Hatcheries collect large quantities of data to monitor performance and to make sure equipment are operating within set operating limits. These data are a valuable resource for the hatchery, and can be used identify problems and areas where improvements can be made. To achieve this it is essential that data are handled and analysed correctly.

Good data analysis requires data to be stored in a database, effectively all the data to be analysed is in a single table or Excel sheet consisting of continuous columns and rows. The quality of the data analysis will also depend on the quality of the data: errors in the data will result in errors in the analysis. One of the largest tasks when undertaking a data analysis is the validating of the source data and this can be done using a variety of methods: (1) plotting all the data points to look for extreme values; (2) sorting or filtering data to look for values outside expected ranges; (3) check for consistent naming.

Reviewing data is an important management function and should be done routinely. The use of Excel Pivot Tables and Charts can be extremely powerful tools to help organise data and present the information in a meaningful way. Creating dashboards, where key management data are presented in tables and charts in a single view, can also a powerful way of monitoring the performance of the hatchery. Key to presenting data is that it shows performance against targets and that it highlights problems.

Statistical analysis can be a very powerful method for truly understanding the factors that are affecting performance. The advantage of statistical methodology is that it can include many factors at the same time within the analysis so that each factor can be evaluated when all the other factors have been accounted for. It is often stated that a statistical analysis can measure the pure effect of a given factor on performance. There are many techniques and computer programs that allow the user to carry out a statistical analysis, but all require the user to have some knowledge of statistical methodology. The main methodologies used to analyse hatch data are multiple regression, standardized least squares and general linear models. Potential pitfalls when running a statistical analysis are that factors being investigated are not independent of each other: class variables are confounded or continuous variables are highly correlated with each other.

The other type of data analysis that may need to be undertaken in a hatchery are results from a field trial, for example comparing the performance of two incubator settings. Running a successful hatchability field trial has three key requirements:

1. As much as possible make sure everything, other than the factor being investigated, is as equal as possible. For example if comparing two incubation settings make sure the eggs in the two test setters are from the same flocks and have the same egg storage.

2. Use lots of eggs. To detect a 2% hatch gain will require approximately 4,800 eggs per treatment and to detect a 1% hatch gain will require approximately 20,000 eggs.

3. Repeat the test several times, typically 3 or more, to make sure the results are consistent. When repeating a trial, if possible change which incubator is used for the control and test treatments.
The effect of nutrient profiles in egg yolk on embryonic survival ability in laying hens

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Low hatchability negatively affects productivity and animal welfare in the poultry industry. About 8% of chicken embryos die before hatching each year; the value is much higher in turkeys. Embryonic viability is influenced by a series of factors such as nutrition, hatching technology, egg quality and genetics. The nutritive components of the yolk are influenced by environmental and genetic factors and could affect the embryonic survival ability. The main goal of this study was to determine metabolite profiles in the egg yolk and to assess possible associations with hatchability.

A large number of hatching eggs were collected from 4 different lines (commercial white- and brown layer lines and experimental unselected lines). Based on estimated breeding values of hatchability traits in hens of aforementioned lines, 1073 egg yolk samples were collected to determine metabolite profiles using gas chromatography–mass spectrometry. A total number of 105 different metabolites known in egg yolk, including fatty acids, amino acids, carbohydrates, steroids, glycerides, vitamins and organic acids were detected. The estimated heritability for different metabolites was in the range between 0 and 70%.

Significant differences were found between different lines. Compared to white layers lower amounts of saturated fatty acids and monounsaturated fatty acids were detected in brown layers’ egg yolks, whereas the content of polyunsaturated fatty acids, was higher in brown layers. A significant association between embryonic survival ability and the polyunsaturated fatty acids arachidonic acid and docosahexaenoic acid was found. These fatty acids are essential for the development of the embryonic brain and nervous system in precocial birds. Furthermore, a significant positive association was observed between embryonic mortality and palmitoleic acid and it’s precursor palmitic acid, which are known to influence insulin content and glucose metabolite pathways during embryonic development.
Effects of different conditions of storage on egg components and blastodermal quality and high temperature environments

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Egg quality is a general term that relates to various standards that are imposed on eggs. This quality usually embraces a range of quality characteristics such as shell colour, albumen quality amongst others. It is therefore necessary to store eggs properly to avoid or reduce the rate at which the quality declines. Egg quality has also shown to be an influencing factor in hatchability and chick quality in general.

