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ORIGINAL ARTICLE

A theoretical model for an electromagnetic antenna in induction of virtual T cells

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Abstract

Cancer cells make a PD1/PD-L1 bridge with T cells and inject death factors into them. Recently, many methods and drugs have been proposed to prevent PD1/PD-L1 connections; however, most of them are very expensive and could not work well. We propose a theoretical model for an electromagnetic antenna which induces virtual T cells within the blood vessels. These electromagnetic T cells deceive cancer cells and their virtual PD1s are connected to real PD-L1s. Consequently, the number of real PD1/PD-L1 connections decrease and real T cells could have the opportunity to kill the cancer cells. This is a theoretical model.

Keywords Antenna · T cell · Cancer · Blood · Electromagnetic wave

1 Introduction

To date, many scientists have used electromagnetic waves to treat cancers and tumors. For example, some authors have summarized the history of EMF from the 1890s to the novel and new innovative methods that target and treat cancer by non-ionizing radiation (Jimenez et al. 2018). In another article, authors have considered the recent development of electromagnetic nanomedicines into combinational cancer immunotherapy. In this research, the mechanisms of electromagnetic nanomedicines in reprogramming the immunosuppressive tumor microenvironment and sensitizing tumors for cancer immunotherapy were highlighted (Pu et al. 2020). In another work, it has been argued that electromagnetic fields increased the expression of critical proteins leading to cell cycle arrest and reduced stemness as evidenced by decreased expression of stemness genes. In addition, the proliferation rate in electromagnetic-exposed cancer cells is reduced compared to that in nonexposed cancer cells (Oh et al. 2020). In another research, the authors have discussed that cancerous cells emit different frequencies with respect to normal ones and for this reason, one can use electromagnetic waves to diagnose cancers (Calabrò and Magazù 2018). In another investigation, the authors have shown that millimeter wave frequencies could be applied in imaging some cancers like breast cancers (Di Meo 2017). In addition, in another papers, it has been shown that millimeter waves could be used in diagnosing skin cancers, while micrometer waves could be applied in imaging lung and breast cancers and more shorter wavelengths could detect early-stage tumors that reside in deeper tissue layers (Mirbeik-Sabzevari and Tavassolian 2019; Iliopoulos et al. 2020; Wang 2018). Motivated by these researches, we propose a new model for the treatment of cancers through induction of virtual T cells within blood vessels using electromagnetic waves.

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2 A model for induction of T cells within the blood vessels

In this section, we propose a model to induce virtual T Cells and deceive cancer cells. This technique helps us to prevent PD1–PD-L1 connections (Bardhan et al. 2016; Blank and Mackensen 2007) and the death of T cells. Using this technique, we can kill cancerous cells and reduce expenses.

To date, it has been known that cancer cells create PD1/PD-L1 connections with T cells and induce death factors within them. On the other hand, T cells create TCR/MHC connections with cancer cells and inject death factors into them (see Fig. 1). If we could prevent the PD1/PD-L1 connections, we can rescue T cells and kill the cancer ones.

There are several methods to reduce PD1/PD-L1 connections. In some of these methods, some types of chemical drugs are used. However, these drugs are expensive. If we could increase the number of T cells within blood vessels such that their numbers are more than the number of cancer cells, we can obtain more TCR/MCH connections with respect to PD1/PD-L1 ones, and consequently, more cancer cells will die (see Fig. 2).

To increase the number of T cells within the blood vessels, we can make use of electromagnetic waves. We design an antenna whose size is equal to or less than the separation distance between the cells or their centers. Then, we connect this antenna to an oscillating potential whose frequency is like the frequency of passing T cells from cancer cells. We put some molecules of T cells on this antenna and bring it near the blood vessels around cancer tissue. This antenna emits some waves which cause T cells to form some electromagnetic holes within their wave shapes. These waves are absorbed by blood vessels and induce virtual T cells within them (see Fig. 3). These virtual T cells deceive the cancer cells and create virtual PD1/PD-L1 connections. Consequently, real T cells could be rescued and induce death factors into them. This causes that the number of cancer cells is reduced significantly and tumors could be controlled very well (see Fig. 4). This model is much cheaper than known expensive methods which use some cancer drugs.

