

7. General Conclusions About Biological Effects of ELF Fields and Their Implication

As the preceding discussions have indicated, there is now a very large volume of scientific findings based on experiments at the cellular level and from studies with animals and people which clearly establish that low frequency magnetic fields can interact with, and produce changes in, biological systems. While most of this work is of very high quality, the results are complex. Current scientific understanding does not yet allow us to interpret the evidence in a single coherent framework. Even more frustrating, it does not yet allow us to draw definite conclusions about questions of possible risk or to offer clear science-based advice on strategies to minimize or avoid potential risks.

Of the effects discussed, the central nervous system effects including circadian effects in animals and the possibility of cancer promotion appear most worthy of concern with respect to public health effects. These are now summarized.

7.1. Central Nervous System Effects

As a system that uses low frequency fields for its intracellular communication and function, the brain and central nervous system are natural candidates for interaction with fields. The implications of tissue or cellular level in vitro experiments for the whole organism are not clear. But the animal studies, including the circadian variations introduced by fields, indicate that:

1. Field-CNS interactions may have dependencies which are at very specific frequencies and intensities, and may vary with the background static fields present, the time of day and the duration of exposure.
2. Developing nervous systems maybe particularly susceptible and effects maybe latent, manifested only in specific situations or later in time.
3. More than any other agent known, except perhaps some psychotropic drugs, ELF fields are specific: with respect to the regions of the brain tissue affected and the point of administration in the circadian rhythm.

How and whether these findings have public health implications remains unclear. What is clear is that these findings about subtle and complex effects demand a carefully planned research agenda in this area.

7.2. Cancer Promotion

The following points summarize the key experimental results that are consistent with a possible association between exposure to ELF fields and the occurrence of cancer:

1. ELF fields are not known to cause any chromosomal damage, and, hence, are not likely initiators of cancer.
2. Some cellular level experiments indicate that the cell membrane is the site of the interaction between ELF fields and the cell. The membrane site responsible for this action has also been shown to be a receptor for chemical cancer-promoters.
3. ELF fields have been shown to increase ornithine decarboxylase (ODC) activity. All known cancer promoters stimulate ODC. However, the converse is not true. Many agents that promote ODC activity are not cancer promoters.
4. Alterations in protein synthesis, in immunological and hormone status, and in metabolic competence via circadian shifts can all contribute to the progress of initiated cancer. To the extent that ELF fields play a role in those, they might have an effect on tumor growth or

indeed tumor inhibition. The increase in ODC activity noted above is indicative of growth enhancement rather than inhibition.

5. Pineal melatonin depression has been associated with cancer growth, and administration of melatonin has been found to slow the growth of cancer. ELF fields depress pineal melatonin levels in animals.
6. Functions of gap junctions are disrupted by ELF fields. Similar disruptions are produced by other known chemical promoters.
7. Epidemiologic studies of ELF exposures and cancer show a weak association between ELF field exposure and nervous system cancer and leukemia.

While the above arguments are consistent with the hypothesis that ELF fields may play a role in cancer or tumor development, none of these constitutes proof or even necessarily a strong indication that it does.