transmission electron micrograph showing degranulation of a rat mast cell. The degranulation occurred under experimental conditions in a research laboratory. (TEM by PG Engelkirk.)



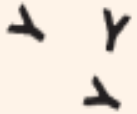
Transmission electron micrograph showing phagocytosis of rat mast cell granules by a rat eosinophil. The phagocytosis occurred under experimental conditions in a research laboratory. (TEM by PG Engelkirk.)

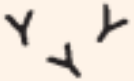
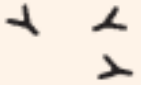
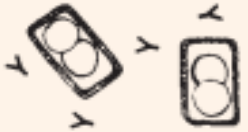
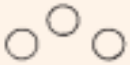
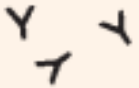
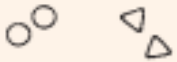
Mantoux skin test. This test is performed by injecting 0.1 mL of tuberculin or PPD intradermally and observing the results 48 to 72 hours later. If the person has been exposed to mycobacteria in the past, redness and swelling will occur at the injection site; this constitutes a positive TB skin test result. The diameter of induration (the palpable raised hardened area)—not the area of redness—is measured and the results are interpreted using standardized criteria. (Courtesy of Gabrielle Benenson, Greg Knobloch, and the CDC.)



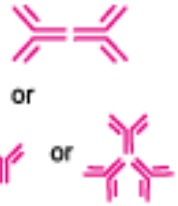
Principles of antigen and antibody detection procedures. Depending on the type of immunodiagnostic procedure being performed, the visible antigen–antibody (Ag–Ab) reaction might be agglutination (clumping) of cells or latex particles, formation of a precipitin line or band, fluorescence, or production of a color (as in enzyme immunoassays).

Immunodiagnostic Procedures for Detection of Antibodies in a Patient's Serum

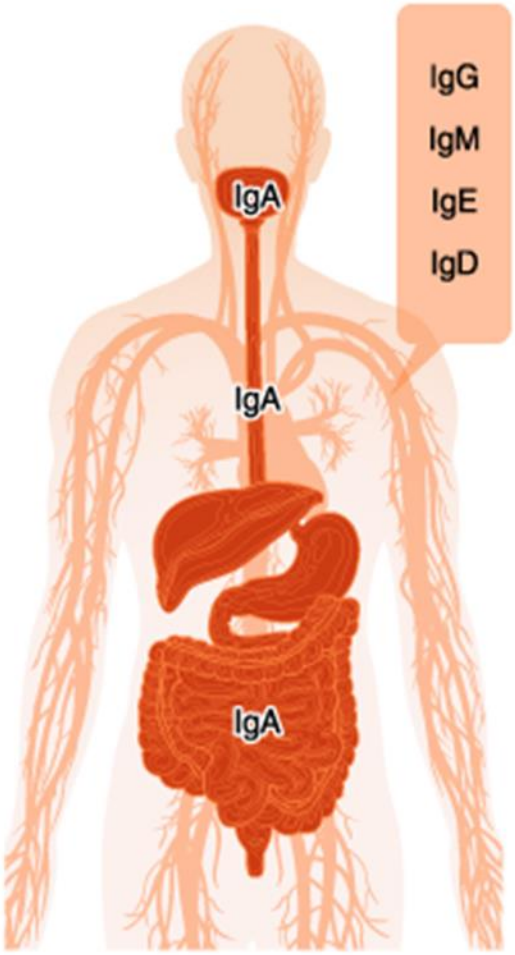
REACTION IN VITRO	REAGENTS			RESULTS	
	Antigen	Antibody	Other	Positive	Negative
Agglutination	Red blood cells or bacteria 	Patient's serum 		Clumping 	No clumping 
Precipitin	Toxins, hormones, proteins 	Patient's serum 	Agar or solution	Precipitate 	No precipitate 