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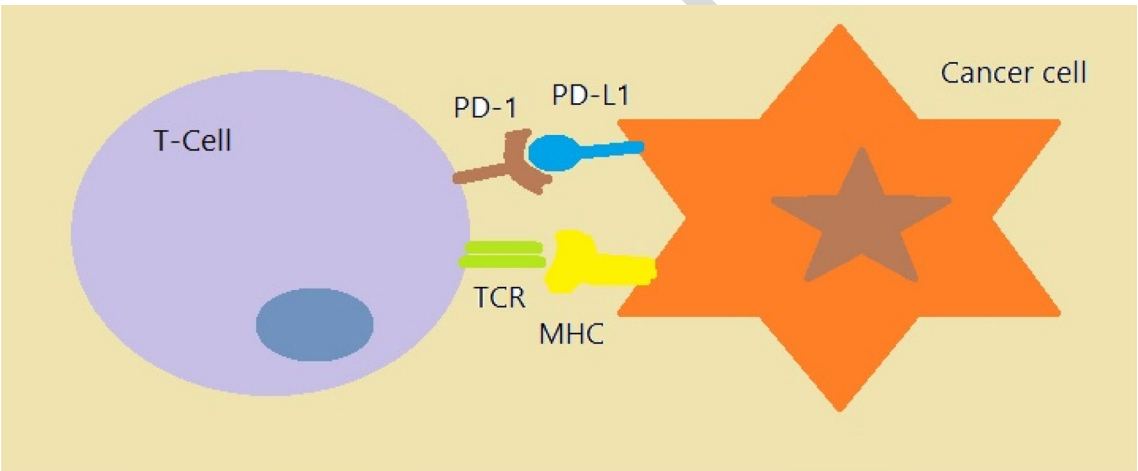

Fig. 1 The interaction between T cells and cancer ones

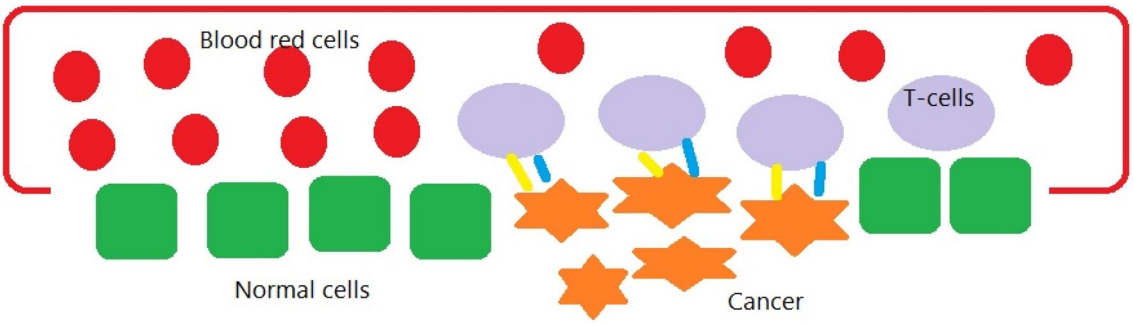

Fig. 2 T cells move within blood vessels and archive to cancer cells

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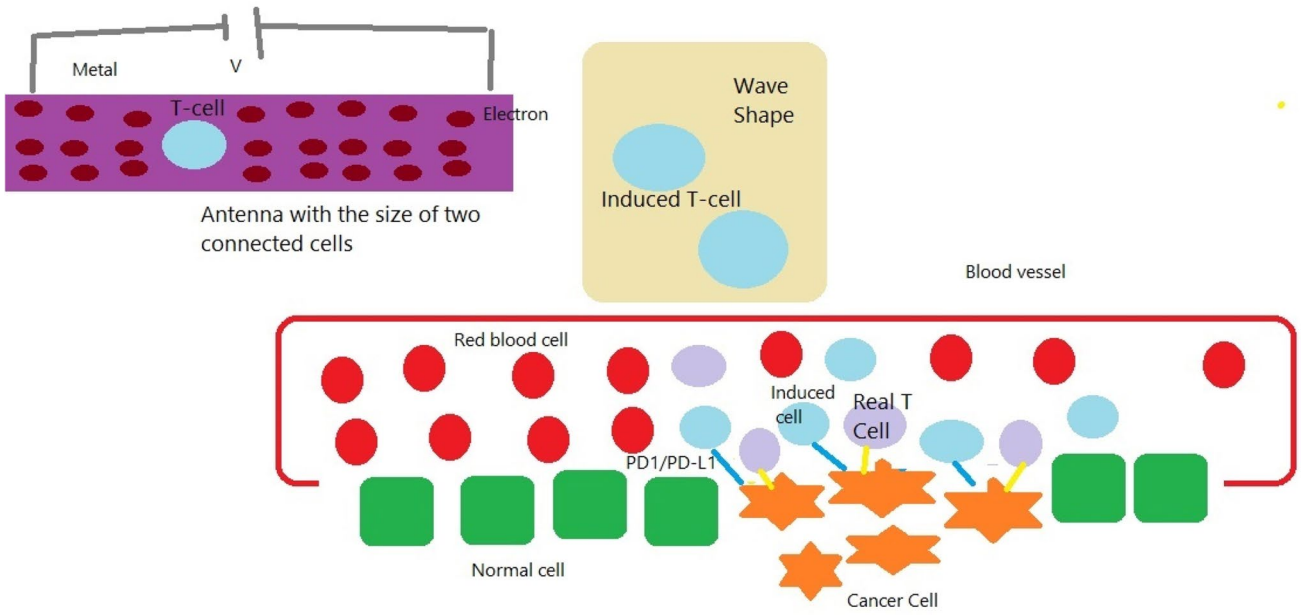

