Alfred Gierer

Informal curriculum vitae

(All publications quoted are available as free full texts under Gierer in the servers http://edoc.bbaw.de and http://www.eb.tuebingen.mpg.de/gierer)

I was born April 15, 1929 in Berlin. From 1934 to the outbreak of the Japanese-Chinese war in 1937, the family lived in Shanghai where the father worked for the AEG and its subsidiary, the China Electric Company, on projects of electric power plants. I went to schools in Shanghai, Berlin and Schwabach in Bavaria, and studied physics in Göttingen from 1946 to 1953. From 1948 to 1953 I worked at the Max-Planck-Institute for Physics, newly founded by Werner Heisenberg, doing Diploma and PhD studies with Karl Wirtz as PhD advisor on proton transfer across hydrogen bonds and physics of liquids. Not infrequently quoted even after 50 years is a paper: A.Gierer and K.Wirtz, "Molekulare Theorie der Mikroreibung" (1953), Z. Naturforsch. 8a, 532-538, with calculations of rotational and translational friction coefficients for molecules of sizes comparable to water.

Wirtz, though a nuclear physicist, envisaged a great future of molecular physics for understanding basic problems of biology, and stimulated my interest in this direction. Pauling`s book on "The nature of the chemical bond", and even more a lecture he gave in Tübingen in 1952 on the newly discovered alpha-helix were then decisive for me to change fields.

As a Fulbright fellow of 1953 – the first year after world war two that German postdocs had an opportunity to go to the US – I worked with Sizer at MIT on enzyme kinetics. Back in Germany 1954, I became a research associate of Hans Friedrich-Freksa at the newly founded Max-Planck-Institute for Virus Research in Tübingen. The place was ideal for a young physicist moving into biology, the time was ideal because the double helix was just discovered and this turned out to be the beginning of the Golden Decade of molecular biology, Freksa was a most inspiring and at the same time very liberal mentor and institute`s director, Schramm`s work laid the foundation for TMV as a model system for basic problems of molecular biology, and his openness to cooperation was most remarkable. Here are the original versions of three short papers in "Nature", one with Schramm showing that the isolated viral nucleic acid is infective and thus the genetic material of the virus, another one showing that the RNA content of the virus forms one single strand, and that the integrity of the molecule is necessary for infectivity, and a third paper, together with Mundry working at Melchers`Max-Planck-Institute for Biology, demonstrating that a single nucleotide substitution in the viral RNA by treatment with nitrous acid in vitro can cause a mutation of the virus.

Gierer, A., Schramm, G. (1956) Infectivity of ribonucleic acid from Tobacco Mosaic Virus. *Nature* 177, 702-703.

Gierer, A. (1957) Structure and biological function of ribonucleic acid from Tobacco Mosaic Virus. *Nature* 179, 1297-1299.

Gierer, A., Mundry, K.W. (1958) Production of mutants of Tobacco Mosaic Virus by chemical alteration of its ribonucleic acid in vitro. *Nature* 182, 1457-1458.

In 1958/59, I spent half a year on invitation by Max Delbrück at CalTech and became acquainted there, in the laboratory of Hildegard Lamfrom, with cell free protein synthesis in the reticulocyte system.

Soon after my return from Pasadena, in 1960, I was offered, on the basis of the TMV work, the position as Scientific Member of the Max-Planck-Society and head of a new, independent department of Molecular Biology at the Virus Institute; presumably I was one of the youngest Members up to then and since then. Membership means tenure, complete scientific independence, and rather ample funding.

The next paper was on protein synthesis in reticulocytes, showing that ribosomes function in aggregates (later called polysomes) linked by messenger-RNA; this, in turn, suggests a tape-reading mechanism of protein synthesis, according to which "growth of the peptide chain is accompanied by shifting the active site of the ribosome from one coding group of the messenger-RNA to the next"(Polysomes were discovered near-simultaneously in several laboratories).

Gierer, A. (1963) Function of aggregated reticulocyte ribosomes in protein synthesis. *J. Mol. Biol.* 6, 148-157.

