



## **Enzyme Immunoassay for the quantitative determination of Estradiol (E2) Concentration in Human Serum**

### **FOR IN VITRO DIAGNOSTIC USE ONLY**

Store at 2 to 8°C.

#### **INTENDED USE**

For the quantitative determination of Estradiol (E2) concentration in human serum or plasma

#### **INTRODUCTION**

Estradiol (E2) is a C18 steroid hormone with a phenolic A ring. This steroid hormone has a molecular weight of 272.4. It is the most potent natural Estrogen, produced mainly by the ovary, placenta, and in smaller amounts by the adrenal cortex, and the male testes (1, 2, 3).

Estradiol (E2) is secreted into the blood stream where 98% of it circulates bound to sex hormone binding globulin (SHBG). To a lesser extent it is bound to other serum proteins such as albumin. Only a tiny fraction circulates as free hormone or in the conjugated form (4, 5). Estrogenic activity is effected via estradiol-receptor complexes which trigger the appropriate response at the nuclear level in the target sites. These sites include the follicles, uterus, breast, vagina, urethra, hypothalamus, pituitary and to a lesser extent the liver and skin.

In non-pregnant women with normal menstrual cycles, estradiol secretion follows a cyclic, biphasic pattern with the highest concentration found immediately prior to ovulation (6, 7). The rising estradiol concentration is understood to exert a positive feedback influence at the level of the pituitary where it influences the secretion of the gonadotropins, follicle stimulating hormone (FSH), and luteinizing hormone (LH), which are essential for follicular maturation and ovulation, respectively (8,9). Following ovulation, estradiol levels fall rapidly until the luteal cells become active resulting in a secondary gentle rise and plateau of estradiol in the luteal phase. During pregnancy, maternal serum Estradiol levels increase considerably, to well above the pre-ovulatory peak levels and high levels are sustained throughout pregnancy (10).

Serum Estradiol measurements are a valuable index in evaluating a variety of menstrual dysfunctions such as precocious or delayed puberty in girls (11) and primary and secondary amenorrhea and

menopause (12). Estradiol levels have been reported to be increased in patients with feminizing syndromes (14), gynaecomastia (15) and testicular tumors (16).

In cases of infertility, serum Estradiol measurements are useful for monitoring induction of ovulation following treatment with, for example, clomiphene citrate, LH-releasing hormone (LH-RH), or exogenous gonadotropins (17, 18). During ovarian hyperstimulation for in vitro fertilization (IVF), serum estradiol concentrations are usually monitored daily for optimal timing of human chorionic gonadotropin (hCG) administration and oocyte collection (19).

Estradiol (E2) EIA kits are designed for the measurement of total Estradiol in human serum or plasma.

### PRINCIPLE OF THE TEST

The Estradiol E2 EIA Test is based on the principle of competitive binding between E2 in the test specimen and E2-HRP conjugate for a constant amount of rabbit anti-Estradiol. In the incubation, goat anti-rabbit IgG-coated wells are incubated with 25 µl E2 standards, controls, patient samples, 100 µl Estradiol-HRP Conjugate Reagent and 50 µl rabbit anti-Estradiol reagent at room temperature (18-25°C) for 90 minutes. During the incubation, a fixed amount of HRP-labeled E2 competes with the endogenous E2 in the standard, sample, or quality control serum for a fixed number of binding sites of the specific E2 antibody. Thus, the amount of E2 peroxidase conjugate immunologically bound to the well progressively decreases as the concentration of E2 in the specimen increases.

Unbound E2 peroxidase conjugate is then removed and the wells washed. Next, a solution of TMB Reagent is added and incubated at room temperature for 20 minutes, resulting in the development of blue color. The color development is stopped with the addition of 1N HCl, and the absorbance is measured spectrophotometrically at 450 nm. The intensity of the color formed is proportional to the amount of enzyme present and is inversely related to the amount of unlabeled E2 in the sample. A standard curve is obtained by plotting the concentration of the standard versus the absorbance. The E2 concentration of the specimens and controls run concurrently with the standards can be calculated from the standard curve.