Fig. 3 A micro-antenna could help us to induce T cells within the blood vessels

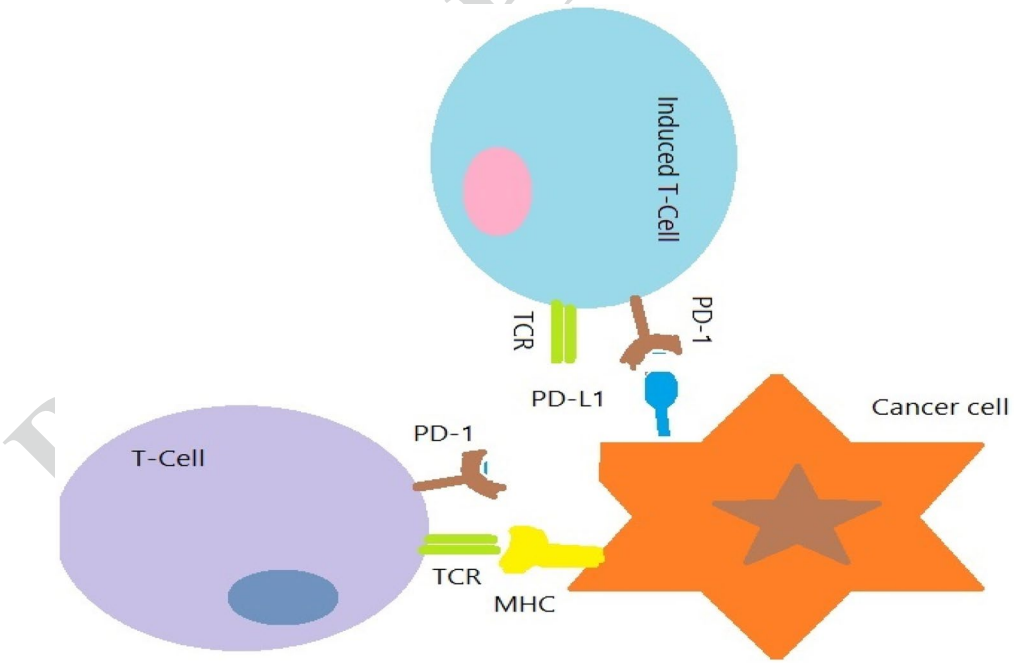

Fig. 4 Induced T cells deceive cancer cells and produce virtual PD1–PD-L1 connections

3 A mathematical technique to design the shape of waves, potential and antenna

To design antennae and equipment in this model, we need to consider the relation between the potentials, currents, frequencies and T cells. In this model, first, we put molecules of T cells on an antenna and connect an oscillating potential to it. We can write

$$V = v_0 \sin(\Omega t), \tag{1}$$

where V is the potential and Ω is its related oscillating frequency. This potential causes the emergence of a current:

$$V = v_0 \sin(\Omega t) = \mathrm{R\,I} \rightarrow I = i_0 \sin(\Omega t), \tag{2}$$

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where I is the electrical current and R denotes the resistance.

This current causes the motion of electrons and also a force on the charges of the T cell. Consequently, T cells also move; however, their masses are much larger than that of the electrons and consequently, the velocity and the frequency of their motion may be much lower than that of the electrons. By the motion of electrons and T cells, a wave emerges. The shape of this wave depends on the shape of the antenna and the molecules of T cells. The energy of these waves could be obtained from the equation below:

$$E = Nhf, \tag{3}$$

where E is the energy, N is the number of waves and f is the frequency of the emitted waves. This frequency has the relation below with the wavelength:

$$f = \frac{c}{\lambda}, \tag{4}$$

where λ is the wavelength of the emitted wave and c is the velocity of light.

