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Laboratory Animal Quality Determining Factors

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The quality of a laboratory animal, of an animal colony is determined by a huge variety of internal and external factors. It is the field of laboratory animal science to investigate and evaluate these factors with respect to quality improvement and standardization.

In Table 1 I have tried to compile and classify the factors which may influence the animal, which may interfere with an animal experiment and its result. This compilation is necessarily arbitrary and incomplete. However, it may give you a summarized impression of the quality-determining factors. These factors may be classified as exogenous and endogenous.

The exogenous factors are factors of environment. They have to be considered while determining the quality of the animals' environment, in the breeding institution and during the course of the experiment in the user's laboratory.

The endogenous factors are those directly responsible for the quality of the animal. They are associated with the animal, they determine its genetic and hygienic status, i.e. the flora-dependent health status.

The influencing factors can be also classified as non-living physical factors and chemical factors and as living, i.e. biological factors, as macrobiological, microbiological and genetic factors.

It has been widely proved in the literature that each of these factors either alone or in interrelation with one or several others causes measurable alterations in mice, rats and other small laboratory animals, and of course in any other animal used in animal experiments. However, the different factors, or combinations of interfering factors have a different influence on the various systems of the animal and are of different importance to the user of the animal depending on the actual experimental programs. While the genetic and hygienic status details such as the temperature or food components are important quality determining factors for almost every animal experiment, other factors such as electromagnetic fields influence only some experimental programs or some of the animal's physiological parameters.

The laboratory animal, like any other warmblooded organism has the ability to adjust itself to a certain extent to changing environmental conditions. The range of this adaptive ability differs depending on the challenging factor and the genome of the challenged organism. The adaptation ability not only differs between animal species but may also differ between different strains and stocks of a given species. As long as the environmental conditions provided for the animal species, strain or stock in question range within the limits of its adaptation ability, the animal organism can achieve a balance. Its systems are able to counterbalance the environmental influence. This ability is in fact a disadvantage to a certain extent, because these exogenous disturbances do not result in a breakdown of our biological gauge or in a clearly visible misfunction like in general, in technical measuring instruments. The self-adjusting ability of this biological tool to changing environmental conditions, the animal's ability to adapt, the silent and mostly unobserved but nevertheless highly complicated internal processes of adaptation suggest an undisturbed biological measuring system. However, the very adaptation process may imperceptibly influence the experiment, making its results misleading.

Following this, it is important to keep the different environmental factors controlled to a standard quality, possibly a value or dimension which meets the species-specific,

Table 1.