### REAGENTS

#### **Materials provided with the kit:**

1. Antibody-Coated Wells (1 plate, 96 wells)  
Microtiter wells coated with goat anti-rabbit IgG
2. Reference Standard Set (0.5 ml/vial)  
Contains 0, 10, 30, 100, 300 and 1000 pg/ml estradiol in human serum with preservatives, liquid, ready to use
3. Rabbit Anti-Estradiol Reagent (7 ml)  
Contains rabbit anti-estradiol in bovine serum albumin (BSA) buffer with preservatives
4. Estradiol-HRP Conjugate Reagent (12 ml)  
Contains estradiol conjugated to HRP
5. Estradiol Control 1 and 2 (0.5 ml/vial)  
Contains approximately 35 and 350 pg/ml estradiol, respectively, in human serum, liquid, 0.5 ml each, ready to use
6. TMB Reagent (11 ml)  
Contains 3, 3', 5, 5'-TMB stabilized in buffer solution
7. Stop Solution (11 ml)  
Diluted hydrochloric acid (1N HCl)

**Materials required but not provided:**

- Precision pipettes: 25 µl , 50 µl, 100 µl, 200 µl, and 1.0 ml.
- Disposable pipette tips.
- Distilled and deionized water.
- Vortex mixer or equivalent.
- Absorbent paper or paper towel.
- Linear-linear graph paper.
- Microtiter plate reader.

**WARNINGS AND PRECAUTIONS**

1. CAUTION: This kit contains human material. The source material used for manufacture of this component tested negative for Hepatitis B surface antigen (HBsAg), Human immunodeficiency virus Type 1,2 (HIV-1/2) and Hepatitis-C virus (HCV) by FDA-approved methods. However, no method can completely assure absence of these agents. Therefore, all human blood products, including serum samples, should be considered potentially infectious. Handling should be as defined by an appropriate national biohazard safety guideline or regulation, where it exists.<sup>17</sup>
2. Avoid contact with 1N HCl. It may cause skin irritation and burns. If contact occurs, wash with copious amounts of water and seek medical attention if irritation persists.
3. Do not use reagents after expiration date and do not mix or use components from kits with different lot numbers.
4. Replace caps on reagents immediately. Do not switch caps.
5. Do not pipette reagents by mouth.
6. For in vitro diagnostic use.

**STORAGE CONDITIONS**

1. Store the unopened kit at 2-8°C upon receipt and when it is not in use, until the expiration shown on the kit label. Refer to the package label for the expiration date.
2. Keep microtiter plate in a sealed bag with desiccant to minimize exposure to damp air.

**REAGENT PREPARATION**

1. All reagents should be allowed to reach room temperature (18-25°C) before use.
2. All reagents should be mixed by gentle inversion or swirling prior to use. Do not induce foaming.
3. Samples with expected testosterone concentrations over 1,000 pg/ml may be quantitated by dilution with diluent available from Ekoweb Ltd.

**INSTRUMENTATION**

A microtiter well reader with a bandwidth of 10 nm or less and an optical density range (OD) of 0 to 3 OD or greater at 450 nm wavelength is acceptable for absorbance measurement.

**SPECIMEN COLLECTION AND PREPARATION**

1. Serum should be used in the test.
2. No special pretreatment of sample is necessary.
3. Serum samples may be stored at 2-8°C for up to 24 hours, and should be frozen at -20°C or lower for longer periods. Avoid grossly hemolytic (bright red), lipemic (milky), or turbid samples.
4. **Please note:** Samples containing sodium azide should not be used in the assay.

### PROCEDURAL NOTES

1. Manual Pipetting: It is recommended that no more than 32 wells be used for each assay run. Pipetting of all standards, samples, and controls should be completed within 3 minutes.
2. Automated Pipetting: A full plate of 96 wells may be used in each assay run. However, it is recommended that pipetting of all standards, samples, and controls be completed within 3 minutes.
3. All standards, samples, and controls should be run in duplicate concurrently so that all conditions of testing are the same.
4. It is recommended that the wells be read within 15 minutes following addition of Stop Solution.