To induce T cell-shape waves within blood vessels, we need to design an antenna whose length depends on the wavelengths. On the other hand, the wavelengths depend on the separation distance between cells and have a direct relation with the number of T cells which pass a cell in each second.

$$\text{Biological antenna} = \frac{\text{Separation distance between cells}}{\text{Number of T cells in each seconds}}. \tag{5}$$

These wavelengths take the shape of the antenna and cause the emergence of entropy and temperature. In fact, the energy of this system has the relation below with the temperature and entropy:

$$E = T\ \text{entropy}, \tag{6}$$

where T is the temperature. Previously, Tsallis has shown that the entropy has the relation below with the area (Tsallis and Cirto 2013):

$$\text{Entropy} = \gamma A^{\beta}, \tag{7}$$

where γ and β are some constants and A is the area of the wave. The area of a wave depends on the area of the antenna. Since the velocity of T cells is less than the velocity of the electrons, the shape of these molecules causes the emergence of some holes in the total shape of the waves. We only want to calculate the area of the waves including the T cell holes. Thus, we can write

$$A = [\text{Area of antenna} - \text{Area of T cells}] \quad [\text{number of T cells in each seconds}]. \tag{8}$$

To calculate the area of the T cells, we have to know its electrons, photons and atoms. We can write the action below (Sepehri 2017):

$$S = \int d^3 l \sqrt{\eta^{ab} g_{\mu\nu} \partial_a \psi^{\mu\uparrow} \Psi^{M\downarrow} \partial_b \psi^{\nu\downarrow} \Psi^{M\uparrow} + \eta^{ab} g_{\mu\nu} \partial_a \varphi^{\mu} \partial_b \varphi^{\nu} + 2\pi \tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \cdots F_i)}{i!\lambda}}, \tag{9}$$

where φ is the molecule wave function, ψ is the semi-coupled electron, g is the metric of the system and F is the photonic field strength with the relation below:

$$F = F_{\mu\upsilon} F^{\mu\upsilon},$$

$$F_{\mu\upsilon} = \partial_{\mu} A_{\upsilon} - \partial_{\upsilon} A_{\mu}, \tag{10}$$

where F is the field strength and A is the photon. For the above action, we can write the momentum density below:

$$\mathbb{III} = \frac{2\pi \tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \ldots F_{i-1})}{i!\lambda} F_{01}}{\sqrt{\eta^{ab} g_{\mu\nu} \partial_a \psi^{\mu\uparrow} \Psi^{M\downarrow} \partial_b \psi^{\nu\downarrow} \Psi^{M\uparrow} + \eta^{ab} g_{\mu\nu} \partial_a \varphi^{\mu} \partial_b \varphi^{\nu} + 2\pi \tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \ldots F_i)}{i!\lambda}}} \tag{11}$$

For this density, we can obtain the Hamiltonian below:

$$H = \int d^3 l \ \mathbb{III} \ \partial_t \tilde{A}_1 - L = \int d \ l \ [l^2 \mathbb{III} \ F_{01} - \partial_t (l^2 \mathbb{III} \ ) \tilde{A}_0] - L \tag{12}$$

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From the above equation, we find that momentum density has the relation below with the radius of the cell:

$$\text{III} = \frac{K^2}{l^2} = \frac{2\pi\tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \ldots F_{i-1})}{i!\,\lambda} F_{01}}{\sqrt{\eta^{ab} g_{\mu\nu} \partial_a \psi^{\mu\uparrow} \Psi^{M\downarrow} \partial_b \psi^{\nu\downarrow} \Psi^{M\uparrow} + \eta^{ab} g_{\mu\nu} \partial_a \varphi^{\mu} \partial_b \varphi^{\nu} + 2\pi\tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \ldots F_i)}{i!\,\lambda}}} \tag{13}$$

where l is the radius of the cell. Thus, we have

$$\mathrm{l} = \left[\frac{K^2}{\left[\frac{2\pi\tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \cdots F_{i-1})}{i!\lambda} F_{01}}{\sqrt{\eta^{ab} g_{\mu\nu} \partial_a \psi^{\mu\uparrow} \Psi^{M\downarrow} \partial_b \psi^{\nu\downarrow} \Psi^{M\uparrow} + \eta^{ab} g_{\mu\nu} \partial_a \varphi^{\mu} \partial_b \varphi^{\nu} + 2\pi\tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \cdots F_i)}{i!\lambda}}} \right]} \right]^{1/2}. \tag{14}$$

Using the above radius, we can obtain the area of the T cells:

$$\text{Area of T cells} = \pi l^2 = \pi \left[\frac{K^2}{\left[\frac{2\pi\tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \cdots F_{i-1})}{i!\lambda} F_{01}}{\sqrt{\eta^{ab} g_{\mu\nu} \partial_a \psi^{\mu\uparrow} \Psi^{M\downarrow} \partial_b \psi^{\nu\downarrow} \Psi^{M\uparrow} + \eta^{ab} g_{\mu\nu} \partial_a \varphi^{\mu} \partial_b \varphi^{\nu} + 2\pi\tilde{l}_h^2 \sum_{i=1}^{n} \frac{-(F_1 \cdots F_i)}{i!\lambda}}} \right]} \right]. \tag{15}$$

