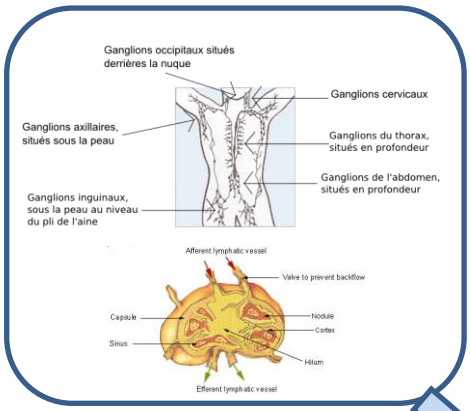
Interaction of the cycle of T lymphocytes with electromagnetic fields.

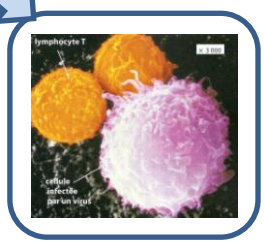
1-T lymphocytes and their cycle.

T lymphocytes are essential cells in the immune system. Their function is to recognize antigens. Only antigens which are recognized by T lymphocytes cause a reaction of the immune system.

In lymph nodes, T lymphocytes meet antigens collected in the entire body.

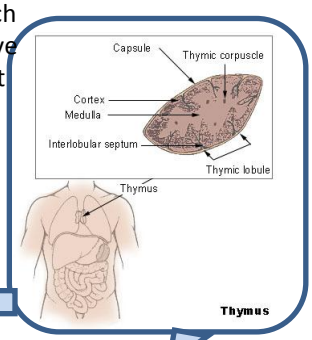


T lymphocytes which have met their cognate antigen proliferate and are transported to diseased organs.

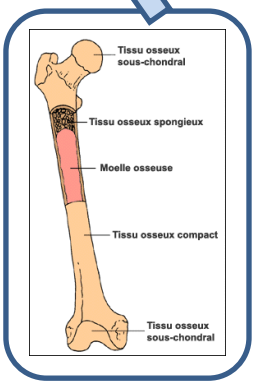


In the diseased organ, the T lymphocyte eliminates the cell which presents its target antigen (infected or cancerous cell)

T lymphocytes which are mature but naive (i.e. have never met their cognate antigen) are transported by blood to lymph nodes.



In the thymus, T lymphoctes mature and are selected. 95% of lymphocytes are eliminated in the thymus.



Immature T lymphocytes are randomly generated in the bone marrow.

Images:
wikipedia
NIH (www.cancer.org);
Jeanvilarssciences.free.fr

Figure 1

2-States of T lymphocytes.

Following an interaction with an Antigen Presenting Cell (APC) a T lymphocyte can enter either of the following states (figure 1):
a) a "cognate antigen recognized" state (CR). Transitions to state CR result in elimination of the T lymphocyte by negative selection (in the negative selection portion of the thymus), proliferation (in lymph nodes), or destruction of the APC (in the diseased organ).
b) an "antigen not recognized" state (ANR). Transitions to state ANR result in elimination by positive selection (in the positive selection portion of the thymus) and in temporary inactivation (elsewhere).

State CR is entered when the affinity of the T lymphocyte for the presented antigen on the Antigen Presenting Cell (APC) is higher than a Recognition Threshold. State ANR is entered when the affinity is lower than a non-recognition threshold.

In the thymus, only antigens of the "self" (i.e. antigens normally present in the body) are presented to T lymphocytes. T lymphocytes which have too strong (above the Recognition Threshold) or too weak (below the Non-Recognition Treshold) an affinity for self antigens are eliminated. Therefore T lymphocytes having survived thymus selection normally remain in the Neutral State when meeting self antigens, i.e. they keep searching for antigens.

Figure 1:

This approach is generally in line with established knowledge, except for the existence of state ANR and temporary inactivation, which is however confirmed by the temporary inactivation of T lymphocytes during about 12 hours in Lyle & al. (1983).