Thereafter we prepared a strong change of direction towards developmental biology, a field that was still mostly considered old-fashioned at that time, making full use of the freedom of MPG members. We choose regenerating Hydra as model system and placed emphasis on spatial pattern formation, the dynamics of stem cell proliferation and pathways of cell differentiation. This work was started with two American postdocs and three German graduate students. Included here is the first paper of our Hydra group showing the capability of aggregates of previously isolated cells to eventually regenerate complete animals. This system proved to be very effective for investigating basic mechanisms of cell interactions, pattern formation, and cell differentiation. Tissue polarity was shown to be due to graded components rather than orientated polar cells.

Gierer, A., Berking, S., Bode, H., David, C.N., Flick, K., Hansmann, G., Schaller, H., Trenkner, E. (1972) Regeneration of hydra from reaggregated cells. *Nature New Biol.* 239, 98-101.

In 1971, my colleague Hans Meinhardt and I began to work on the theory of biological pattern formation. Primarily, it addresses the formation of striking patterns within originally near-homogenous tissue, the process prototypical for embryology, and represented in particularly puristic form by cut sections of hydra regenerating, by internal reorganisation of the pre-existing tissue, a complete animal with head and foot. Our basic idea was that the essential requirements are autocatalytic, self-enhancing activation, combined with inhibitory or depletion effects of wider range – "lateral inhibition". Not only de-novo-pattern formation, but also the well known, striking feature of developmental regulation such as induction, inhibition, and proportion regulation can be explained on this basis. The theory provides a mathematical recipe for the construction of molecular models with criteria for the necessary non-linear interactions. It has since been widely applied to different developmental processes. Our primary paper was

Gierer, A., Meinhardt, H. (1972) A theory of biological pattern formation. *Kybernetik* (continued as *Biological Cybernetics*) 12, 30-39.

A more recent review with emphasis on the Hydra model is:

Gierer, A. (2012) The Hydra model – a model for what? Int. J. Dev. Biol. 56, 437-445.

In the course of time, more sections of the Virus Institute turned to development until its name was changed, in 1984, into "Max-Planck-Institute for Developmental Biology". In that decade, we started a joint project on neuroembryology, especially on directional guidance of growing axons in forming the neural network. Here is the title of a paper on the theory of such guidance by gradients.

Gierer, A. (1987) Directional cues for growing axons forming the retinotectal projection. *Development* 101, 479-489.

Ever since I was a graduate and PhD student at Heisenberg`s Max-Planck-Institute for Physics in Göttingen around 1950, I was interested in philosophical aspects of physics in general, and in the range and limits of a physical foundation of biology in particular; the latter was in fact the dominant motive for shifting from physics to biology. In 1964, I gave a course on this in the summer school of the Austrian College in Alpbach. There I met the protagonist of Analytical Philosophy, Herbert Feigl, who induced and inspired my continuing interest in the brain-mind-problem. I wrote an article on this subject which appeared in "Ratio" in 1970. It combines strict physicalism with epistomological scepticism: Brain processes occur according to the laws of physics, and yet physical brain states may not be fully decodable with respect to corresponding mental states by finite algorithmic procedures, especially when self-referential features are involved.

Gierer, A. (1970) The physical foundation of biology and the problems of psychophysics. *Ratio* XII, 47-64.

A more recent version based on these concepts is:

Gierer, A. (2008) Brain, mind, and limitations of a scientific theory of human consciousness. BioEssays 30, 499-505.

I gave a course at Tübingen University on the physical foundations of biology in the seventies, a series of lectures there for a general audience in the eighties, and wrote a book on physics, life and mind (in German)

Gierer, A. (1985) Die Physik, das Leben und die Seele. Piper, München

that sold 20 000. Subsequent books and monographs were on the historical origins of modern science and its implications for our image of man; and on the pro-scientific cultural change in the Middle Ages and the Renaissance, exemplified by Eriugena, al-Kindi and Nicolas de Cusa. Topics of articles include the biological basis of human cooperativity and empathy, and comparisons of biological evolution and technological innovation.