On the other hand, we can write the relations below between the fermionic, scalar and photonic wave functions with their charges, masses and numbers:

$$\partial_a \psi^{\mu\uparrow} \Psi^{M\downarrow} \partial_b \psi^{\nu\downarrow} \Psi^{M\uparrow} \approx \sum_{i=1}^{I} (\text{mass of coupled charges})_i^2 (\text{number of coupled charges})_i e^2 \tag{16}$$

$$\eta^{ab} g_{\mu\nu} \partial_a \varphi^{\mu} \partial_b \varphi^{\nu} \approx \sum_{j=1}^{J} (\text{mass of molecules})_j^2 (\text{number of molecules})_j$$
$$\sum_{l=1}^{L} \frac{-(F_1 \cdots F_i)}{l!\lambda} \approx \sum_{l=1}^{L} (m)_l h(\nu)_l \tag{17}$$

where ν is the photonic frequency which is exchanged between electrons. Thus, the area of a T cell could be written in terms of its electrons, photons and molecules:

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$$\text{Area of T cells} = \pi l^2 = \pi K^2 \left[\sum_{i=1}^{I} (\text{mass of coupled charges})_i^2 (\text{number of coupled charges})_i e^2 + \sum_{j=1}^{J} (\text{mass of molecules})_j^2 (\text{number of molecules})_j + \sum_{l=1}^{L} (m)_l h(\nu)_l \right] \left[2\pi \tilde{l}_h^2 \sum_{l=1}^{L} (m)_l h(\nu)_{l-1} h(\nu) \right]^{-1} \tag{18}$$

The above equation shows that the real area of a T cell could be written in terms of numbers, charges and frequencies of molecules, electrons and photons. Using the above equation, we can obtain the energy of the waves:

$$E = T\gamma([[\text{Area of antenna}] - \pi K^2 \left[\sum_{i=1}^{I} (\text{mass of coupled charged})_i^2 (\text{number of coupled charged})_i e^2 + \sum_{j=1}^{J} (\text{mass of molecules})_j^2 (\text{number of molecules})_j + \sum_{l=1}^{L} (m)_l h(\nu)_l \right] \left[2\pi \tilde{l}_h^2 \sum_{l=1}^{L} (m)_l h(\nu)_{l-1} h(\nu) \right]^{-1} \times [\text{number of T cells in each second}])^{\beta} \tag{19}$$

On the other hand, the energy of the waves has the relation below with their numbers and frequencies:

$$E = Nhf = Nh \frac{c \text{ number of T cells in each second}}{\text{separation distance between cells}}. \tag{20}$$

Thus, the number of emitted waves could be obtained from the equation below:

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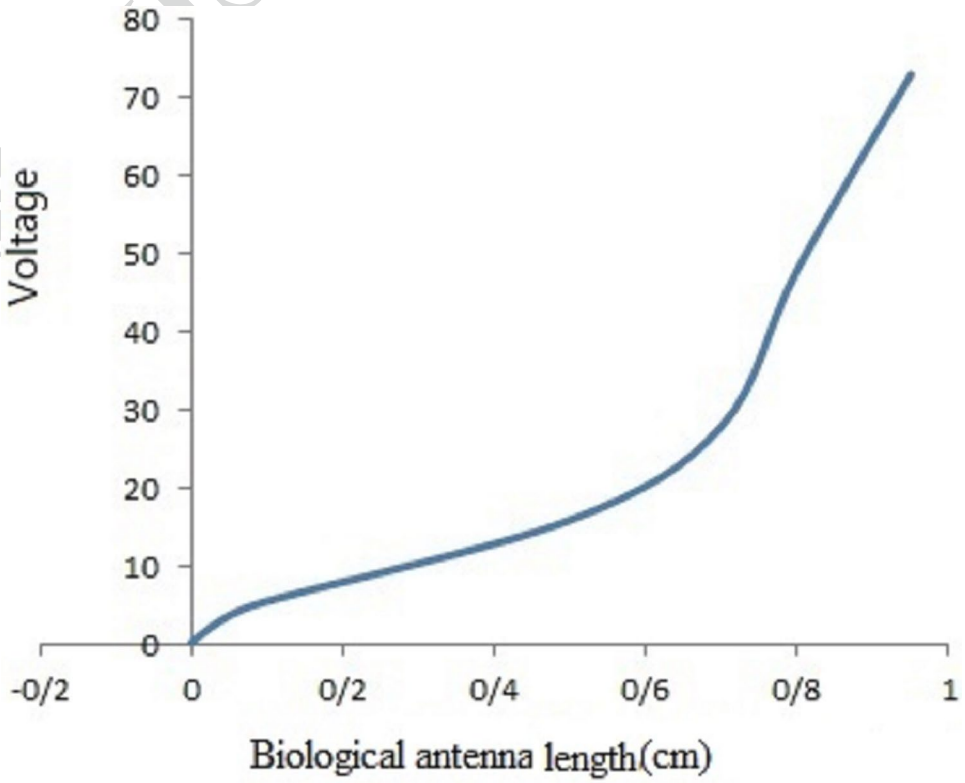