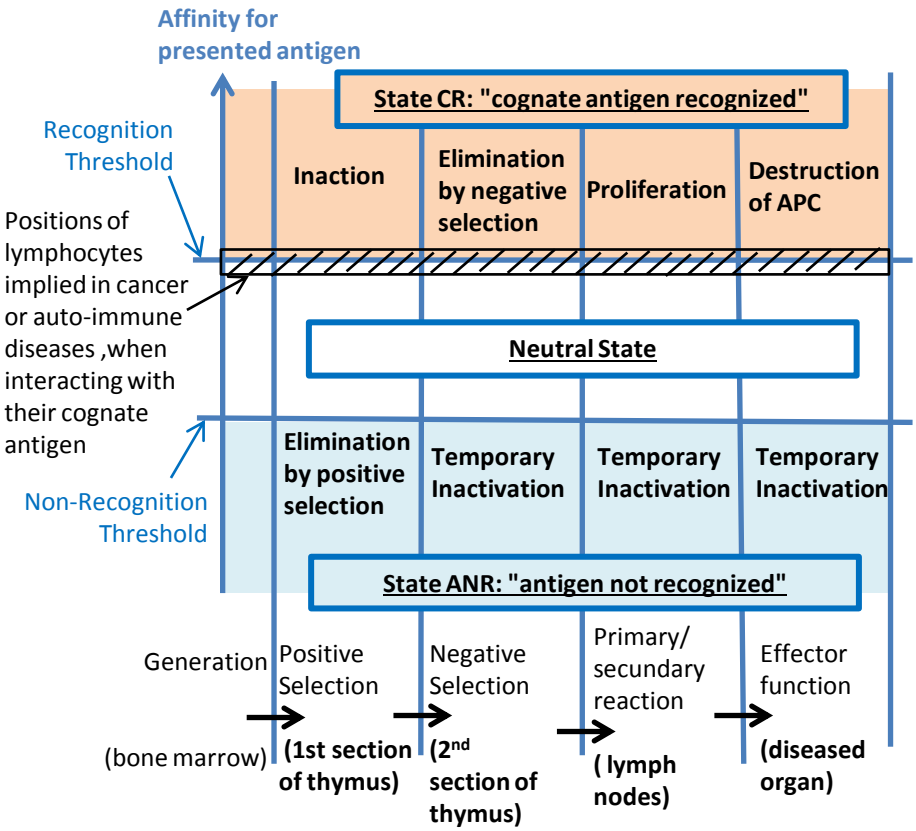


Figure 2

A temporarily inactivated T lypmhocyte stops searching, which facilitates its evacuation and leaves access to the non-recognized antigen to other lymphocytes which may recognize it as their cognate antigen and generate an immune response.

An individual antigen on an Antigen Presenting Cell (APC) is recognized by an individual T Cell Receptor (TCR) on a T lymphocyte. However at lymphocyte level the overall affinity of the T lymphocyte for the antigen on the APC depends on the antigen but also on the number of copies of the antigen which are presented by the APC. Some T lymphocytes have inhibitory receptors and may be able to enter state CR only if the number of TCRs having recognized their cognate antigen overcomes a weighted number of activated inhibitory receptors, yielding a strong dependency on the number of copies of the antigen. The dependency of the overall affinity on the number of presented copies of the antigen allows T cells to recognize not only abnormal antigens but also normal antigens presented in abnormal numbers.

3 – Interaction of T lymphocytes with electromagnetic waves.

Electromagnetic waves below 3 GHz act on T lymphocytes based on the following mechanisms:

Mechanism INH: an electromagnetic wave having a frequency below 3 GHz and a sufficient bandwidth inhibits transition to state (CR). (*for reference, the bandwidth of a wave occupying all frequencies between 100 MHz and 110 MHz is 110-100=10 MHz.*)

Mechanism INA: an electromagnetic wave having a frequency below 3 GHz stimulates transition to state (ANR), even at very low bandwidth. *This stimulation was directly observed on T lymphocytes (Lyle & al 1883)*

These mechanisms, in particular INH for which there is no direct experimental verification, are justified on a basis of fundamental physics in an annex (separate pdf document). However, the fact that these sole mechanism explain a large number of experimental and statistical result is proof of the mechanisms, independent of the underlying physics.