Lysis by Complement	Cells, bacteria 	Patient's serum 	Complement 	Lysis 	No lysis 
Fluorescent Antibody Technique	Pathogen 	Patient's serum 	Fluorescein-tagged rabbit antihuman antiserum 	Fluorescent pathogen 	No fluorescence 
Capsular Swelling (Quellung Reaction)	Encapsulated bacteria 	Patient's serum 		Capsule appears to swell 	No appearance of swelling 
Enzyme-linked assay	Test microbe 	Patient's serum 	Enzyme-linked antibody  +Substrate 	Color change 	No color change 

Types and characteristics of antibodies

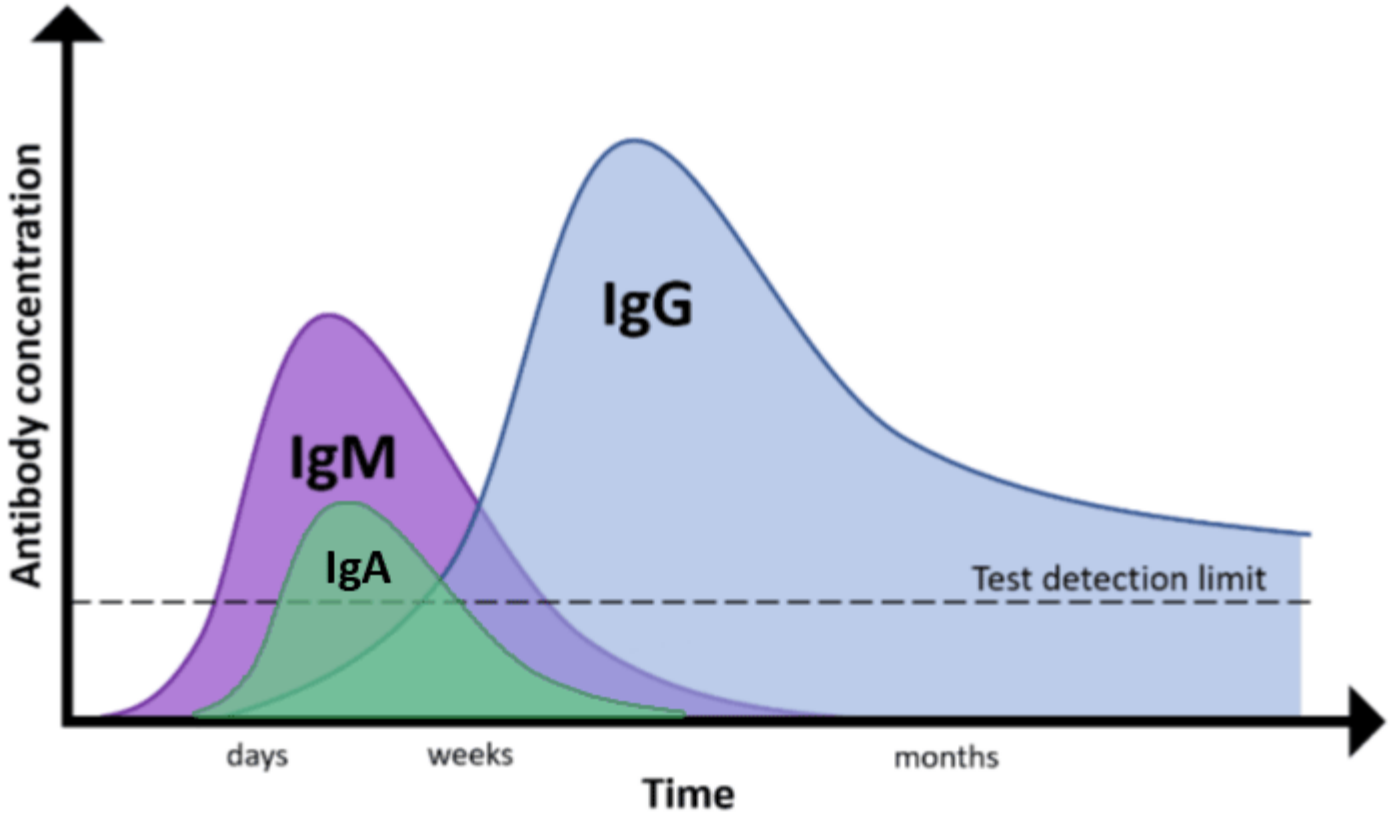
IgG		• Highest opsonization and neutralization activities. • Classified into four subclasses (IgG1, IgG2, IgG3, and IgG4).
IgM		• Produced first upon antigen invasion. Increases transiently.
IgA		• Expressed in mucosal tissues. Forms dimers after secretion.
IgD		• Unknown function.
IgE		• Involved in allergy.