Fig. 5 Voltage in terms of biological antenna length

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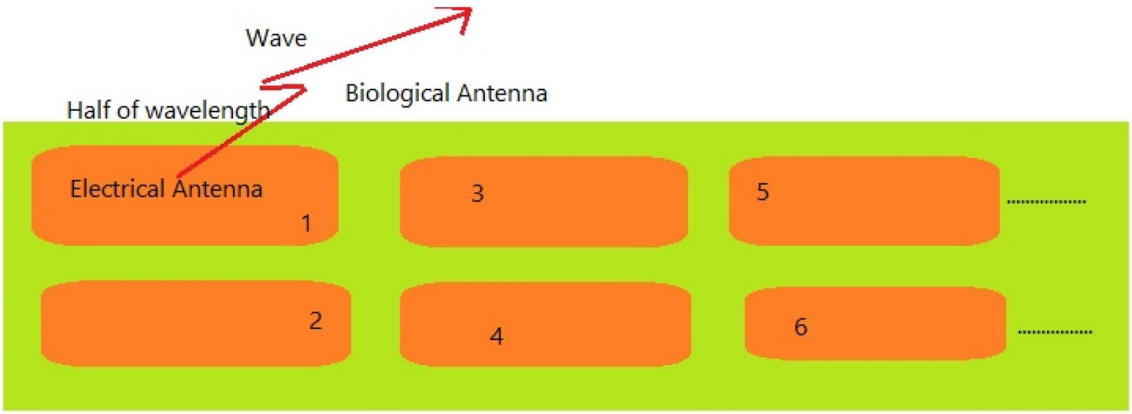

Fig. 6 Each biological antenna is formed from N electronic antenna

$$N = \left[\left[\frac{c \text{ number of T cells in each second}}{\text{separation distance between cells}}\right]\right]^{-1} \times T\gamma \tag{21}$$
$$([[\text{Area of antenna}] - \pi K^2 \left[\sum_{i=1}^{I} (\text{mass of coupled charges})_i^2 (\text{number of coupled charges})_i e^2 + \sum_{j=1}^{J} (\text{mass of molecules})_j^2 (\text{number of molecules})_j + \sum_{l=1}^{L} (m)_l h(\nu)_l\right]\left[2\pi \tilde{l}_h^2 \sum_{l=1}^{L} (m)_l h(\nu)_{l-1} h(\nu)\right]^{-1}$$
$$\times [\text{number of T cells in each second}])^{\beta}$$

The above equation shows that the number of emitted waves from an antenna including T cells depends on the temperature, area of the antenna, number and charges of the molecules, electrons and the number and frequencies of the photons.

On the other hand, we know that the energy has the relation below with the potential and charges:

$$E = QV = (\text{Number of electrons} \times \text{Charge of electrons} - \text{Charge of } T - \text{cells})V. \tag{22}$$

Thus, potential of the system could be obtained from the equation below:

We can use the relations below between the number of charges with currents and resistance of the system or antenna:

$$\text{Number of electrons} \times \text{charge of electrons} \approx (\text{current})\,(\text{velocity of charges})^{-1} \text{ velocity of charges} \approx (\text{resistance})^{-1}$$

$$\text{Resistance} \approx (\rho \text{Genus of antenna})\,(\text{length of antenna})\,(\text{area of antenna})^{-1} \tag{24}$$

Using the above relation, we can re-write the potential of the antenna as:

$$V = \left[\text{Number of electrons} \times \text{charge of electrons} - \text{charge of T-cells}\right]^{-1} \times T\gamma([[\text{Area of antenna}] - \pi K^2 \left[\sum_{i=1}^{I} (\text{mass of coupled charges})_i^2 (\text{number of coupled charges})_i e^2 + \sum_{j=1}^{J} (\text{mass of molecules})_j^2 (\text{number of molecules})_j + \sum_{l=1}^{L} (m)_l h(\nu)_l\right]\left[2\pi \tilde{l}_h^2 \sum_{l=1}^{L} (m)_l h(\nu)_{l-1} h(\nu)\right]^{-1} \times [\text{number of T cells in each second}])^{\beta} \tag{23}$$