Therefore, studies were conducted to determine the influence of storage temperature, condition and duration on egg quality characteristics, shelf life and blastodermal size.

A total of one hundred and ten eggs were used for two experiments. In the first experiment, a total of 60 table eggs were divided into two treatments of oil and non-oil coating. Eggs (n = 10) for each treatment were stored for either 0, 2, 4, 6, 8 and 10 days at ambient temperature. A Completely Randomized Design (CRD) in a 2x5 factorial arrangement was used. Experiment two comprised of two treatments of cold storage (18°C) and ambient temperature storage (23-26°C). Fertile eggs under each storage condition were stored for 1, 3, 6, 10 and 14 days. Parameters measured included proportions of yolk, shell, albumen and blastodermal size. Data was analysed using the SAS Proc. GLM procedure (P<0.05).

The results showed that in experiment 1, shell thickness was affected by oil preservation. Yolk weight and Haugh unit were significantly affected by storage duration. The Haugh unit decreased as the storage days increased. In experiment 2, the egg weights were not affected significantly by storage conditions but were significantly affected by storage duration and interactions between storage condition and storage duration. The blastoderm size decreased significantly in cold temperature compared to ambient temperature and increased significantly as the day of storage increased. In a similar way, the yolk weight increased as the day of storage increased.

Based on the research findings it was concluded that in table eggs egg quality as measured by Haugh unit is not affected by oil preservation but quality decreases with increasing storage duration. In fertile eggs while the blastoderm quality on both dependent on both storage temperature and duration, the egg components of yolk, shell and albumen were much dependent on storage duration.
**Session 4**  
**Incubation temperature and hatching time**

**Increasing and decreasing incubation temperatures during embryonic myogenesis influences muscle growth and energy metabolism in broiler embryos**

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In ovo embryogenesis in broiler can be modulated by alteration of external factors, like the incubation temperature, as shown in several publications. Embryonic myogenesis in broiler is characterized by the formation of primary and secondary myotubes during embryonic day (ED) 3 to 8 and ED 8 to 14, respectively and it was shown that increase of the incubation temperature during this period has an impact on the growth of the embryos and animals post-hatch (Maltby et al., 2004; Hammond et al., 2007; Janisch et al., 2015).

Assuming that the described effects of the in ovo temperature alteration on the muscularity were related to the metabolism of the embryo, in the present study the mitochondrial respiratory activities and the activities of enzymes of the energy metabolism within the breast muscles of differently incubated embryos were analysed directly after treatment (ED 10, ED 13). Therefore eggs of a commercial fast growing broiler line were incubated at higher (38.8 °C), lower (36.8 °C) or normal temperatures (37.8 °C (Control)) between ED 7 and 10 or ED 10 and 13. Weight characteristics as well as mitochondrial respiratory (MRA) and enzyme activities of the breast muscle samples of the ED 10 and 13 embryos were analyzed.

Temperature increase results in higher body, liver and heart weight on ED 10 and higher body weights on day 13 compared to at 36.8 °C incubated embryos. The same differences could be determined for the MRA on days 10 and 13, the activities of the lactate dehydrogenase and cytochrome oxidase on day 10 and the glycogen phosphorylase, phosphofructokinase, cytochrome oxidase activities on day 13. Control results were variable differing from the high or low tempered samples, from both or none of them.

The data show that the temperature effect on the embryo growth was related to the muscle metabolism probably due to direct alterations of the MRA and enzymes and/or general change of embryo activity/movement.
The impact of raised incubation temperature on hatch, chick quality and broiler performance

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It is well recognized that eggs which have been overheated during incubation do not hatch as well as they would have if incubated under more appropriate conditions. However, there is less information available about the direct impact of high incubation temperatures on the performance of the chicks after they hatch.

Two experiments were conducted at the Aviagen product development center in the USA to investigate the effect of increased eggshell temperature during mid to late incubation on hatchability, chick quality, yolk sac, heart, digestive organs, and broiler performance. Three treatments were imposed in each experiment. Egg shell temperatures were recorded using Gemini data loggers feeding to a wireless broadcast system that could be interrogated in real time. Incubator conditions were changed as necessary to maintain the desired egg shell temperature. From set to day 10, all the eggs were held at the same eggshell temperature, 100.0°F (37.8°C). Treatment 1 was the control, and eggshell temperature was set at 100.0°F all the way through to transfer. Treatment 2 was set at 101.5°F (38.1°C) and Treatment 3 at 103.0°F (39.4°C) from day 11 to transfer.

