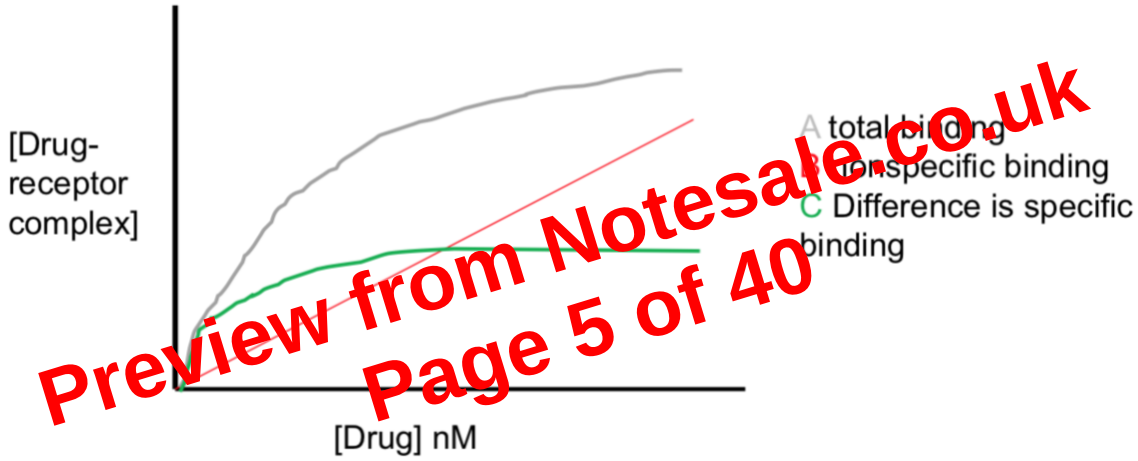
Saturation curve

- Total binding is the ability of the ligand to bind to any type of receptor.

- Ligand wants to bind to R, but may also bind to non-specific receptors too (such as R_a and R_b)

The difference between the two types of binding is represented by line C on the graph. Shows the actual saturation curve of the ligand binding to the target receptor.

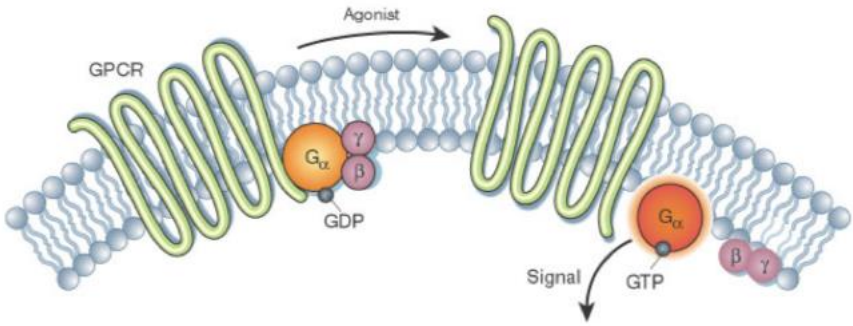


Spare receptors

- When a ligand is introduced, and it interacts with a receptor or enzyme, the biological response will gradual increase into a maximal response is reached.

- Not all of the binding sites need to be activated in order to see a maximal binding response