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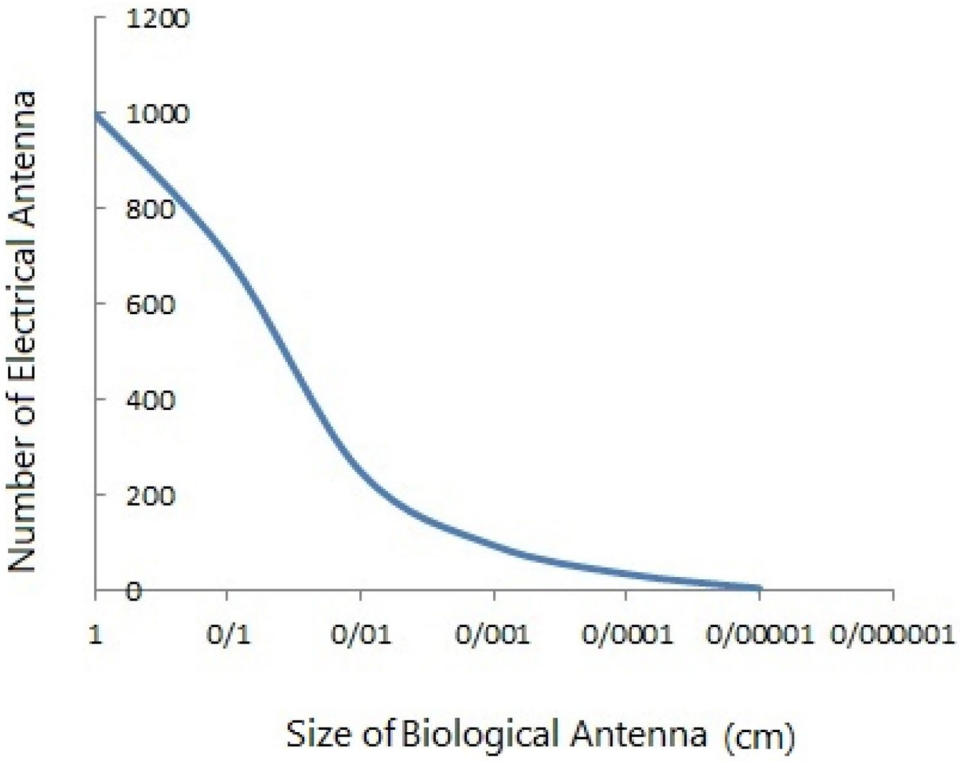

