GENERAL SUMMARY
I. **The circannual ovarian cycle** has been extensively studied mostly in fresh water teleosts. Such information is also available in some marine teleosts, but it is absolutely inadequate in estuarine teleost fishes and unreported in the Indian grey mullet *Mugil cephalus* L. In the current thesis, the circannual ovarian cycle has been studied by investigating the gonadosomatic index, histology, oocyte diameter, follicular (oocyte) population, follicular and oocyte ultrastructure, and hormonal and blood glucose profiles each month round the year. All the hormones were assayed by ELISA, except DHP, E$_2$ and testosterone which were assayed by RIA. Adrenomedullary epinephrine, norepinephrine and pineal serotonin, N-acetyl serotonin and melatonin were quantitated by fluorometric methods. Blood glucose profile was determined by glucose oxidase method. Ultrastructural study of the ovarian follicles was carried out only during prebreeding (recrudescence phase) and breeding phases of the mullets.

The findings revealed that there is a distinct circannual ovarian cycle that occurs through 3 phases, prebreeding (September-October), breeding (November-December) and postbreeding (January-August) in the grey mullet.

(a) The GSI (%), oocyte size, and total follicular (oocyte) population per paired ovary were moderately high in pre-breeding, highest in breeding and declined in post-breeding mullets. Simultaneously, follicular population per mg of ovary and per microscopic field were moderately high in pre-breeding, least in breeding and highest in postbreeding phases.

(b) Healthy follicular population was higher than the atretic follicles, but their populations (%) were not significantly altered during different phases of the ovarian cycle.
(c) Ultrastructurally, three types of follicles or oocytes were recognized: i) the early primordial type was characterized by thin plasma membrane of the oocyte, ii) previtellogenic by the abundance of lipid droplets and iii) early vitellogenic by yolk globules and vitelline membrane with short microvilli. Whereas in the breeding phase two types of vitellogenic oocytes were noticed. i) The late vitellogenic type was identified by the differentiation of the vitelline membrane into zona interna and zona externa with penetration of long microvilli from the oocyte to the follicular cells and from the latter to the former across the zona interna and zona externa. ii) But in the postvitellogenic oocytes, zona interna became thin and both the layers of the vitelline membrane were regressed with the retraction of the microvilli and microvilli pore canals were closed in the zona externa and interna.

(d) Serum FSH, prolactin, estradiol-17β (E_2), testosterone, T_3 and T_4 levels were at peak in prebreeding phase, whereas LH, DHP, cortisol, epinephrine, norepinephrine and insulin levels were highest in the breeding phase with lowest blood glucose level. But pineal serum N-acetyl serotonin and melatonin levels were least in breeding and highest in post breeding mullet. The serotonin profile was reversely altered to that of NAS and melatonin.

(e) The findings suggest that FSH, PRL, E_2, testosterone, T_3 and T_4 probably initiate the induction of oocyte growth and vitellogenesis, whereas LH, DHP, cortisol, epinephrine, norepinephrine and insulin are involved in subsequent oocyte growth of ovulable size and oocyte maturation in the mullet.

(f) Pineal hormones are not required for oocyte growth or oocyte maturation, but their absence may help in the induction of oocyte growth in the mullet.
In addition to hormones, environmental factors, such as lower temperature, short photoperiod and other relevant factors are probably required in the induction of circannual ovarian cycle in the Indian grey mullet.

II. **Circadian rhythms** of ovarian activity were studied only during the breeding phase of the circannual ovarian cycle in an estuarine teleost, *Mugil cephalus*. Ovarian activity was evaluated by studying tropic hormones, sex steroids, adrenal, thyroid and pancreatic hormones and blood glucose profiles at 4 different time points (06.00 hr, 12.00 hr, 18.00 hr and 24.00 hr) of a 24-hr period. The findings revealed that during the breeding phase estradiol-17β, testosterone and DHP profiles were higher in the photophase (06.00 hr to 18.00 hr) than the scotophase (18.00 hr to 06.00 hr), with a peak at 12.00 hr. Whereas FSH, LH and prolactin concentrations were higher in the scotophase than the photophase with a peak at 24.00 hr. Extra-gonadal hormonal levels (T₃ and T₄) were higher in the late scotophase with TSH peak in late photophase. But cortisol, epinephrine, norepinephrine, and insulin levels were higher in the photophase than the scotophase, but their peaks were different being at 06.00 hr for T₃ and T₄, 12.00 hr for adrenal hormones and 06.00 h to 18.00 hr for insulin. Insulin level was lowest at 24.00 hr. Blood glucose profile was also reversely altered to that of insulin being lower in the photophase than the scotophase with a peak at 12.00 hr. The findings indicate that circadian rhythms well exist in gonadonal and extra-gonadal hormones and blood glucose profiles in the grey mullet. It is suggested that environmental photoperiod and clock genes may be responsible for the induction of circadian rhythms of hormones and blood glucose profiles in estuarine mullets.
III. *In vitro inductions of oocyte maturation* (characterized by the germinal vesicle breakdown of the oocyte) and steroidogenesis were studied in the postvitellogenic follicles during the breeding phase (December) of the circannual ovarian cycle of an estuarine grey mullet *Mugil cephalus*. Several hormones (DHP, E₂ progesterone, 17α-OH progesterone, testosterone, hCG, LH, bovine-insulin and salmon calcitonin) and growth factor IGF-I were tested for oocyte maturation. Oocyte maturation was evaluated by studying the germinal vesicle breakdown (GVBD) percent and steroidogenic profiles (DHP, E₂ and testosterone) assayed by RIA. The findings revealed that

(a) DHP of all the sex steroids, is the most potent MIH in the induction of oocyte maturation of the postvitellogenic oocytes. Role of E₂ on oocyte maturation is also indicated. Testosterone is least effective.

(b) hCG, LH and IGF-I are more potent than all the sex hormones including DHP, E₂, IGF-I with DHP, b-insulin and s-calcitonin. All these hormones (except DHP) and IGF-I have time-dependent actions on oocyte maturation (GVBD%) and steroidogenic profiles (DHP, E₂ and testosterone) with maximum effect observed in 15 h incubation.

(c) All the tropic (hCG and LH) and other (b-insulin and sCT) hormones and IGF-I also have time- and dose-dependent actions on oocyte maturation and steroidogenic profiles (DHP, E₂ and testosterone) with maximum effect observed in highest dose and maximum time of incubation.

(d) hCG of all the test compounds is most effective in the induction of oocyte maturation (both in GVBD% and steroid productions).
(e) hCG induces oocyte maturation via steroid-dependent pathway mainly by DHP production involving both homologous and heterologous gap junction communications and transcription, translation and MAP kinase (PI3 kinase) signal transduction cascade leading to denovo synthesis of protein required for oocyte maturation.

(f) Whereas IGF-I/b-insulin induces oocyte maturation via steroid and transcription independent pathways, involving translation and PI3 kinase signaling cascade and homologous gap junction contact.

(g) IGF-I induces oocyte maturation probably rapidly as compared to hCG, b-insulin or even DHP, because IGF-I involves only translation and PI3 kinase pathways with homologous gap junctions (without requiring steroid, heterologous gap junction couplers and transcription pathways) in the mullet ovary.

(h) Use of IGF-I may be commercially viable for rapid production of the Indian grey mullet.