Introduction
The gestation length for the Old World camelids is 13 months.
In all mammalian species the embryo starts life as a spherical clump of cells enclosed within a mucopolysaccharide coat, the zona pellucida, which is transparent, tough and elastic. The transformation from this stage (called a morula) to a blastocyst usually occurs soon after the embryo has reached the uterine lumen from the oviduct.

Early Embryo Morphology and Development
The embryo usually enters the uterus between days 6 and 7 after ovulation in the dromedary.
On Day 6 after ovulation the camel embryo is a spherical early blastocyst still encased within its zona pellucida. The blastocoele had started to develop and the ICM is clearly visible at one pole of the embryo.
By Day 8 the embryo has increased in size and has now become a fully expanded blastocyst that has hatched from its zona pellucida.
At Day 10 the embryo is just starting to elongate so it now has the outline shape of a rugby football of about 4 mm length.
By Day 12 it has further elongated to approximately 20 mm in length.

Implantation and Placentation
Camelids, although closely allied to ruminants, have a "diffuse epithiochorial" placenta.
By Day 14 the majority of the trophoblast had become closely apposed to the luminal epithelium of the endometrium to form the start of an epithliochorial placenta.
By Day 25 microvilli on the surface of the trophoblast cells interdigitate with those on the surface of the underlying luminal epithelial cells to form a well developed microvillar junction between foetal and maternal tissues.
By Day 35 the foetus can be easily seen situated in the middle of the left horn and its head, neck and limb buds are easily discernible. Histologically, large multinucleate giant trophoblast cells had developed at frequent but irregular intervals along the trophoblast. The allantochorion now covers the entire lumenal surface of the left horn and body of the uterus but it has only reached halfway up the right horn.
By Day 56 the foetus now has a more finely defined head, neck, limbs and tail and the allantochorion now fills both the right and left horns. Histologically, numerous large, multi-nucleate syncytium-like cells are present in the trophoblast layer.

Second Half of Gestation - There is little real change in the trophoblast during the rest of gestation. The large multi-nucleate cells are present throughout pregnancy. However, the chorionic villi become more extensively branched and very dense intraepithelial and subepithelial networks exist both in the chorion and endometrium, so the maternal and foetal capillaries are in very close contact with each other.

Methods of Pregnancy Diagnosis
Tail "cocking" - Several Bedouin have asserted that it is possible to detect pregnancy in camels from as early as 15 days by observing an erect and coiled tail in the pregnant animal when approached by a male camel. However, this response has been noted in unmated animals treated with exogenous progesterone.

Changes in cervical mucous
i) Viscosity - Other studies have shown that changes occur in pH and flow elasticity of the cervical mucous in pregnant versus non-pregnant camels. The cervical mucous tends to be turbid in most stages of the ovarian cycle, although during oestrus it becomes less viscous, but not watery. In pregnant females the mucous becomes whitish and opaque and it decreases gradually in amount until the second month when it becomes almost impossible to collect.
ii) pH - The pH varies between 6.74 and 7.36 during the follicular cycle in non-pregnant camels but it becomes more alkaline during early pregnancy, increasing from pH 7.05 after mating to as high as 8.2 at the beginning of the sixth week of gestation.

iii) Flow elasticity and vaginal smears - Flow elasticity values and vaginal smear patterns and temperatures showed no differences between pregnant and non-pregnant animals.

However these are not very practical methods under field conditions.

**Rectal Palpation** - The membrane slip test, described in cattle pregnancy diagnosis, is not possible in camelidae because of the diffuse type of placentation. Therefore positive pregnancy diagnosis can only be achieved if the CL and foetus are palpated. The earliest sign of pregnancy is the persistence of the CL which continues to grow until day 35 of pregnancy. It is usually soft, flabby and spherical in shape, measuring about 25 mm in diameter, but becomes out of reach after about 90 days. It is not until about day 45 that uterine changes due to pregnancy can be detected by rectal palpation and the first sign is an increase in the diameter of the left horn. However it is not until approximately the third month of pregnancy that the gravid horn feels obviously bigger and softer than the non-gravid horn and the uterus becomes more abdominal as the amount of foetal fluid increases. The cervix is pulled forward and lies just at the brim of the pelvis at 4 months, and by the fifth month the uterus is completely in an abdominal position with a small degree of fluctuation, but the foetus is not always palpable. From the 6 month onwards the foetus can be palpated, first by ballotment, then the head and legs become easily palpable as the foetus starts its ascent. Precise estimation of the stage of pregnancy by rectal palpation in the dromedary is not possible beyond 3 months because of the absence of structures such as cotyledons and difficulty in reaching the foetus in this species.