In the first experiment, 2,310 Ross 308 broiler hatching eggs from a 38 week old flock were used in each treatment. The eggs were taken through to hatch, and full hatch data were recorded. Chick quality was evaluated after takeoff and the chicks placed as broilers, reared to 38 days. The treatment of 100.0°F (37.8°C) eggshell temperature throughout the incubation period resulted in better hatchability, a higher percentage of first quality chicks, a higher body weight at 38 day, and improved FCR at 38 day when compared to incubation with eggshell temperatures of 101.5°F (38.6°C) or 103.0°F (39.4°C).

In the second trial, 1,815 Ross 308 and 1,815 Ross 708 broiler hatching eggs from a 39 week old flock were placed for each treatment. Full hatch data were collected; chicks were evaluated for chick quality and then placed as broilers, grown through to 53 days. The treatments were the same as in the first trial.

Eggs that were hatched using a 100.0°F (37.8°C) eggshell temperature throughout the incubation period had better hatchability and body weight at 53 day when compared to incubation with eggshell temperatures of 101.5°F (38.6°C) or 103.0°F (39.4°C). The chicks on the control incubation treatment had bigger hearts as a percentage of yolk-free body weight than those incubated on the two hotter treatments.

Chicks that were hatched after a constant 100.0°F (37.8°C) eggshell temperature throughout the incubation period had fewer red hocks, bad navels, lower residual yolk weight, and better liveability at 53 days compared to the high temperature treatments on both Ross 308 and 708.

In both trials, hatchability was as expected when eggs were incubated too hot. Broiler performance was impaired when higher egg shell temperatures were imposed from 11-18 days incubation.
Improvement of body weight gain and feed conversion in laying-type cockerels of Lohmann Dual by short-timing temperature stimulation before hatching – a comparative study

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Laying-type cockerels or spring chicken cannot be reared economically. But routine culling of these day-old male chicks is more and more an ethical problem and to find alternative solutions is a great challenge. Lohmann Tierzucht bred the dual-purpose chicken (producing eggs and meat) in response to growing criticism of conventional practices in modern egg production. Recent research with birds shows that incubation climate may have a long-lasting influence on poultry performance up to the age of slaughter. In poultry embryos at the end of incubation, peripheral and central nervous thermo-regulatory mechanisms, as well as other body functions, are well developed, so that after mild temperature variations no negative side effects will be expected. Therefore the following study was carried out, to investigate whether short-term variation in incubation temperature during the last days of incubation have a long-lasting effect on performance, also in laying-type cockerels.

Methods:
2880 eggs (Lohmann Brown-LB/Lohmann Dual-LD) were incubated from days 1 to 17 under common incubation temperature (37°C). From day 18 until hatching the eggs were sorted in hatch incubators with different temperature programs: 37°C (control) and 1°C over standard for 2 hours daily (38°C: short-term warm stimulation). Chicks were sorted by sex and male cockerels were randomly distributed in 8 treatment groups (two origins of chicks -LB, LD; two hatch incubators; two different protein/energy-200 g crude protein/11 MJ AMEn/kg - low; 215 g/12 MJ - high) from day 1 to 70 of age. Data were analyzed via a three-way ANOVA (SAS).

Results and conclusion:
Growing performance of LD cockerels was significantly better compared to LB males (Table 1). Final body weight of LD birds was 1000 g higher and feed to gain ratio 10% lower. Short-term temperature stimulation during the end of incubation resulted in a 3.5% higher final body weight by LD cockerels. The daily feed intake and the feed to gain ratio was significantly improved through the increased protein/energy concentration of the “high” feed.

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<th>Final body weight, g/bird</th>
<th>kg feed/kg weight gain</th>
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P-values

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<td>&lt;0.001</td>
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Effect of lighted incubation from set till hatch on broiler leg bone development

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Hatcheries incubate eggs in complete darkness, while hatching eggs are regularly exposed to light in a natural situation. It can be speculated that light during incubation will influence bone development through the pathways of melatonin (involved in bone development with a rhythmic darkness-dependent release pattern) and increased embryonic activity. The present experiment aimed to investigate effects of light schedule throughout incubation on leg bone development during embryonic development, at hatch, and in later life in broiler chickens.

