Metronidazole protects cells from microwaves

Svetlana Rogacheva, Pavel Kuznetsov, Era Popyhova, and Alexander Somov

An antibiotic can mitigate low-intensity microwave damage to red blood cells by reorganizing the structure of water.

Low-intensity physical factors and low-dosage biologically active compounds can cause unusually large effects in living systems. Some have suggested that water-structure changes by these agents are responsible.\(^1\) For example, significant responses due to weak ‘millimeter’ waves—microwaves with wavelengths in the 1–10mm range—have been observed in water solutions and biological fluids.\(^2\) These responses occur at definite ‘resonant’ frequencies where, it is thought, electromagnetic fields shake the hydrogen-bond networks of subsurface water in membranes and proteins, inducing the observed biochemical changes. We present here an approach for protecting cells from millimeter-wave damage by stabilizing these hydrogen-bond networks.

In our previous work,\(^3, 4\) we showed that some physiologically active compounds can structure the water of subsurface cell membranes and proteins. We propose here that one of these compounds, the antimicrobial drug metronidazole, induces hydrogen-bond network reorganization that increases hydrate shells, protecting cells from electromagnetic fields.

We tested our hypothesis by determining the stability of erythrocytes, or red blood cells, under the isolated and combined effect of a 5 \(\times\) 10\(^{-6}\) % metronidazole solution and millimeter waves. Microwaves were used at the resonant frequencies of 55 and 65GHz, as well as at 60, 69, and 73GHz, three frequencies that provoked no unusual behavior.

Metronidazole \([1-(2'\text{-hydroxyethyl})-2\text{-methyl}-5\text{-nitroimidazole}]\) was extracted from the drug Trichopol with a 1:1 chloroform-benzene mixture. The filtered extract was further refined by twice evaporating and recrystallizing from boiling ethanol. The 5 \(\times\) 10\(^{-6}\) % solution was prepared in a 0.05M phosphate buffer of pH 7.2.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Nonhemolyzed erythrocyte content, %</th>
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<tbody>
<tr>
<td>Control (no effect)</td>
<td>98.5 (\pm) 10.4</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>84.8 (\pm) 5.6</td>
</tr>
<tr>
<td>EM</td>
<td>36.9 (\pm) 4.2</td>
</tr>
<tr>
<td>EM + metronidazole</td>
<td>67.3 (\pm) 5.4</td>
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Table 1. A 5 \(\times\) 10\(^{-6}\) % metronidazole solution mitigates the effects of 65GHz electromagnetic radiation (EM) on erythrocyte hemolytic stability.

Cell suspensions with an initial optical density OD\(_{670}\) = 0.8, at a wavelength of 670nm, were prepared using the same phosphate buffer. The cells were obtained by centrifuging the blood of white laboratory rats at 3000g for 15min. We used a continuous-wave generator to provide millimeter waves of current density 120 \(\mu\)W/cm\(^2\). The cell suspensions were exposed to the waves using a pyramidal horn-type antenna of length 12cm and aperture 42 \(\times\) 50cm.

The experimental procedure involved exposing cell suspensions to electromagnetic radiation, the metronidazole solution, or both, for 150min at room temperature. The optical density was measured every 30min with a spectrophotometer to monitor for changes that would indicate departures from erythrocyte hemolytic stability.

While hemolytic stability did not exhibit meaningful change under metronidazole exposure, an electromagnetic field increased the hemolysis rate. However, incubating the erythrocytes in a metronidazole solution reduced these effects at resonant frequencies 55GHz and, as shown in Table 1, 65GHz. The field effect at nonresonant frequencies 60, 69, and 73GHz was not reduced by the substance.

We conducted a direct microscopic count of the erythrocytes using a Goryaev chamber. The 65GHz resonant frequency led to hemolysis of nearly 63% of the cells, while the addition of metronidazole reduced this to nearly 32% (see Table 1). Thus, the drug protected red blood cell membranes from destruction by electromagnetic radiation at a resonant frequency. However,

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the drug did not protect cells from millimeter waves at nonresonant frequencies. This protective phenomenon is well explained by the contrary effects of the field and the substance on the structure of hydrogen bond networks of membrane and protein subsurface water.

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**References**