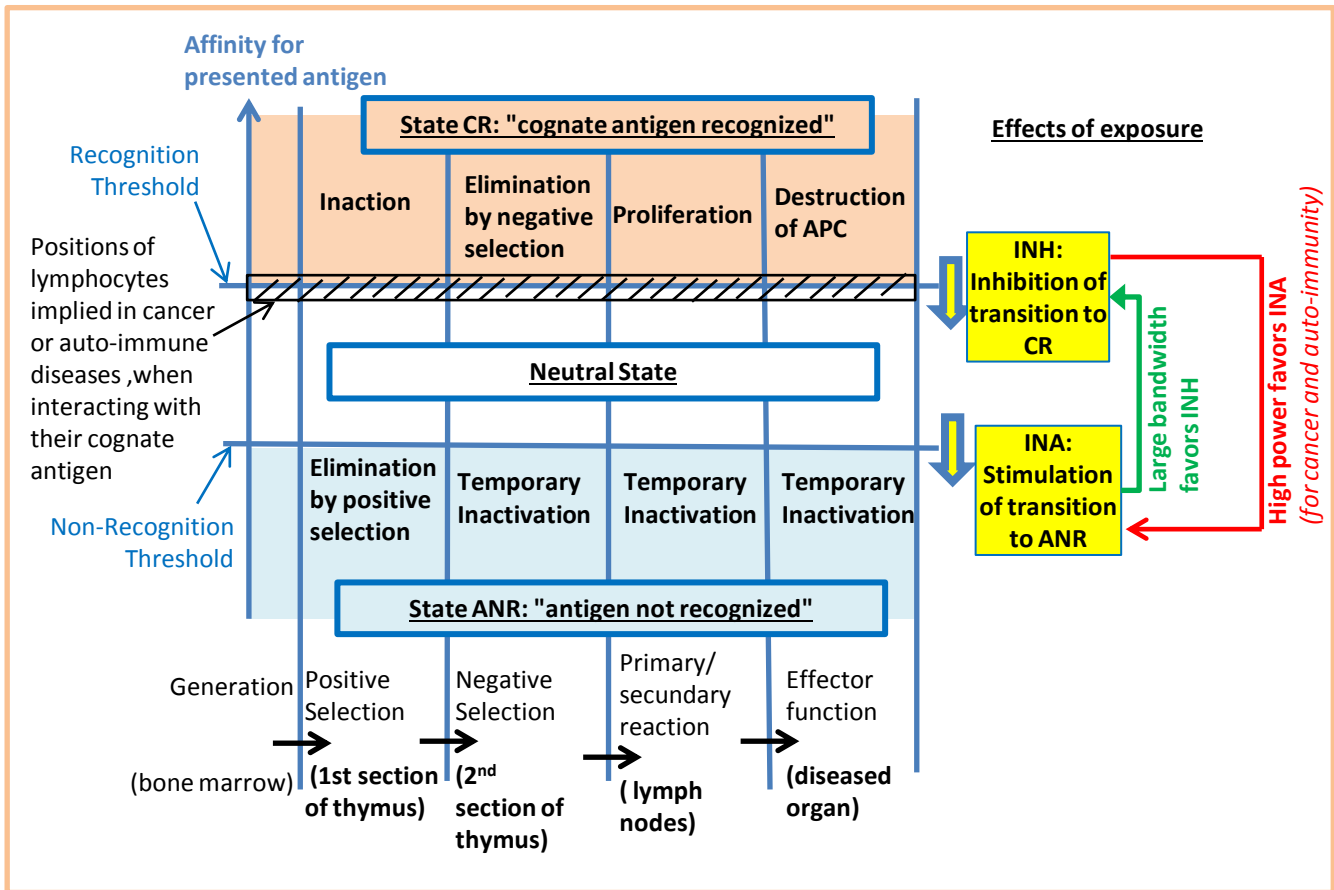


Figure 3 (based on Lauer 2014)

4-Influence of thymus selection.