EXOGENOUS	EXOGENOUS	EXOGENOUS	EXOGENOUS	ENDOGENOUS	ENDOGENOUS
PHYSICS	CHEMISTRY	BIOLOGY	BIOLOGY	BIOLOGY	BIOLOGY
ABIOTIC	ABIOTIC	MACROBIOLOGY	MICROBIOLOGY	MICROBIOLOGY	GENETICS
CLIMATE TEMPERATURE (C°) Δ T HUMIDITY (REL. %) ATMOSPHERIC PRESSURE (BAR) AIRFLOW (M/SEC) LIGHTING INTENSITY (LX) TIME (H) COLOUR (KELVIN) SOUND INTENSITY (PHON) FREQUENCY (Hz) ELECTROMAGNETIC – SIGNALS (–WAVES, – UNDULATION) WAVE LENGTH (λ) FREQUENCY (Hz) EL. FIELDS (V/m) MAG. FIELDS (GAUSS) EL. MAG. FIELDS RADIATION OF PARTICLES IONISATION CAGE/ROOM MATERIAL HEATCONDUCTIVITY FLOOR COVERING BEDDING	BREATHING AIR GASES COMPONENTS CONCENTRATION AEROSOLS CARCINOGENS CONTAMINANTS FOOD – SOLID FOOD – LIQUID COMPOSITION COMPONENTS TOXINS HARMFUL SUBSTS. CARCINOGENS REGIMEN RESTRICTED NON RESTRICTED BEDDING DISINFECTANTS DRUGS SOLVENTS CHEM. COMPOUNDS NUTRITION QUALITY QUANTITY DUST PARTICLES RHYTHM	MAN – STAFF SCIENTIFIC-TECHNICAL-CARETAKER ANIMALS OF OTHER SPECIES INSECTS WILD RODENTS VERMIN ANIMALS OF THE SAME SPECIES SOCIAL RELATIONS – INTERFERENCE ANIMAL/ROOM ANIMAL/CAGE CAGE SIZE SPECIES SPECIFIC BEHAVIOUR PATT. SPACE REQUIREM. EXERCISE (TRAINING OF ANIMAL TECH. – SCIENTIF. STAFF)	ENVIRONMENTAL – GERM BURDEN AIRBORN GERMS MICROBES OF FOOD WATER DRINKING WATER PERSONNEL INSECTS CONTAMINATED ANIMALS	FLORA PARASITES BACTERIA AEROB ANAEROB VIRUS GNOTOBIOTIC SPF – SPECIFIED PATHOGEN FREE CONVENTIONAL	HETEROGENOUS OUTBREEDING "STOCK" NO MATING OF RELATIVES "RANDOM" "ROTATION" "LINEAR PROGRAMMING" ISOGEN INBREEDING "STRAIN" MORE THAN 20 GENERATIONS BROTHER/SISTER MATING INHERITED – QUALITIES – DEFECTS

strain-specific or stock-specific demands of the animal as well as the needs of the planned or ongoing experimental program and if possible of economic requirements too.

It is of the utmost importance to keep the organism, the laboratory animal as a biological gauge, in balance during the course of the experiment. If not the total organism, it is necessary to keep at least those physiological systems of the organism which are the desired scientific information.

To repeat it once more: it is not just environmental factors that influence the organism. It is the uncontrolled changing quality of the factor which interferes with the organism, which forces the animal to redress its balance with the environment, which leads to a new balance probably on another level.

Because the changing of an environmental factor happens mostly unnoticed, the triggering and course of the adaptation process also occurs silently, with no clinical symptoms. The process itself also remains unnoticed. If uncontrolled these mechanisms may interfere with and disrupt an experiment or may even lead to useless results.

Standardisation does not mean to keep a certain environmental factor absolutely fixed and constant on a certain dimension! To keep a factor controlled also does not imply always and automatically an absolutely fixed figure or value of a factor in question! To standardize, to keep controlled in this context may also mean to standardize a certain variation of a factor.

It includes keeping an agreed modulation of the factor or a standardized and controlled range of fluctuation of the factor. It might be better for the animal with respect to its ability to redress a balanced condition, a controlled, induced circadian rhythm is maintained in the environment e.g. temperature. For a number of environmental factors it might even be desirable to expose the animals to a certain controlled variation or modulation, of the factor in question, e.g. the temperature, in order to keep the organism trained, i.e. to increase its ability to adapt itself to changes in the pattern of exogenous and endogenous factors.

This may sound at first glance odd and contradictory. However, a pre-set variation, desired fluctuation, a limited modulation of a factor or group of factors can be standardized and controlled just as well as an absolutely constant figure. It may be more difficult, laborious and sometimes more expensive.

With respect to the three headlines in the field of laboratory animal science

- genetic monitoring,
- microbiological/hygienic monitoring and
- environmental monitoring

the keyword in animal husbandry is "controlled and defined environment" and not constant environment! This is often misunderstood.

In this context some remarks are called for on the control animal, the control or reference group of animals normally part of an animal experiment.

It is not just the difference between the results from the control group and the challenged group which makes the final result of the experiment. Unfortunately it is not that simple and convenient. It is conceivable that an interfering factor may cause no detectable alterations in the control animals' systems. However, the same environmental factor may possible add to or multiply the effect of the experimental challenge in the test group.