### ASSAY PROCEDURE

1. Secure the desired number of coated wells in the holder.
2. Dispense 25  $\mu$ l of standards, specimens and controls into appropriate wells.
3. Dispense 100  $\mu$ l of Estradiol-HRP Conjugate Reagent into each well.
4. Dispense 50  $\mu$ l of rabbit anti-Estradiol (E2) reagent to each well.
5. **Thoroughly mix for 30 seconds. It is very important to mix them completely.**
6. Incubate at room temperature (18-25°C) for 90 minutes.
7. Rinse and flick the microwells 5 times with distilled or deionized water. (Please do not use tap water.)
8. Dispense 100  $\mu$ l of TMB Reagent into each well. Gently mix for 10 seconds.
9. Incubate at room temperature (18-25°C) for 20 minutes.
10. Stop the reaction by adding 100  $\mu$ l of Stop Solution to each well.
11. Gently mix 30 seconds. **It is important to make sure that all the blue color changes to yellow color completely.**
12. Read absorbance at 450 nm with a microtiter well reader **within 15 minutes**.

### CALCULATION OF RESULTS

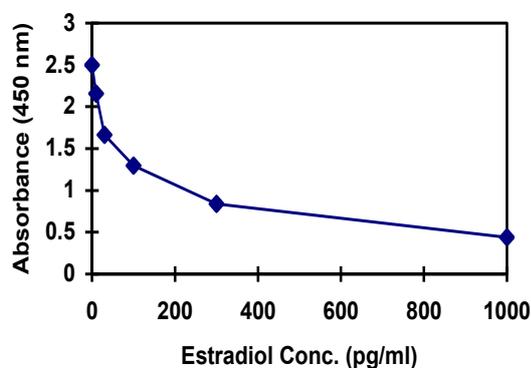
1. Calculate the mean absorbance value ( $A_{450}$ ) for each set of reference standards, controls and samples.
2. Construct a standard curve by plotting the mean absorbance obtained for each reference standard against its concentration in pg/ml on a **linear-linear graph paper**, with absorbance values on the vertical or Y axis, and concentrations on the horizontal or X axis.
3. Use the mean absorbance values for each specimen to determine the corresponding concentration of Estradiol in pg/ml from the standard curve.
4. Any values obtained for diluted samples must be further converted by applying the appropriate dilution factor in the calculations.

### EXAMPLE OF STANDARD CURVE

Results of a typical standard run with optical density readings at 450 nm shown in the Y axis against Estradiol concentrations shown in the X axis. **Note:** This standard curve is for the purpose of illustration only, and should not be used to calculate unknowns. Each laboratory must provide its own data and standard curve in each experiment.

Estradiol (pg/ml)	Absorbance (450 nm)
0	2.500
10	2.155
30	1.664

100	1.296
300	0.837
1000	0.440



### EXPECTED VALUES AND SENSITIVITY

Each laboratory should establish its own normal range based on the patient population. Ekoweb's Estradiol EIA was performed on randomly selected outpatient clinical laboratory samples. The results of these determinations are as follows:

Males:		< 60 pg/ml
Females:	postmenopausal phase	< 18 pg/ml
	ovulating, early follicular	30-100 pg/ml
	late follicular	100-400 pg/ml
	luteal phase	60-150 pg/ml
	pregnant, normal	up to 35,000 pg/ml
	prepubertal children, normal	< 10 pg/ml

### PERFORMANCE CHARACTERISTICS

#### 1. Accuracy

A statistical study using 112 human serum samples demonstrated good correlation with a commercially available kit as shown below.

Comparison between the Ekoweb's Estradiol EIA and the DRG Estradiol kit provided the following data:

N = 112  
 Correlation coefficient = 0.979  
 Slope = 0.658  
 Intercept = 30.082  
 Ekoweb Estradiol EIA Test Mean = 152 pg/ml  
 DRG Mean = 130 pg/ml

## 2. Sensitivity

The minimum detectable concentration of the Ekoweb's Estradiol ELISA assay as measured by 2 SD from the mean of a zero standard is estimated to be 10 pg/ml.