Influence on mechanism INH:

In cancer, a "normal" cell becomes abnormal and presents antigens which are "near-self", or may even present self antigens in abnormal numbers. T lymphocytes that control cancer recognize these near-self or self antigens as their cognate antigen, so as to enter state CR yielding to destruction of the cancerous cell, but they recognize them only weakly, else they would be eliminated by negative selection when interacting with a similar antigen in the thymus. Thus these lymphocytes when interacting with their cognate antigen are near the Recognition Threshold on Figure 3 as shown. Likewise, in an auto-immune disease a self antigen is "accidentally" recognized as its cognate antigen by a T lymphocyte. It recognizes this cognate antigen only weakly, otherwise (as should ideally be the case) it would be eliminated by negative selection when interacting with a similar antigen in the thymus.

Because T lymphocytes implied in cancer and auto-immune diseases are near the Recognition Threshold, they are affected soon when exposure conditions inhibit transitions to state (CR) under mechanism INH, even at very low power, yielding a direct pro-cancer (since cancerous cells are no more recognized) and anti-auto-immune effect (since "accidentally recognized" self antigens are no more recognized).

Thymus selection of T lymphocytes in exposed conditions is based on recognition of self antigens in the presence of the electromagnetic wave, so that T lymphocytes selected in exposed conditions behave normally in exposed conditions with respect to self and near-self antigens. Therefore the above-mentioned pro-cancer, anti-auto-immune effect is transient and ceases when enough T lymphocytes have been renewed and replaced by T lymphocytes selected by the thymus in the presence of the electromagnetic wave. Naive mature T lymphocytes implied in cancer and auto-immune diseases are likely short-lived due to their agressiveness towards the self, so only a pool of recent thymic emigrants needs to be replaced.

A single abnormally agressive naive T lymphocyte can suffice generate a T lymphocyte lineage controlling a cancer or causing an auto-immune disease, so alternances of exposure and non-exposure yield an anti-cancer, pro-auto-immune effect effect due to the abnormal agressiveness in non-exposed conditions of T lymphocytes selected under exposed conditions.

Lymphocytes implied in recognition of pathogens are not generally near the Recognition Threshold when interacting with self antigens, so that they are little affected by thymus selection. Therefore the inhibition of antigen recognition yields an anti-pathogen effect independent of thymus selection.

	A	B	C	D	E
exposure Immune threat	Permanent low exposure (thermal)	Permanent high exposure	Transition from Low to High exposure: period immediately after transition	Transition from High to Low exposure : period immediately after transition	Alternance between low and high exposure (at least half time low exposure)
cancer	**standard**	**standard**	**Pro cancer**	**Anti cancer**	**Anti cancer**
auto-immune disease	**standard**	**standard**	**Anti-autoimmune**	**Pro-autoimmune**	**Pro-autoimmune**
Infectious diseases	**standard**	**Pro-pathogen**	**Pro-pathogen**	**Pro-pathogen**	**Pro-pathogen**

Table 1: effect on diseases under mechanism INH (based on Lauer 2013, 2014).

Influence on mechanism INA:

If exposure is strong and permanent, or for sufficiently frequent and long exposure periods, essentially all lymphocytes are eliminated by Positive Selection yielding a pro-cancer, anti-auto-immune, pro-pathogen effect.

But if exposure is weak or rare, a significant part of the lymphocytes survive positive selection and some of them are temporarily inactivated during negative selection, thus escaping following steps of negative selection. These lymphocytes having escaped negative selection tend to be abnormally aggressive against the self, yielding a pro-auto-immune, anti-cancer effect.