Die folgenden Beiträge beziehen sich auf neuere wissenschaftliche Originalarbeiten zur Wirkung hochfrequenter Felder der Mobilfunks. Die Auswahl der Publikationen ist vom Autor Prof. Roland Glaser selbst getroffen und durch sein subjektives Urteil der Relevanz bestimmt.

The latest scientific news

A collective at the Tel-Aviv University has used a new indicator to investigate probable **effects of high frequency fields on DNA**. The investigation dealt with **alternations in the number of chromosomes** ("aneuploidy"), which can occur during the cell division process as a **somatic mutation**. This is frequently associated with **carcinogenesis**. Although the genetic mechanisms which trigger aneuploidy and the cellular biological consequences of this process are not fully understood, it seems we are dealing here with a sensitive indicator. The authors investigated cultures of human lymphocytes in an incubator between two metal plates, which were exposed for 72 hours at a continuous field of 830 MHz. The controls were also placed in the same incubator shielded with metal. The calculations which resulted were caused by reflections in the incubator and the field distribution inside the culture flasks was so inhomogeneous that the SAR-values fluctuated between 2 and 24 W/kg. The authors gave 9.8 W/kg as a mean average value. Due to the field inhomogeneity temperature differences in the culture medium were established to be between 34.5° and 37.5°C. In order to maintain a dosage dependent effect, the samples were divided into 4 groups with different mean average SAR-values. In this way a correlation between the frequency of aneuploidy and irradiation intensity could be determined. Already in the second intensity stage (2,9 ± 0.3 W/kg) an increase of 65% was established ($p<0.004$), and at the highest stage (8.2 ± 0.6 W/kg) there was an increase of 100% ($p<0.00002$). The authors are of the opinion that this is a non-thermal effect since with no exposure, similar effect was not observed unless the temperature in the incubator was increased to 40° C. These findings are without a doubt interesting, however they urgently require a re-examination in a homogenous field with a more controlled dosimetry and more exact temperature controls. (Mashevich, M.; Folkman,D.; Kesar, A.; Barbul, A.; Korenstein, R.; Jerby, E.; and Avivi, L.: Exposure of human peripheral blood lymphocytes to electromagnetic fields assiciated with cellular phones leads to chromosomal instability. Bioelectromagnetics 24, 82-90. 2003).

In the journal "Medical Hypotheses", which is open to all kinds of ideas regarding medical topics, perhaps too open, an article was published on an hypothesis **explaining health effects associated with using mobile telephones.** In the article it is surmised that cases have been described where headaches, vomiting, dizziness, sleep disturbances, memory loss and tiredness occurred after using a mobile phone. The authors do not seem to be concerned that there is no scientific evidence to support what they are postulating. The authors maintain that epidemiological investigations have failed to find a correlation between brain cancer induced by mobile phones because the studies have been too short and the number of people affected has been too low. The hypothesis proposed explaining the postulated harmful effects is based on two assertions: one is that the 16cm wide (from ear to ear) human head makes up exactly half a wavelength at 900 MHz and the whole head makes up a whole wave-length at 1800 MHz. The other is that the oscillations in the brain are demodulated ("in the same way that a radio receiver acts...") The first assertion is formally correct but it does not explain the problem of energy absorption in the brain. The authors have completely ignored numerous investigations on the actual dosimetry of RF-frequencies in the human head. The second thesis refers to, in spite of many contradictory findings, at least concerning popular arguments the work of Bawin et al of 1978, which unfortunately cannot be considered finished. Bawin's et al work concerns the alleged calcium-release in chicken brains and its dependency on a small window in the modulations frequency. It has been completely ignored that in many discus-

sions and publications it has been explained for some time that this kind of demodulation in the sector of RF is biophysically impossible and also could not be experimentally proven. Perhaps not only the authors but also the naïve readers are so ignorant that they wouldn't even think of this. Whether or not this serves any useful purpose is still open. (Weinberger, Z. and Richter, E.D.: Cellular telephones and effects on the brain. The head as an antenna and brain tissue as a radio receiver. Medical Hypotheses.; 59, 703-705. 2002).

Are there any **micro-thermal effects**? Is it possible that local heating can be caused by UHF-fields without there being any change in temperature in the entire system? Are these non-thermal effects? From many discussions in the past, it was concluded that "hot spots" are only possible at a millimetre level, since the speed of the thermal exchange prohibits stationary temperature gradients in the microscopic area. Presently a study in the field of bio-technology has shown that this does not have to be the case.

A small covalent synthetic gene-sequence was coupled to gold balls with a diameter of 1.4 nanometers. The replication frequency of this sequence is dependent on the temperature. It can be demonstrated that this process is reversible, it can be switched on and off with the irradiation of a 1GHz-field. This process which is obviously triggered by a local temperature increase of 15°, was strictly limited to the nano-crystal bound nucleotide chain. Sequences which were located in molecular dimensions next to these molecules were not affected by this warming. Shouldn't this publication which is aimed at a very specific bio-technological application, make us think anew about the micro-thermal effects of RF-fields? (Hamad-Schilfferli, K.; Schwartz, J.J; Santos, S.T.; Zhang. S.; and Jacobson, J.M.: Remote electronic control of DNA hybridisation through inductive coupling to an attached metal nanocrystal antenna. Nature 415, 152-155. 2002.