A total of 744 Ross 308 eggs of a 40 week old breeder flock were incubated from embryonic day (E) 0 till hatch at 1 of 3 light schedules: continuous darkness (24D); 12 hours of darkness, followed by 12 hours of light (12L:12D); and continuous light (24L). Eggshell temperatures were maintained at 37.8°C throughout. From E6 until E14, 10 embryos per measurement, per treatment (N = 270) were removed from the incubator daily for measurement of ossification of the femur and tibia through histological staining. 50 chicks per treatment (N = 150) were sampled within 3 hours after hatch to determine leg bone measurements (tibia and femur weight, length, width, and depth). 108 chicks per treatment were moved to a grow out facility and sampled for leg bone measurements at D21 (N = 162) or D35 (N = 162).

On E13, femoral ossified percentage was higher for 12L:12D than for 24L (+2.8%) and 24D (+3.2%; P = 0.002) and on E14, it was higher for 12L:12D than for 24L (+5.5%; P = 0.008). At hatch, femur length was higher for 12L:12D than for 24D (+0.32 mm) and 24L (+0.45 mm; P < 0.001). Tibia weight differed among treatments (P = 0.02), but after Bonferroni adjustment, LSMeans were no longer significantly different. At day 21, tibia length was higher for 12L:12D than for 24L (+1.62 mm; P = 0.01). At day 35, femur depth was higher for 24D than for 24L (+0.28 mm) and 12L:12D (+0.23 mm; P = 0.01). Femur weight was higher for 12L:12D than for 24L (+0.65 g; P = 0.03).

To conclude, applying a 12L:12D rhythm during incubation had a stimulatory effect on embryonic ossification and bone development at hatch and in the grow-out period compared to 24L in particular.
Incorrect incubation conditions can generate leg problems in poults

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The incidence of splayed legs in poults at hatch is low, normally no more than 0.50%, but it can increase notoriously on some occasions. The aetiology of the splayed legs and lameness are complex and has been associated to genetics, nutrition, infection, management, environmental and recently to incubation conditions. The ossification process in turkeys begins during the embryonic period. Simsa and Monosonego-Ornan (2007) detected signs of ossification, such as collagen type X, alkaline phosphatase, and expression of metalloproteinases at 18 d of embryo development. The highest growth rate of bones occurs a couple of days before hatch and a few days post-hatch (Ballock and O’Keefe, 2003). Therefore it is crucial that the incubation conditions be ideal to not affect bone development (Yalçın and Siegel, 2003). Temperature has been suggested to be the most important factor controlling embryo growth and development (Meijerhof, 2000). Higher temperatures during incubation can affect bone, tendon and muscle development, and thyroid metabolism (Oviedo-Rondón et al., 2008). Temperature has an important influence on the thyroid-IGF1-GH hormonal axis that controls growth plate chondrocyte differentiation, and in general bone development (Christensen et al., 2005). High temperatures also depress the expression of collagen type X and Transforming Grow Factor Beta, two important proteins involved in bone ossification. Additionally, to accelerate embryo growth to rates that demand higher oxygen consumption than can passively diffuse through the pores of the eggshell, the embryo shifts energy metabolism from lipids of the yolk, which requires oxygen, to glycogen that the embryo stored in muscles (Oviedo-Rondón and Wineland, 2011). If the yolk is not absorbed during this period, bones will not receive nutrients critical for their early development and bone modeling and remodeling. The overheated poults may have lower muscular strength to stand up at hatch because they have lower glycogen reserves in the muscles and their myofibers are also thinner (Molenaar et al., 2011). When acidity increases important contractile and metabolic functions of muscles are hindered. In the case that acidity is not regulated, the accumulation of lactic acid may be a factor in muscular fatigue (Christensen et al., 2007). Sometimes, this effect can be severe and cause late embryo mortality, but frequently the overheated poults that hatch will be lethargic, may appear exhausted, slow to search for feed and water, and potentially become the starve outs at the farm increasing the first week mortality (Oviedo-Rondón and Wineland, 2011).

It has been reported that early low and later high incubation temperature can generate thinner gastrocnemius tendon fibers and differing collagen banding patterns during subsequent growth. Christensen et al. (2007) reported that in turkeys, incubation temperatures higher than 38°C and O2 concentrations below 21% at the plateau affected muscle growth and physiology. In conclusion ossification of bones begins during embryonic period. Independent of the turkey strain stressful conditions during the artificial incubation such as high temperature and low levels of oxygen can affect the bone development.