## 3. Precision

### a. Intra-Assay Precision

Within-run precision was determined by replicate determinations of four different serum samples in one assay. Within-assay variability is shown below:

<b>Samples</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
# Replicates	24	24	24	24
Mean Estradiol (pg/ml)	13	73	247	633
S.D.	3	7	10	31
C.V. (%)	24. 1	10. 3	4.1	4.9

### b. Inter-Assay Precision

Between-run precision was determined by replicate measurements of six different serum samples over a series of individually calibrated assays. Between-assay variability is shown below:

<b>Samples</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
# Replicates	20	20	20	20
Mean Estradiol (pg/ml)	14	82	264	691
S.D.	4	8	17	45
C.V. (%)	26. 7	10. 3	6.4	6.6

## 4. Recovery Studies

Various patient serum samples of known Estradiol levels were combined and assayed in duplicate. The mean recovery was 101.3%.

<b>PA IR N</b>	<b>EXPECT ED [Estradiol</b>	<b>OBSER VED [Estradi</b>	<b>% RECO VERY</b>
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O.	l (pg/ml)	ol (pg/ml)	
1	580	599	103.3
2	810	733	90.4
3	280	249	89.2
4	265	285	107.5
5	81	91	112.6
6	62	67	107.3
7	18	18	98.7

## 5. Specificity

The following materials have been checked for cross reactivity. The percentage indicates cross reactivity at 50% displacement compared to Estradiol.

Data on the cross-reactivity for several endogenous and pharmaceutical steroids are summarized in the following table:

$$\text{Cross-reactivity (\%)} = \frac{\text{Observed Estradiol Concentration}}{\text{Steroid Concentration}} \times 100$$

<u>Steroid</u>	<u>Cross- Reactivity</u>
Estradiol	100%
Estrone	2.10%
Estriol	1.50%
17a Estradiol	0.30%
Cortisol	<0.01%
Cortisone	<0.01%
Progesterone	<0.01%
Testosterone	<0.01%
DHEA-Sulphate	<0.01%
5a- Dihydrotestosteron	<0.01%

### LIMITATIONS OF THE PROCEDURE

1. Reliable and reproducible results will be obtained when the assay procedure is carried out with a complete understanding of the package insert instructions and with adherence to good laboratory practice.
2. The wash procedure is critical. Insufficient washing will result in poor precision and falsely elevated absorbance readings.
3. Serum samples demonstrating gross lipemia, gross hemolysis, or turbidity should not be used with this test.
4. The results obtained from the use of this kit should be used only as an adjunct to other diagnostic procedures and information available to the physician.

## QUALITY CONTROL

Good laboratory practice requires that controls are run with each calibration curve. A statistically significant number of controls should be assayed to establish mean values and acceptable ranges to assure proper performance.

Estradiol EIA kit also provides with internal controls, Level 1 and 2.

## CLINICAL APPLICATION

Information is cited from reference # 19

### 1. Assessment of Female Menstrual Dysfunctions:

- Hyperestrogenism in girls:

Elevated E<sub>2</sub> can be used in the evaluation of precocious puberty in girls. However, extensive ancillary aids are required for specific diagnoses.

- Hypoestrogenism in women:

E<sub>2</sub> measurements are frequently utilized in the assessment of hypoestrogenism in cases of delayed puberty, primary and secondary amenorrhea, and menopause. **In hypoestrogenism women, E<sub>2</sub> concentrations are usually <30 pg/ml.**

### 2. Assessment of Excessive Estrogen Production in Women:

**In pregnant women, E<sub>2</sub> concentrations will >1,000 pg/ml.** In non-pregnant women, excessive estrogen may indicate ovarian neoplasms.

### 3. Monitoring Ovulation:

E<sub>2</sub> is often measured to monitor ovulation induction and for patient follow-up during infertility therapy, e.g. in vitro fertilization (IVF).

### 4. Estradiol Measurement in Male:

E<sub>2</sub> measurement is used in the differential diagnosis gynecomastia, feminizing syndromes, hypogonadism and testicular tumors.

## REFERENCES

1. Tsang, B.K., Armstrong, D.T. and Whitfield, J.F., Steroid biosynthesis by isolated human ovarian follicular cells *in vitro*, *J. Clin. Endocrinol. Metab.*, 1980; 51: 1407-1411.
2. Gore-Langton, R.E. and Armstrong, D.T., Follicular steroidogenesis and its control. In: Knobil, E., and Neill, J. et al., ed. *The Physiology of Reproduction*. Raven Press, New York; 1988: 331-385.
3. Hall, P.F., Testicular steroid synthesis: Organization and regulation. In: Knobil, E., and Neill, J. et al., ed. *The Physiology of Reproduction*. Raven Press, New York; 1988: 975-998.
4. Siiteri, P.K., Murai, J.T., Hammond, G.L., Nisker, J.A., Raymoure, W.J. and Kuhn, R.W., The serum transport of steroid hormones, *Rec. Prog. Horm. Res.*, 1982; 38: 457-510.