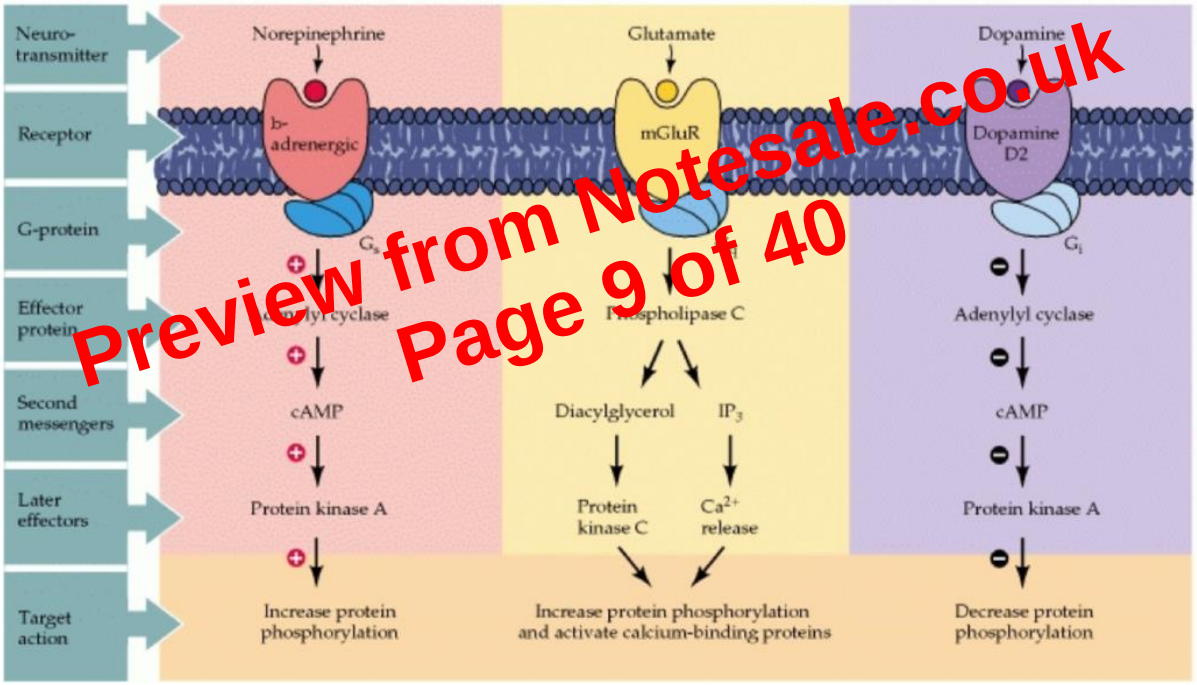
- In terms of spare receptors, it may be seen for some biological systems, only a small number of ligands are needed to interact with a small number of receptors.
  For example, only 10% of acetylcholine receptors need to be activated to see a maximal response and produce muscle contraction.
  As only a small amount is needed the body only needs to synthesise a small number.
  This induces a quick response and is biologically efficient.



Second messengers and GPCR signals

- There are 3 different types of G-protein. Type depends on the region of the body where they are located.
- Gq, Gs and Gi
  (Gs – looking at histamine and immune responses)

Different types of G-proteins:



- Type of G-protein determines which type of biochemical pathway is activated. Overall action is always a change in phosphorylation. This all helps to regulate biochemical (and immune) responses.

- Type 1 gives millisecond responses, there are typically involuntary actions and therefore an instant response.

- Type 2 is typically slower and response times are slower. Usually voluntary controls. However, some are involuntary, e.g. immune response.

- Nitric oxide pathway. Nitric oxide helps to regulate blood pressure, this takes place out of phagocyte cell. In immune response more oxygen is found, this activates nitric oxide to cross the phagocyte outer membrane via the O_2 and NO interaction, the highly reactive nitrogen species is produced. Reactive species is antimicrobial.

- $ONOO^-$ and NO_2^- are both antimicrobial. Interact with bacterial DNA and disrupt reproduction.

- Uses 3 key enzymes to kill bacteria. (Nitric oxide synthase – typical enzyme found in the nitric oxide pathway, superoxide dismutase, myeloperoxidase)

4. **Viral mechanisms** (When virus interacts with a cell it is engulfed)

Types of Phagocytes

Macrophages

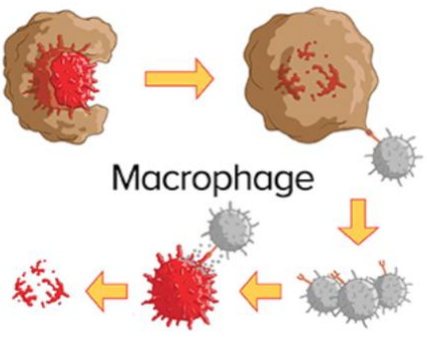
- Macrophages engulf pathogens covered in surface proteins, breaking down the pathogen via previous pathways (lysing the cell membrane, using reactive oxygen species etc)

- This activates an immune response, bringing in an immune cell with their own surface proteins, allowing interaction with the engulfed pathogen.