Embryonic development and heat production of embryos from two modern broiler strains

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Modern broiler strains are intensively selected for high growth rate at a low feed conversion ratio. These production traits might have an influence on embryonic development and heat production during incubation.

To examine the effects of broiler strains, hatching eggs of Ross 308 and Cobb 500 fast feathering were selected from breeder flocks aged 43 to 46 weeks at an egg weight range of 60 to 63 g. Eggs were obtained in 2 batches, 120 eggs per strain per batch. For each batch, 20 eggs per strain were used to determine egg composition. The remaining eggs were incubated separately in 1 of 2 climate respiration chambers at an eggshell temperature of 37.8 °C.

The results showed that Ross 308 eggs had a higher yolk: albumen ratio with 0.9 g more yolk and 0.7 g less albumen than Cobb 500. Cobb 500 and Ross 308 embryos had similar growth rate during the first two weeks of incubation. At incubation day (E) 18, Ross 308 embryos tended to have a heavier yolk free body mass (YFBM) than Cobb 500 embryos. At hatch Ross 308 chicks were 0.2 cm longer and had a 0.6 g heavier YFBM than Cobb 500 chicks. Absolute and relative heart and liver weights did not differ between strains. At 3 h after hatch the residual yolk of Ross 308 chicks tended to be lower than that of Cobb chicks, which suggested that Ross embryos used more yolk during incubation. Egg weight loss at E18 tended to be higher in Ross 308 than in Cobb 500. The moment of internal pipping did not differ; but the moment of external pipping and hatching moment was about 4 h earlier in Cobb 500 than in Ross 308. The embryonic heat production of Ross 308 was numerically higher than Cobb 500 only between E16 to E18, about 3 mW/egg.

It can be concluded that, Cobb 500 and Ross 308 differ in egg compositions and have different trajectories for embryonic development during incubation even when egg weight and breeder age is the same.
Reprogramming of Broiler Growth and Immunity through Changes in Breeder Hen Bodyweight

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Reprogramming of developmental events is increasingly recognised as having lifelong effects on animal health, welfare and productivity. Whilst most studies have concentrated on metabolic effects of reprogramming, the immunity of the progeny may also be compromised. This is of particular significance in broiler birds which are prone to infectious diseases post hatch. Broiler breeder hens are feed restricted to 50% of ad libitum feed intake, leading to a state of chronic hunger. This persistent hunger may cause stress to hens, leading to re-programming of progeny immunocompetence. This study examined the link between maternal stress caused by feed restriction in hens and the ability of their offspring to respond to an immune challenge.

Thirty six Cobb 500 broiler breeder hens were maintained at three levels of bodyweight; 3.4kg, 3.6kg and 4.0kg, over 19 weeks. Hen behaviour was observed daily using an ethogram over two weeks of lay, and serum was collected at 31 weeks for corticosterone levels. From these hens, 170 viable chicks were hatched, weighed and placed into group rearing pens of ten birds from the same hen treatment group, with three replicates of each group. Half of the chicks from each hen were given a series of three injections of lipopolysaccharide (LPS) E.coli O55:B5 at 16, 18 and 20 days old. Birds were injected at a dose rate of 0.5 mg/kg bodyweight, intraperitoneally. Blood samples were collected from the brachial vein of three birds per pen on days 21 and 35 and heterophil/lymphocyte (H/L) cells were counted. H/L counts were completed by counting one hundred cells per slide, three times. Birds were grown until 42 days old.

Hens maintained at a lower bodyweight showed increased pecking behaviour compared to hens at a higher bodyweight (P<0.05). Corticosterone levels were also higher in low bodyweight hens (P=.013). Together these results indicate an unfulfilled hunger drive and possible stress in these birds. Hen bodyweight also influenced progeny growth from days 35 to 42 in male birds (P<0.05). Males from heavy hens grew heavier in this week than those from medium and low bodyweight hens. Sex effects were also observed on day 23 H/L counts (P<0.05) with a higher H/L ratio in female progeny from heavy hens compared to male birds from all hens, and females from low and medium bodyweight hens, demonstrating an effect of hen bodyweight on the response of female birds to an LPS challenge. Females from heavy hens were therefore more sensitive to the LPS immune challenge and increased immune cell numbers to a greater extent than those from hens restricted to lower bodyweights.