**Ultrasonography** - Realtime ultrasonography, using a 3.5 or 5 MHz transrectal linear array transducer is now regarded as the method of choice for detecting pregnancy and monitoring early foetal development in large domestic animal species. In camelids it is possible to detect the pregnancy as early as 17 days of gestation as a small accumulation of fluid within the uterine lumen. The embryo then becomes visible on day 20 - 21 as a small, echogenic speck within the fluid and the heartbeat becomes discernible between days 22 - 25. Between days 30 and 40, the overall diameter of the conceptus increases more rapidly due to accumulation of foetal fluids and during this period the allantochorion elongates further to occupy the remainder of the right uterine horn. Also at this time, a clear division can occasionally be seen between the amniotic fluid surrounding the foetus and the much larger volume of allantoic fluid external to this; the former tending to contain echogenic cell debris, whereas the allantoic fluid is much cleaner and non-echoic. By day 55, the head, neck, abdomen and individual limb buds of the foetus can be easily identified, but beyond day 60 the foetal fluids have increased to such an extent that the foetus cannot longer be viewed easily as it was generally lying beyond the penetration range of a 5 MHz transrectal probe.

**Hormone Secretion Patterns During Pregnancy**

There are several hormones involved in the maintenance of viability in the foetus, growth of the uterus and preparation for parturition. These hormones include: oestrogens, progesterone, relaxin, prostaglandin, thyroid hormones.

**Progesterone** - Studies on progesterone concentrations during pregnancy in the camelidae confirm that these species depend on ovarian progesterone throughout their pregnancy. Ablation of the CL-bearing ovary or administration of PGF2α or its analogue causes abortion or premature parturition at all stages of pregnancy, thus it would seem likely that the placenta either fails to secrete progesterone at all, or it does so in amounts insufficient to maintain pregnancy without help from the ovaries (Fig. 1). The measurement of progesterone concentration in peripheral blood can be invaluable in the early detection of pregnancy. If a blood sample is taken between days 12 - 15 and the value is still high (i.e. > 1.0 ng/ml) this would indicate that the camel is possibly pregnant. If the value has dropped to < 1.0 ng/ml then the camel is definitely not pregnant.

![Figure 1. Mean (+sem) serum progesterone concentrations in pregnant camels.](https://www.ivis.org)
secretion of oestrogen could be ovarian or placental in origin. The latter seems more likely as we have shown that extra embryonic membranes of the camel conceptus possess considerable aromatizing capacity from as early as day 10 after ovulation. The timing of the oestrogen increase in the final 70 - 80 days in the pregnant dromedary coincides with the important period of increase in foetal weight and foetal fluid volume between 9 and 12.5 months.

Figure 2. Mean (+sem) serum oestradiol-17\(\alpha\) concentrations in pregnant camels. - To view this image in full size go to the IVIS website at www.ivis.org . -

Oestrone sulphate - In dromedaries the oestrogen sulphate concentrations show two definite peaks of about 10 ng/ml in early gestation. The first peak occurs around day 26 and the second around day 70 (Fig. 3).

Figure 3. Mean (+sem) serum oestrone sulphate concentrations in pregnant camels. - To view this image in full size go to the IVIS website at www.ivis.org . -

13, 14 dihydro-15-keto prostaglandin F2\(\alpha\) (PGFM) - Secretion of prostaglandin F2\(\alpha\) in the dromedary, as revealed by measurement of its metabolite PGFM, remains between approximately 100 - 200 pg/ml during the first 320 days of gestation, thereafter over the next 50 days it rises sharply to around 1000 pg/ml, before a further explosive increase to peak values of 2000 pg/ml on the day of calving.

Thyroid Hormones - Thyroid hormones play an important role in modulating metabolic activity, growth and differentiation of vital organs. The average peripheral concentrations of T4 (thyroxine) and T3 (Triiodothyronine) in pregnant dromedaries varies from 76 to 116 ng/ml and from 0.7 to 1.3 ng/ml respectively.

Relaxin - Relaxin is probably secreted by the feto-placental unit and is implicated in the growth of the uterus during pregnancy and relaxation of the ligaments and cervix at the end of pregnancy.

Postpartum Involution
Genital Tract Involution - Softening of the vulva is usually observed a few days before parturition but maximum dilation occurs during birth. At the end of parturition, the vulva is very edematous and remains that way for about 2 to 3 weeks. In the dromedary the size of the vulva returns to prepartum size about 16 to 42 days after parturition.
Involution of the Uterus - Uterine involution is rapid in the female camelidae due to the diffuse nature of the placentation in this species, which does not cause a great loss of uterine tissue. This process is completed in 94% of the cases between 30 - 50 days.

Postpartum Ovarian Activity
Corpus Luteum Regression - Regression of the CL probably starts just before parturition under the effect of massive secretion of PGF2\(\alpha\) which causes luteolysis and degeneration of the luteal tissue.
Follicular Activity - The time of resumption of ovarian function and follicular activity following parturition is highly variable. In the dromedary, postpartum anoestrus was reported to last anywhere between 15 days and 1 year. According to my observations the major factors affecting length of postpartum anoestrus in the dromedary are nutritional status and suckling. In well-fed females, ovarian activity, as assessed by ultrasonography, is evident in some females by 30 days postpartum. Also, the majority of females that lose their offspring or are weaned, show a mature follicle within 10 - 12 days.