- The immune cell picks up an antibody (a memory of said pathogen).

- Leading to a production of immune cells with a new surface protein, allowing them to recognise the pathogen.

- Allows for a secondary response, which is much quicker.



(immune cells learning to recognise non-self-cells)

- Mainly found at the site of infection, in particular injuries. Good at taking up dead/dying cells.

Mast cells

- Derived from bone marrow

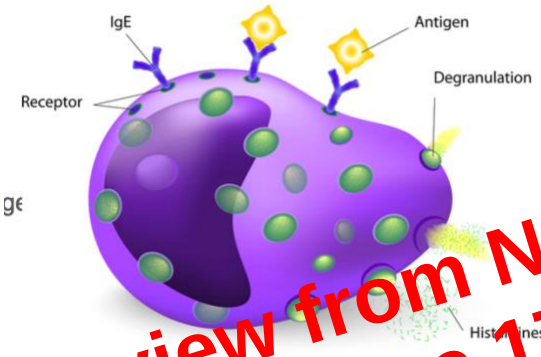
- Mast cell contain chemicals including basophil granules and histamine, meaning these cells can help in allergic reactions and inflammation.

- Responsible for releasing histamine. Histamines can interact with a variety of receptors throughout the body and can activate a multitude of immune responses.

- Have surface proteins, call IGE (essentially an antibody).

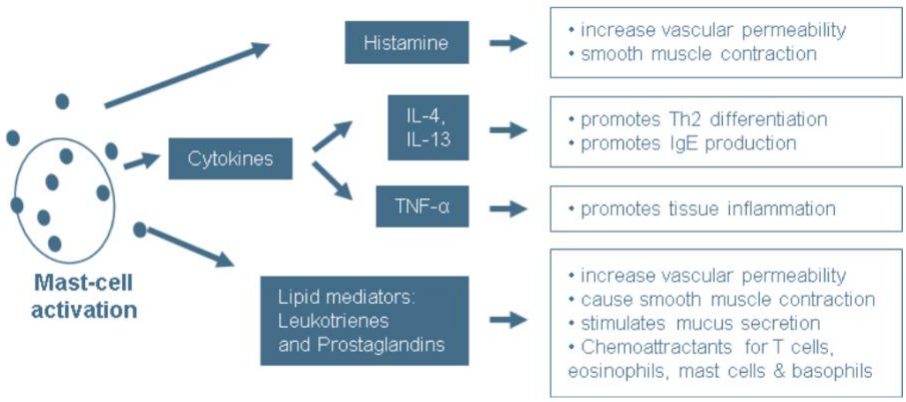
- When body is subjected to a pathogen, the body produces antibodies which interact with mast cells activating them.

- Once activated they can release basophil granules and histamine which can act on histamine receptors which can be used to activate biochemical pathways.



- Mast cell activation

- Summary: Antigen enters the body resulting in the production of an antibody by IGE. This then attaches to the surface of the mast cell, making is susceptible to attack. The next attack is when the IGE binds to the antigen and prompts the mast cell to release granules, histamine and cytokines



(increased vascular permeability, is increasing the ability of a membrane to leak, this results in swelling)

- Mast cells can also release cytokines which are also involved in immune responses. They help to promote the production of more antibodies. They can also promote tissue inflammation.

- Also produce lipid mediators, leukotrienes and prostaglandins.

Antibodies e.g. IGE

- These are Y shaped proteins that recognise antigens. At the ends they have specific protein structures and sequences to a particular antigen.
- They are highly variable binding sites.
- They are secreted by B cells and can be found free or bound to the B cells. Some B cells require activation from T cells to release antibodies.

B cells and T cells

Key functions:

- B cells: type of white blood cell. Mainly come from red bone marrow (where they mature) and main job is to secrete antibodies.

- T cells: have receptors on the surface:
  T_h cells help to activate and mature B cells.
  T_c cells are killer T cells that destroy virus infected cells.
  They are typically learning cells that can differentiate to do different functions. They mature within the thymus.