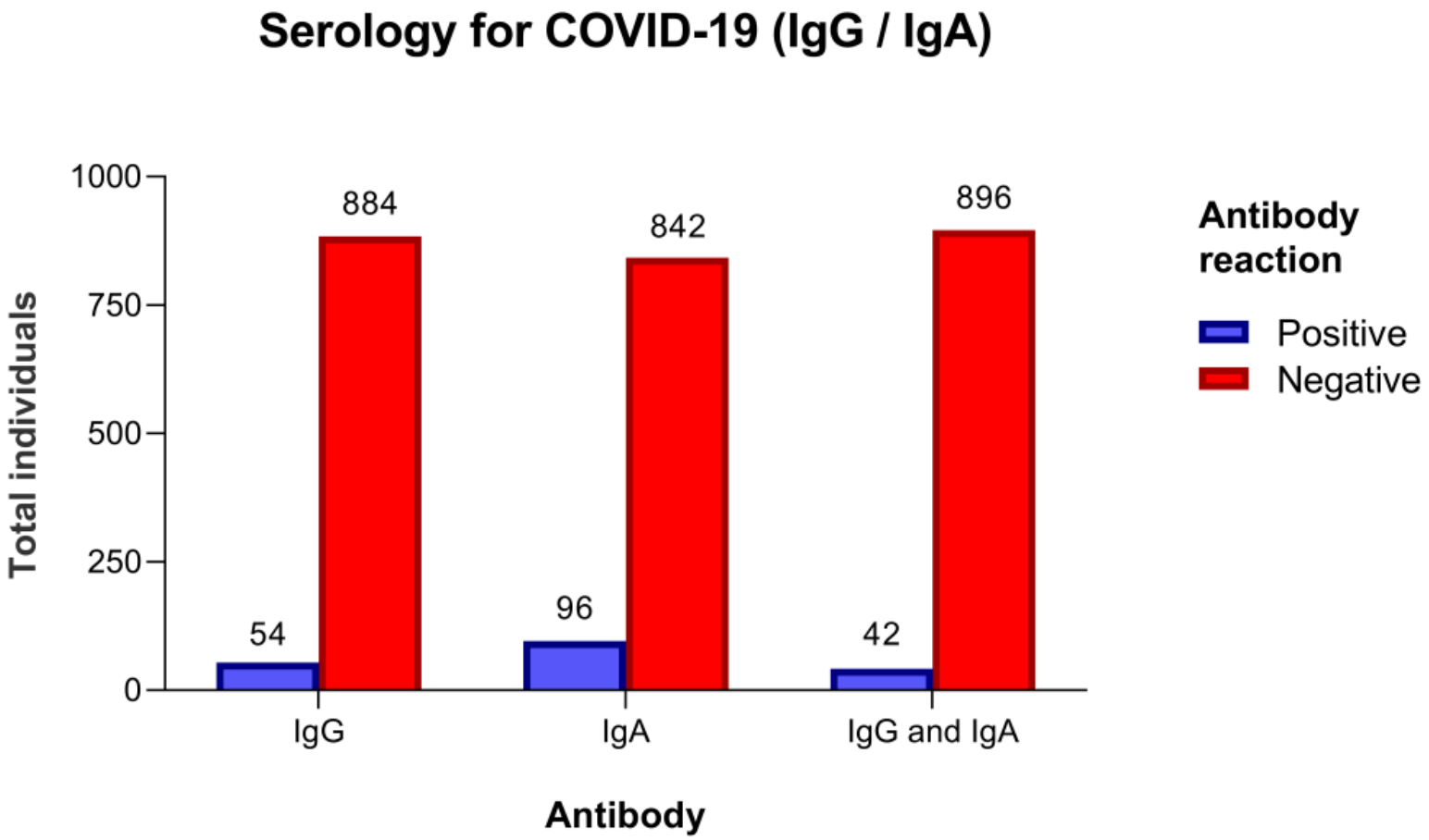
Distribution in the body



EXAMPLE

Antibodies in SARs-CoV-2 and COVID-19





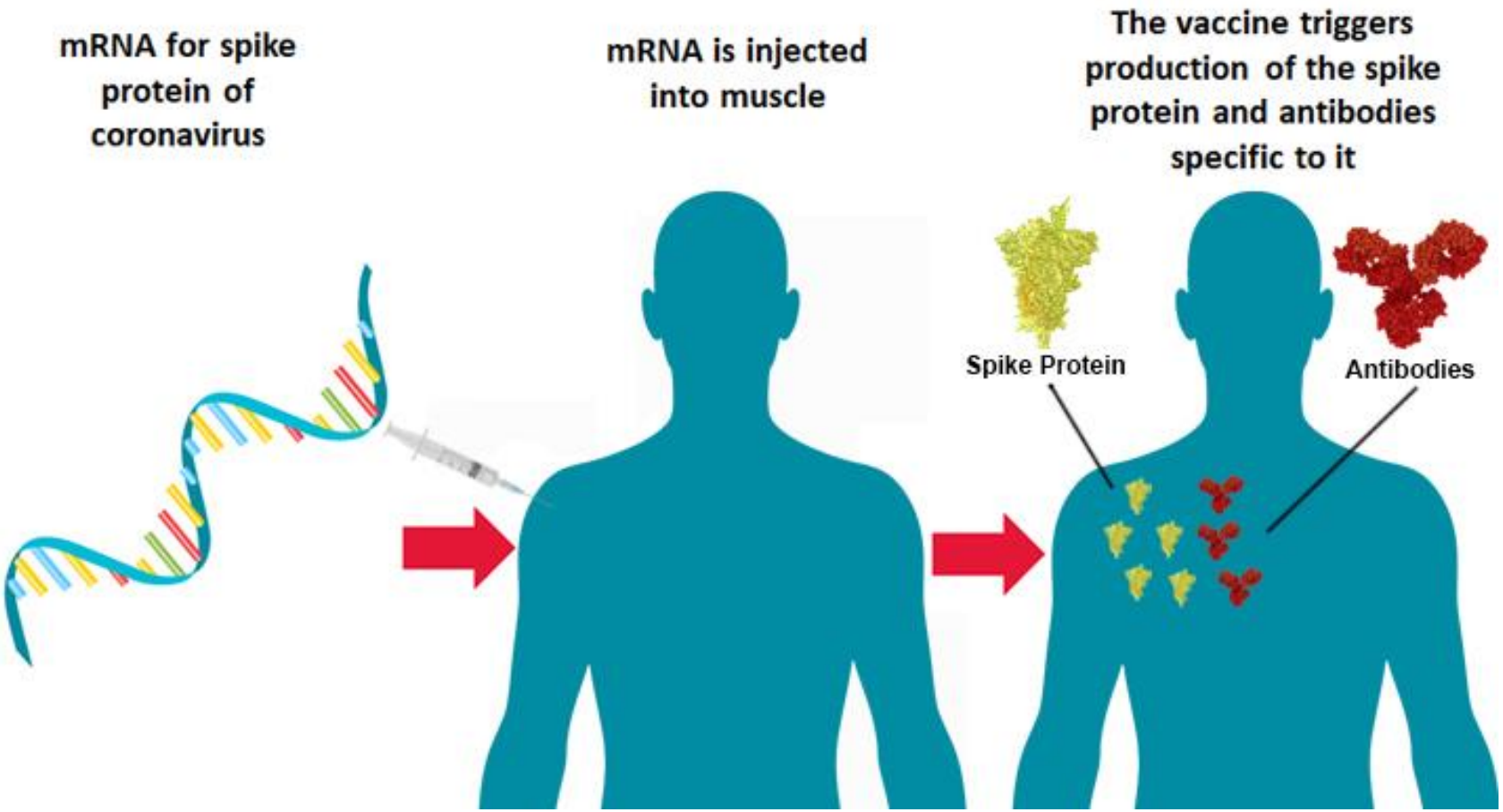
https://jogh.org/the-false-positive

Immunoglobulin Classes

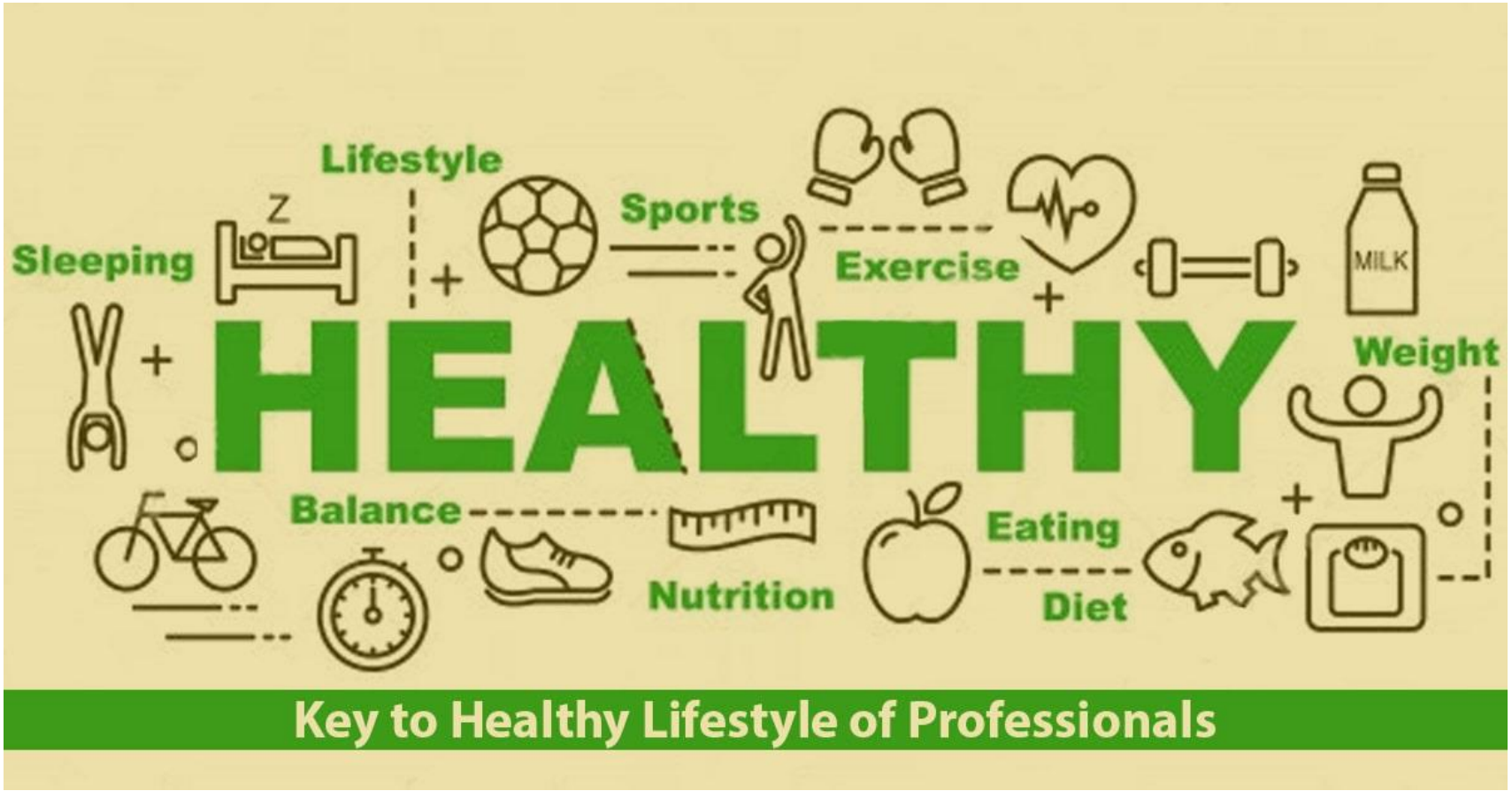
IG CLASS	MOLECULAR WEIGHT (IN DALTONS)	% OF TOTAL IG IN SERUM (APPROXIMATE)	FUNCTIONS
IgA	160,000 to 385,000; can exist as a monomer or as a dimer (two monomers held together by a short protein chain called a J-chain ["J" for joining])	10 to 20	The predominant immunoglobulin class in saliva, tears, seminal fluid, colostrum, breast milk, and mucous secretions of the nose, lungs, and gastrointestinal tract. In secretions, IgA is primarily present as secretory IgA (sIgA), a dimer that contains an additional protein called the secretory component. The secretory component apparently facilitates the transport of sIgA into secretions and may serve to protect the IgA molecule from enzymatic damage within the gastrointestinal tract. Protects external openings and mucous membranes from the attachment, colonization, and invasion of pathogens. IgA in colostrum and breast milk helps protect nursing newborns. In the intestine, IgA attaches to viruses, bacteria, and protozoal parasites, such as *Entamoeba histolytica*, and prevents the pathogens from adhering to mucosal surfaces, thus preventing invasion.