5. Baird, D.T., Ovarian steroid secretion and metabolism in women. In: James, V.H.T., Serio, M. and Giusti, G., eds. *The Endocrine Function of the Human Ovary*. Academic Press, New York; 1976: 125-133.
6. McNatty, K.P., Baird, D.T., Bolton, A., Chambers, P., Corker, C.S. and McLean, H., Concentration of oestrogens and androgens in human ovarian venous plasma and follicular fluid throughout the menstrual cycle, *J. Endocrinol.*, 1976; 71: 77-85.
7. Abraham, G.E., Odell, W.D., Swerdloff, R.S., and Hopper, K., Simultaneous radioimmunoassay of plasma FSH, LH, progesterone, 17-hydroxyprogesterone and estradiol-17 $\beta$  during the menstrual cycle, *J. Clin. Endocrinol. Metab.*, 1972; 34: 312-318.
8. March, C.M., Goebelsmann, U., Nakumara, R.M., and Mishell, D.R. Jr., Roles of estradiol and progesterone in eliciting the midcycle luteinizing hormone and follicle-stimulating hormone surges. *J. Clin. Endocrinol. Metab.*, 1979; 49: 507-513.
9. Simpson, E.R., and MacDonald, P.C., Endocrinology of pregnancy. In: Williams, R.H., ed., *Textbook of Endocrinology*. Saunders Company, Philadelphia; 1981: 412-422.
10. Jenner, M.R., Kelch, R.P., Kaplan, S.L. and Grumbach, M.M., Hormonal changes in puberty: IV. Plasma estradiol, LH, and FSH in prepubertal children, pubertal females and in precocious puberty, premature thelarche, hypogonadism and in a child with feminizing ovarian tumor. *J. Clin. Endocrinol. Metab.*, 1972; 34: 521-530.
11. Goldstein, D., Zuckerman, H., Harpaz, S., et al., Correlation between estradiol and progesterone in cycles with luteal phase deficiency. *Fertil. Steril.*, 1982; 37: 348-354.
12. Kirschner, M.A., The role of hormones in the etiology of human breast cancer. *Cancer*, 1977; 39: 2716-2726.
13. Odell, W.D. and Swerdloff, R.S., Abnormalities of gonadal function in men. *Clin. Endocr.*, 1978; 8: 149-180.
14. MacDonald, P.C., Madden, J.D., Brenner, P.F., Wilson, J.D. and Siiteri, P.K., Origin of estrogen in normal men and in women with testicular feminization, *J. Clin. Endocrinol. Metab.*, 1979; 49: 905-916.
15. Fishel, S.B., Edwards, R.G., Purdy, J.M., Steptoe, P.C., Webster, J., Walters, E., Cohen, J., Fehilly, C. Hewitt, J., and Rowland, G., Implantation, abortion and birth after in vitro fertilization using the natural menstrual cycle or follicular stimulation with clomiphene citrate and human menopausal gonadotropin, *J. In Vitro Fertil. Embryo Transfer*, 1985; 2: 123-131.
16. Ratcliffe, W.A., Carter, G.D., Dowsett, M., et al., Oestradiol assays: applications and guidelines for the provision of a clinical biochemistry service, *Ann. Clin. Biochem.*, 1988; 25:466-483.
17. Tietz, N.W. ed., *Clinical Guide to Laboratory Tests*, 3<sup>rd</sup> Edition, W.B. Saunders, Co., Philadelphia, 1995: 216-217.
18. USA Center for Disease Control/National Institute of Health Manual, "Biosafety in Microbiological and Biomedical Laboratories", 1984.
19. *ICN Guide to Endocrine Testing*. Diagnostic Division, ICN Biomedicals, Inc. pp. 2:15-19.