Fig. 7 Number of electrical antennae in terms of the size of biological antenna

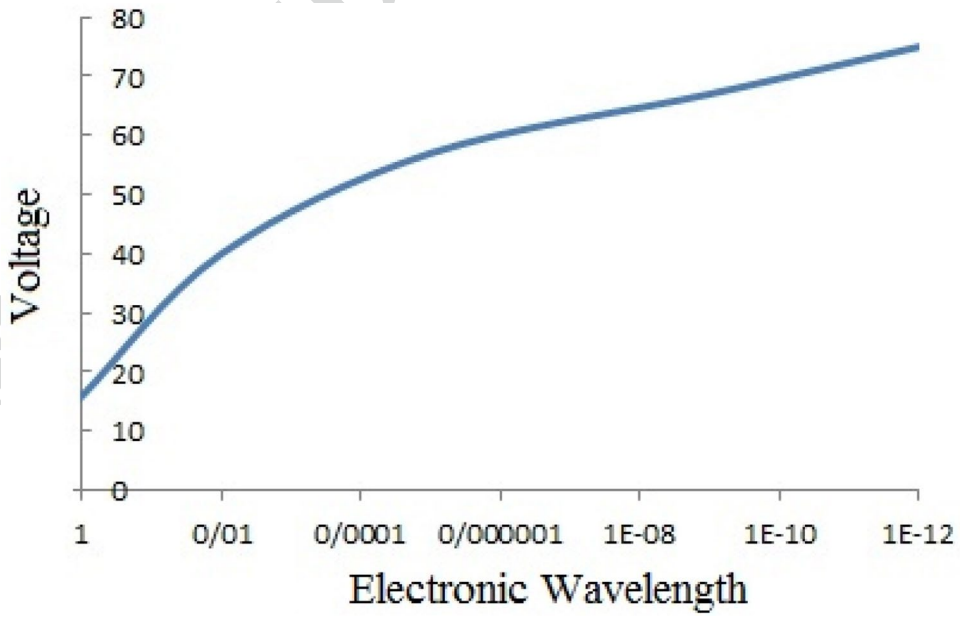

Fig. 8 Voltage in terms of electronic (photonic) wavelength

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$$V = \Big[(\rho\text{Genus of antenna})(\text{length of antenna})(\text{area of antenna})^{-1} \times (\text{current}) - \text{charge of T cells}\Big]^{-1} \times T\gamma([[\text{area of antenna}] - \pi K^2 \Bigg[\sum_{i=1}^{I}(\text{mass of coupled charges})_i^2(\text{number of coupled charges})_i e^2 + \sum_{j=1}^{J}(\text{mass of molecules})_j^2(\text{number of molecules})_j + \sum_{l=1}^{L}(m)_l h(\nu)_l\Bigg]\Bigg[2\pi\tilde{l}_h^2 \sum_{l=1}^{L}(m)_l h(\nu)_{l-1} h(\nu)]^{-1}\Bigg] \times [\text{number of T cells in each second}])^{\beta} \quad (25)$$

The above equation shows that for inducing T cells within the blood vessels, we should design an antenna with the size of inter-cellular separation distance and a potential which depends on the genus of the system, length of the antenna, area of the antenna, mass of the molecules and electrons within T cells, frequency of inter-particle waves, number of photons, electrons and T cells. If the genus of the metal and blood vessels are the same, we can obtain a better potential.

This potential produces an oscillating current. This current includes the current of electrons and T cells. By the motion of these charges, some waves emerged whose shapes depend on the shape of the antenna and T cells. In fact, T cells are like some holes within antenna waves. These waves are absorbed by the blood liquid and some T cell holes emerge within them. Cancer cells make a mistake in diagnosing real T cells from virtual ones and try to erase them. Consequently, real T cells could be saved from PD1/PD-L1 interactions, and induce death factors into the cancer cells and cause their disappearance.

To design a biological antenna, we put T cells on a metal like iron and connect it to an oscillating voltage. Figure 5 considers the dependency of voltage on the biological antenna length, theoretically. It is clear that for the smaller biological antennae, the resistance is smaller and the needed voltage and potential for producing the current and the wave has lower values. By increasing the length of the biological antenna, the resistance increases, and the needed voltage grows. This potential oscillates between negative and positive maxima, and produces an oscillating current of T cells and electrons. This current emits a wave whose shape depends on the shape of the antenna and T cells. These waves induce T cells within the blood vessels. Concepts of biological antenna are different from known electrical antenna which we will describe about these differences in next section.

4 Differences between biological antenna and electronic antenna

Perhaps, a question that arises is how biological antennae has the relation with photonic wavelength. A biological antenna is formed from a large number of electronic antennas. An electrical antenna has a direct relation with the photonic wavelength. In fact, the size of an electronic antenna is in comparable with its radiated wavelength. The electronic antenna is an antenna in which only electrons can move in it and emit waves. It is clear that by increasing the length of the biological antenna, more photonic wavelengths emerge and thus, the number of electronic antennae grows (see Fig. 6). In Fig. 7, we present the number of electrical antenna in terms of the size of the biological antenna. It is clear that by increasing the size of the biological antenna, more electronic antennas are formed. These electronic antennas emit photonic waves which their lengths are in comparable with their antenna sources. On the other hand, Eq. (25) shows that by increasing voltage, smaller electronic wavelengths are emerged (see Fig. 8). These wavelengths are emerged by electronic antennas and thus, by increasing voltage, a biological antenna could be divided into more number of electronic antennas.

This biological antenna could be used for curing other types of diseases so. For example, when some microbes such as bacteria or viruses attack to human's body, we can emit some special waves which take shape of some non-real target cells. Microbes could not determine the difference between real and non-real receptors and move towards non-real receptors. We can change waves such as microbes move along an special road and finally come out of human's body. Using this method, expenses of curing diseases decrease. This a theoretical model and we hope to build real antenna in near future.

5 Conclusion

When a tumor or cancer tissue emerges, T cells move within the blood vessels, reach their destination, and induce death factors within cancer cells. However, cancer cells also make some PD1/PD-L1 connections with T cells and kill them. We suggest that using electromagnetic waves, some virtual or photonic T cells are induced within the blood vessels. These virtual T cells make some non-real PD1/PD-L1 connections with the tumor cells and keep them busy. Consequently, real

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T cells could be rescued and cause a reduction in the number of tumor cells.

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