From this study, a link between hen bodyweight and progeny growth and immunity was demonstrated through differences in growth, circulating immune cell counts and response to an immune challenge (LPS). The mechanism behind these differences needs to be investigated further as well as differences between males and females observed in this study.
Endocrine disruption by various compounds has become an emerging concern especially for aquatic wildlife because surface waters are the main sink of endocrine disruptors (ED). Amphibians are the classical model organisms to assess the modes of action of ED because it has been shown that all phenotypic changes associated with metamorphosis from tadpoles to juveniles are triggered by the thyroid system and the bioavailability of thyroid hormones. In addition, first classical experiments in the 50’s of last century concerning phenotypic sex reversal demonstrated that the sex steroids, estrogens and androgens, can lead to feminization and masculinization due to changes of the hormonal relation between estrogens and androgens during larval development. In the past ED research focused on (anti)estrogenic, (anti)androgenic, and later on also on (anti)thyroidal substances affecting reproduction and development in vertebrates but further endocrine systems might be also targets for ED. In the model organism Xenopus laevis (South African clawed toad) impacts of (anti)estrogenic and (anti)androgenic ED affect sexual differentiation during larval development but also during adult stages affecting the hypothalamus-pituitary-gonad (HPG)-axis and induces also drastic behavioural changes concerning male mating calls. (Anti)thyroidal ED affect the bioavailability of thyroid hormones in general or in determined tissues and thus induce drastic phenotypic changes associated with metamorphosis and development by impacts on the hypothalamus-pituitary-thyroid (HPT)-axis or direct effects on thyroid or on deiodinases differentially expressed in various tissues. More recently environmental gestagens, including the natural progestogens, e.g. progesterone, and synthetic progestins, have been identified as potential ED. Gestagens have been supposed to affect vertebrate reproduction via progesterone receptors especially by progestins being the major compound of the “mini pill” for contraception of humans and thus progestins are also present in surface waters. Amphibians are suitable models to assess endocrine disruption and also targets of gestagens. Exposure to progestogens such as progesterone seems to be less effective in comparison to progestins. During larval exposure the progestin levonorgestrel (LEVO) disrupts sexual development in Xenopus laevis by affecting gene expression of pituitary gonadotropins and gonadal steroidogenic enzymes. In Xenopus tropicalis larval exposure to LEVO had long lasting effects on adults affecting especially females lacking oviducts and having histopathological patterns of the ovaries. Surprisingly, in parallel LEVO also impairs metamorphosis by disruption of the thyroid system. However, the underlying molecular mechanisms need still to become elucidated. Recently, in order to get a better insight into the mechanisms how ED e.g. gestagens affect phenotypes a shift from in vivo experiments to in vitro organ cultures of thyroid and gonads is our strategy to reveal potential direct effects of ED on target organs.
Selection for contrasting yolk testosterone deposition affects HPG axis of male Japanese

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Androgens deposited in the eggs by the avian mother may programme physiological and a behavioural phenotype of offspring. Maternal testosterone (mT) deposition is related to a genetic background of the mother and reflects environmental and social conditions during egg formation. Since mT is deposited by mothers it is expected that its content in the egg yolk is exclusively determined by the female. However, since our results experimentally proved high heritability of this trait it is possible that maternal T deposition is to some extent affected also by the male.

We tried to answer this question on the basis of results obtained from our bidirectional selection of Japanese quail for low (LET) and high (HET) egg testosterone content. Selection resulted in establishing two strains and the HET line exceeded twice LET line in content. Breeding of females from both lines with males from control random bred population resulted in an increase in egg T in LET and the decrease in the HET lines. Basal plasma LH and T levels did not differ between LET and HET males but the response of LH to GnRH was higher in HET than LET males.

Our results suggest that selection for high egg T deposition increased sensitivity of the hypothalamo-pituitary axis in male Japanese quail. Genetic background of males can therefore influence deposition of maternal T in their daughters with possible consequences for their progeny performance.