In several publications the working group of Theodore A. Litovitz (Washington D.C.) presented the following two hypotheses: a) **Weak low frequency electromagnetic fields induce the development of stress proteins** (mainly Hsp 70), which on the other hand enable the organism to cope better with the following different kinds of stress (at least concerning anoxien). b) **Exposition with a low frequency noise in stochastic magnetic field reverses this effect.** The latter was based on the theory of coherence time that Litovitz published ten years ago (Litovitz et al.: Bioelectromagnetics; 14, 395. 1993), he has unwaveringly held on to his theory despite many other studies demonstrating contradictory and opposite findings (s.: Glaser: Bioelectrochem. Bioenerg.; 46, 301. 1998). In a new study this model has been extended to **high frequency fields**. For this purpose, chick embryos in stage 22-25 were exposed in the course of 30 minutes to 915 MHz (SAR: 1,75 and 2,5W/kg). In some cases this was overlapped with 20 micro-tesla low frequency noise. A representative Hsp70 blot analyses (unfortunately the only, half-quantitative, data in the publication!) showed that in cases of high SAR values the Hsp70 content which was present in the embryo anyway increased 2 to 3 hours after exposure. Moreover, the survivability of the embryos in an almost oxygen free atmosphere (30 minutes) was measured. This proved to be better after the embryos were exposed at both SAR-values. Through the overlapping of the RF-fields with a stochastic magnetic field this effect was reversed. The reaction is considered to be "non-thermal", since even at a SAR of 2.5 W/kg the temperature only increased by 1.5°. The situation that the stochastic field reverses the survival effect is seen as an indicator that a "hot-spot" reaction can be ruled out. (Shallom, J.M.; DiCarlo, A.L.; Ko, D.J.; Penafiel, L.M.; Nakai, A., and Litovitz, T. A.: Microwave exposure induces hsp70 and confers protection against hypoxia in chick embryos. J. Cell. Biochem. 86, 490-496. 2002).

Does using a mobile phone facilitate memory. After a number of publications have already indicated with tests done on volunteers that using a mobile phone facilitates memory, this proposition is supported by another study done in the UK at the University of Bradford. Sixty-two healthy right-handed volunteers of both sexes aged 19-53 underwent tests from which conclusions could be drawn concerning **long and short-term memory**. During the first phase the test person was given the chance to study for three minutes a A4 sized sheet of paper where 12 boxes were drawn in the shape of a pyramid and in each box there was one word. During the second phase, in order to avoid any kind of active learning with a repetition effect the volunteer was required to read aloud something from a newspaper for 12 minutes. In the third phase the volunteer was given the same sheet of paper but this time the pyramid boxes were blank. The volunteer was asked to remember the original 12 words and write them in the boxes. Semantic mistakes were evaluated (words which were wrong or missing words) and placement mistakes (the right word in the wrong box while taking into account the distance from the correct location in the pyramid). This test on short-term memory was done again after a week to evaluate long-term memory. The tests were conducted in phase 1 and 2 as follows: a) without a mobile phone, b) with an inactive mobile phone, c) with an ac-

tive mobile phone held on the left side (Ericsson A 2618s, 1800 MHz, SAR: 0,79 W/kg). The memory test (phase 3) was conducted without a mobile phone: The test results showed that fewer mistakes were made with the inactive mobile phone as with the test carried out without a mobile phone, which could be contributed to a psychological effect since the volunteers without a mobile phone knew that they were "only" undergoing control tests and therefore did not try very hard to recall the words.

What was interesting was that the male volunteers with an active handy made significantly fewer placement mistakes (concerning the semantic mistakes it was less clear but noticeable) when compared to those who tested with an inactive mobile phone. However, no difference was observed with the female volunteers. No difference was observed concerning long-term memory. The authors have no explanation for the results. (Smythe, J.W. and Costall, B.: Mobile phone use facilitates memory in male but not in female subjects. Neuroreport 14, 243-246, 2003).