IgD	180,000 to 184,000 (a monomer)	<1	Found in large quantities on the surface of B cells. Its function is unknown, but it is possible that the IgD molecules on the B cell's surface serve as antigen receptors and determine which specific antigen that particular B cell is able to respond to.
IgE	188,000 to 200,000 (a monomer)	<1	In atopic individuals, IgE is produced in response to allergens. Found on the surfaces of basophils and mast cells. Plays a major role in allergic responses. (Basophils are granulocytes that circulate in the blood. Mast cells are morphologically very similar to basophils, but they are found in tissues—especially tissues that surround the eyes, nose, respiratory tract, and gastrointestinal tract.)

IgG	146,000 to 170,000 (a monomer; the lightest of the immunoglobulins)	70 to 85 (the most abundant immunoglobulin type in serum)	The only class of immunoglobulin that can cross the placenta. Maternal IgG antibodies that cross the placenta help protect the newborn during its first months of life. Antigen-bound IgG can bind to and activate complement, a process known as "complement fixation." IgG molecules can bind to a wide range of cellular receptors to promote phagocytosis and antibody-dependent cytotoxicity. As a result of memory cells, high levels of IgG are produced very rapidly (within 1 to 3 days) during the secondary response to antigens (described earlier). IgG antibodies are long-lived, sometimes persisting for the lifetime of the individual.
IgM	900,000 to 970,000 (a pentamer, consisting of five monomers held together by a J-chain; the largest of the immunoglobulins)	10	Because a pentamer has 10 antigen-binding sites, IgM can potentially bind to 10 identical antigenic determinants. Theoretically, an IgM molecule could bind to 10 separate virus particles, thus preventing the viruses from attaching to target cells. IgM antibodies are the first antibodies formed in the primary response to antigens (including pathogens), although IgG antibodies later become the most prevalent class. IgM antibodies are relatively short-lived, remaining in the bloodstream for only a few months. Because of its large size, IgM does not cross the placenta. Provides protection in the earliest stages of infection. Bactericidal to Gram-negative bacteria. IgM is the most efficient complement-fixing (complement-binding) immunoglobulin.



https://directorsblog.nih.gov/2020


Lifestyle
Sleeping
Sports
Exercise
MILK
HEALTHY
Weight
Balance
Eating
Nutrition
Diet
Key to Healthy Lifestyle of Professionals


"Prevention is better than cure."
~ Desiderius Erasmus