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Egg deposition of maternal testosterone is primarily controlled by the preovulatory peak of luteinizing hormone

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Variability of androgen concentrations in avian eggs is often explained by an adaptive hypothesis according to which differential maternal deposition of yolk hormones may adjust offspring’s phenotype to ambient environmental conditions. In line with this hypothesis, numerous studies have shown that experimentally increased yolk testosterone levels affected a wide array of offspring’s traits. However, a mechanistic view on the variability of yolk androgen deposition is still missing. To understand physiological mechanisms of egg hormone deposition, we analysed a temporal pattern of plasma luteinizing hormone (LH), testosterone and estradiol concentrations during the ovulation-oviposition cycle in two lines of Japanese quail that were divergently selected for low (LET line) and high (HET line) yolk testosterone levels.

After six generations of selection, HET females laid eggs with more than twice yolk testosterone concentrations as LET females. Exact time of egg laying was recorded for each female over one week-period to estimate timing of individual ovulation-oviposition cycle and then serial blood samples were collected at 6.5, 3.5 and 0.5 hours before expected ovulation. In the second experiment, we evaluated responsiveness of LH to a single stimulation with an analogue of gonadotropin releasing hormone (GnRH) in females of both lines. The GnRH challenge was performed around 3.5 hours before ovulation. In HET females, the highest LH levels were found 3.5 hours before ovulation and they corresponded to the expected preovulatory LH peak. Surprisingly, in LET females, maximum LH concentrations were reached 0.5 hours before ovulation. Moreover, plasma LH levels were significantly higher in HET than LET females 6.5 and 3.5 hours before ovulation with no line differences around the time of expected ovulation. Preovulatory peaks of plasma testosterone and estradiol concentrations were found between 6.5 and 3.5 hours before ovulation in both LET and HET females. Plasma LH levels increased five minutes after direct GnRH stimulation but the responsiveness did not differ between lines.

In conclusion, our results demonstrated that high yolk testosterone deposition is associated with the preovulatory peak of LH in the circulation and probably depends on factors that influence hypothalamic-pituitary sensitivity during the ovulation-oviposition cycle.

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Session 11:
Epigenetic modification and stress

Short-term temperature training in the hatcher improves stress response in broiler chickens? – First results from behavioural observations and blood analysis

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An alternative approach to improve functional traits alongside with the production efficiency of fast growing broiler chicken lines provides temperature training in the hatcher (PTT: perinatal temperature training from day 18 until hatching) with short-term mild warm loads. Temperature training of the developing thermoregulatory system during critical periods has long lasting effects on thermal adaptability and various body functions, because of the strong relationship between the central control of body temperature and body functions, like metabolism, feed intake and body weight regulation as well as immune und stress response. The hypothesis is that perinatal temperature training improves robustness via long-lasting reduction of the basic metabolism. In previous experiments we found especially in male chickens a lower hypothalamic neuropeptide-Y (NPY) expression as long-lasting effect on basic metabolism after PTT. Hence, robust chickens have more energy available for adaptation, immune and stress responses during environmental challenges.

In two pilot studies (summer 2012, spring 2013) the influence of short-term perinatal temperature training on stress level and welfare in broiler chickens (Ross 308) was investigated. Eggs were incubated under commercial conditions using incubators with total capacity of 115,200 eggs (SmartSet, Pas Reform). The eggs were incubated under standard single stage incubation programme (control) or with PTT in the hatcher (+1°C, maximum 2 hrs per day). Random sampling (120 males and 120 females) of hatched chickens from control and PTT group was used for subsequent broiler growth trial of 35 days in the experimental research station of the FLI (Federal Research Institute for Animal Health, Institute for Animal Welfare and Husbandry in Celle, Germany). During the growing period locomotor activity was observed. On day 34 fear response was examined using a novel object test (NOT). Blood samples for hormone analysis (T3/4, cortisol, corticosterone) and preparation of blood smears for calculation of heterophile to lymphocyte ratio (HLR) were collected. Locomotor activity was not different between the groups. However, it must be pointed out that the chickens in the PTT group have a higher body weight compared with the control. In the NOT a slight tendency to less fear response was found. HLR was statistical significant lower in the PTT group than in the control group. Acute stress (e.g. during slaughtering) is typically related to increase in energy mobilization. Hence, our hypothesis was that PTT chickens, especially the males, can mobilize more energy during acute stress. This hypothesis was confirmed. Male chickens have higher increase in blood T3/T4 level during acute stress, which was accompanied by similar increase in stress hormone level (cortisol and corticosterone). In females only slight changes in metabolic and stress hormones were observed, which corresponds with NPY expression in a previous experiment. It has to be noted that all results are similar in both growing trials. It means that the long-lasting effect of PTT was repeatable.