Mika Koivisto et al. reported in two publications on **a subtle increase in cognitive function** in volunteers exposed to the **fields used in mobile phones** (Neuroreport, 2000, 11, 413-415 and 1641-1643). To a lesser degree similar stimulated effects of less significance were observed by others (Preece et al. 1999, Edelstyn and Oldershaw 2002, Lee et al. 2001). A report has been recently published on this problem in which a collaborative research project by Finnish and Swedish researchers applied broader, better statistical and double-blind methods in their investigations in order to ensure a secure framework. M. Koivisto's team was one of the partners. When compared to prior investigations the number of volunteers was greater (in both laboratories there were 32 volunteers) and the test spectrum was also enlarged. The volunteers were exposed to 902 MHz pulses with the usual frequency of 217 Hz by attaching a mobile phone to the left side of their heads. The SAR-value relative to one gram of tissue, was in the middle at 0.88 W/kg with the highest values recorded at 1.2 W/kg. Temperature measurements showed lower temperature increases on the surface after 40 minutes, without a field they were at 36.0° C and with a field at 36.1° C. The authors are of the opinion that this temperature increase is too subtle to feel and therefore cannot endanger the double-blind character of the experiment in any way. The results of this investigation finally demonstrated that in not one of the tests carried out, was a difference observed between a device that was on or off. No one among the volunteers could be designated as being especially sensitive. The authors came to the conclusion that high frequency fields have no effects on human cognitive function. They especially emphasized that their report contained no evidence of possible long-term health effects from RF-fields. (Haarals, Ch.; Björnberg, L.; Ek, M.; Laine, M.; Revonsuo, A.; Koivisto, M., and Hämäläinen, H.: Effect of a 902 MHz electromagnetic field emitted by mobile phones on human cognitive function. A replication study. Bioelectromagnetics 24, 283-288. 2003).

How reliable are reports stating that specific effects found in *in-vitro* experiments have to be non-thermal, since during exposure no increase in temperature in the experimental Petri dishes or flasks was detected or because the SAR-value that was reached was too low? Schuderer and Kuster (Zurich) have pointed out the **inhomogeneity in SAR-values at the solid/liquid interface of receptacles,** which even with the tiniest thermistors cannot be measured and they addressed the question as to whether or not the meniscus causes a field distortion at the liquid interface and if a local change in SAR-values is possible. First the authors modelled the form of the meniscus of a nutrient solution in a Petri-dish based on exact measurements as an e-function. The field distribution for 1800 MHz was then numerically calculated with a resolution of 0.2 mm. **Depending on how high the Petri dish was filled, it showed a significant field distortion and a clear inhomogeneity of the corresponding SAR-values.** Ignoring this effect leads, therefore, not only to a distinct under estimation of the SAR-values in the centre of the receptacle, but also ignores ranges where SAR-values are locally increased. The authors have stressed that in order to report on an exact ascertainment of the effect a calculation with a higher resolution is necessary. One can also justifiability ask the following: Are the subtle effects of a non-thermal kind, which are always published as being the result of RF-irradiation of cells, perhaps not the "thermal" effects of a fewer number of cells in a smaller SAR-intensive area of the experimental receptacle? These calculations also show that heating caused by diathermy is not identical to thermostat heating! (Schuderer, J. and Kuster, N.: Effect of the meniscus at the solid/liquid interface on the SAR distribution in Petri dises and flasks. Bioelectromagnetics 24,103-108. 2003).

In two prior studies Alexander Borbély et al. (Neuroscience Letters 275, 207-210. 1999) and Reto Huber et al. (Neuroreport 11, 3321-3325. 2000) determined that **exposure to RF-fields from a nearby mobile phone will cause changes in sleep EEGs.** In a new joint publication this finding was investigated with much better controlled dosimetry. A GSM-signal (900 MHz) was used to simulate the

pulses of a base station. Corresponding to the initial publications the study contained the results from two experimental approaches. In the first case 24 young male volunteers were exposed during sleep with an on-off signal (15 minute rhythm), in which the antenna system was located 30 cm from the top of the volunteer's head along the body axes; the volunteer was lying, so that in spite of the different positions of the head, it could be more or less exposed to the same degree. In the second case 16 male volunteers were exposed while sitting with an antenna next to their heads. In this case the volunteers were examined 30 minutes after exposure, which was applied during a three-hour period of sleep on a day after a night where the volunteers did not sleep very much. Despite the different exposure conditions and different physiological situation in both cases an increase in EEG activity in the range of 9-14 Hz after exposure could be determined when compared to the control group. This is all the more astonishing as the detailed calculations carried out on both experimental set-ups showed, of course, for the volunteers a completely different head dosage distribution. Even under conditions where intensities at right-left exposures differed by 1:10, no asymmetric effects in the EEGs could be determined. The authors believe that the measured effect can be traced back to reactions taking place in the hypothalamus, which in both cases absorbed about 0.1 W/kg (in comparison to 1 W/kg average SAR relative to 10 g, which corresponds to the CENELEC-standards). The authors are of the opinion that further investigations on this finding is especially required with regard to the different field modulations (Hüber, R.; Schuderer, J.; Graf, Th.; Jütz, K.; Borbély, A. A., Kuster, N., and Achermann, P.: Radio frequency electromagnetic field exposure in humans estimation of SAR distribution in the brain, effects on sleep and heart rate. Bioelectromagnetics 24, 262-276. 2003).

Interphone – seeking the cau

Christoph Bächtle

The project "Interphone", is the most extensive research project being conducted under the direction of the World Health Organization (WHO) with scientists from 13 countries, including three working groups from Germany. They want to find out if there is a correlation between using a mobile phone on a regular and long term basis and the development of brain tumours.