Histamine

- Involved in immune responses as well as acting as a neurotransmitter. A main function of histamine as a neurotransmitter is to help activate and regulate acetylcholine. (helps to regulate functions such as learning and muscle contractions within the fight or flight response)

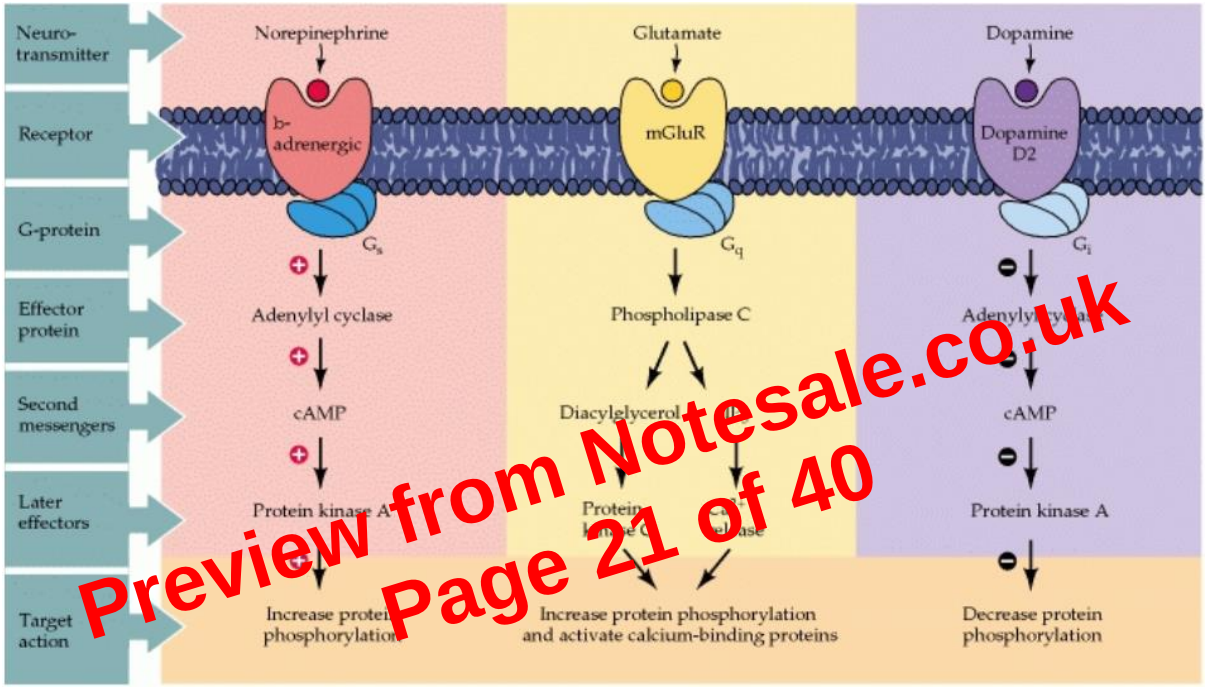
- Commonly associated with itching.

membrane. On the intracellular side there will be a G-protein. The histamine receptor itself will have a binding site for histamine or pharmaceuticals.

- Doxepin is an antidepressant with antihistamine properties. Can be used for the treatment of chronic hives. It is used as a reference standard in the quantification of histamine and receptor interactions.

G-Proteins and their targets

- Binding site on extracellular side and G-protein on the intracellular side of the membrane. Shows examples of neurotransmitters binding to proteins. They are similar structurally to histamine receptors, with only binding site differences.



(All activated via the alpha subunit)

- Gs biochemical pathway increases phosphorylation
- Gq pathway increases protein phosphorylation in addition to calcium release
- Gi pathway decreases phosphorylation

All help to regulate the body's immune response. Activation of the G-protein coupled receptor leads to a conformational change. Allows the g-protein to dislocate from the receptor.

H1 receptor

- Mast cell is activated due to being bound to an antibody, allowing the release of histamine.