Journal of
Medical Physiology & Therapeutics

Review Article OMICS International

Role of Homeostasis in Human Physiology: A Review

Sarvani Palaparthi*

Department of Biotechnology, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India

Abstract

Homeostasis plays a major role in the proper functioning of the body. It is regulated by different mechanisms such as osmoregulation, thermoregulation and chemical regulation by different systems in the body like respiratory system, digestive system, nervous system, urinary system. These systems maintain the stability of the body by releasing the stimulus when the hormone levels increases or decreases. The stimulus is generated; the cells act accordingly to maintain the proper functioning of the cell. Thus feedback mechanisms work and maintain the cells to meet the set point. The endocrine system has a regulatory effect on other organ systems in the human body. In the muscular system, hormones adjust muscle metabolism, energy production, and growth. In the nervous system, hormones affect neural metabolism, regulate fluid and ion concentration and help with reproductive hormones that influence brain development.

Keywords: Homeostasis; Diffusion; Osmosis; Pituitary gland; Prolactin; Blood plasma

Introduction

Homeostasis is the word derived from the 2 Greek Words 'homeo' meaning 'similar,' and 'stasis' meaning 'stable.' Homeostasis [1-4] refers to stability, balance, or equilibrium within a cell or the body. Homeostasis is an important characteristic of living things. Maintaining a stable internal environment which requires adjustments as conditions change inside and outside the cell. The maintenance of systems within a cell is called homeostatic regulation. The continuous adjustments are made to meet the Set Point.

Homeostasis is regulated by 3 different mechanisms and they are:

a) Osmoregulation [5];

b) Thermoregulation [6];

c) Chemical Regulation.

These mechanisms are performed in the body by various systems of the body like Respiratory system, Endocrine system, Reproductive system, Urinary System, Nervous system.

Feedback Regulation

Hormones regulate the activity of body cells. The release of hormones into the blood is controlled by a stimulus. The response to a stimulus changes the internal conditions and itself may become a new stimulus and this self-adjusting mechanism by the internal system is called is called feedback regulation [1-64].

The feedback regulations are of 2 types:

1. Positive feedback regulation.
2. Negative feedback regulation.

Positive feedback regulation

Positive feedback is less common in biological systems. Positive feedback acts to speed up the direction of change e.g. Lactation (milk production) [40-45]. When the baby starts sucking the nerve messages the mammary glands which cause the hormone prolactin which is secreted by the pituitary gland [46-49]. The prolactin [50-55] release is directly proportional to the baby sucking the milk.

Negative Feedback regulation: Thermoregulation

Negative feedback is the most common feedback loop in the biological system. To maintain the homeostatic balance the system acts to reverse the direction of change to maintain the things constant. Example 1: When the carbon dioxide level increases in the air which we breathe, the lungs are signalled to exhale carbon dioxide more which causes increase in the breathing rate and CO_2 level is balances and then lungs will function normally.

Example 2: When the body temperature increases then automatically the receptors in the skin and hypothalamus senses the temperature change and triggers a command from the brain which makes skin to sweat, the blood vessels near the skin surface will dilate and that helps to decrease the body temperature and this is called thermoregulation and this also comes under negative feedback loop.

Osmoregulation

Osmosis [6-11] is the essential process that is carried out in the body for the proper functioning of cells. Water movement in the body is carried out through Osmosis. Osmosis is carried out by balancing both sides of the cell membrane, for the proper functioning of Biochemical process [38,39] of the cells which is most required.

Two conditions which will alter the biochemical process and results in the death of the cells are:

1. When the concentration of solutes increases above normal in the extracellular fluid which causes in the movement of intracellular fluid to extracellular surface will occur which will result in the cell shrinkage?
2. When the concentration of solutes decreases in the extracellular fluid which causes in the movement of extracellular fluid inside

***Corresponding author:** Sarvani Palaparthi, Department of Biotechnology, Acharya Nagarjuna University, Guntur, Andhra Pradesh, India, Tel: +91 9885610011; E-mail: palaparthi.sarvani@gmail.com

Received April 03, 2017; **Accepted** April 06, 2017; **Published** April 12, 2017

Citation: Palaparthi S (2017) Role of Homeostasis in Human Physiology: A Review. J Med Physiol Ther 1: 101.

the cells and will result in the swelling of the cell and ruptures the cell after certain extent.

The maintenance of stable concentration of solutes is most required for the proper functioning of cells and the organisms and is maintained through osmosis and diffusion.

Unicellular organism which lives in the atmosphere by the utilisation of nutrients [17-21] and oxygen from the external environment and produce the energy required for its growth and survival. It will also release the waste and CO_2 directly into the environment.

Multi cellular organisms like human beings are made up of trillions of cells and the most of the cells are embedded inside the organisms and so they cannot exchange with the environment directly so cells exchange substances with the fluid surrounding them. Blood plasma [22-26] is a part of the extracellular fluid of our organism. The extracellular fluid, which is formed on the external environment, is through the cells. Cells are in continuous contact with the extracellular fluid (Figures 1-5) [27-32].

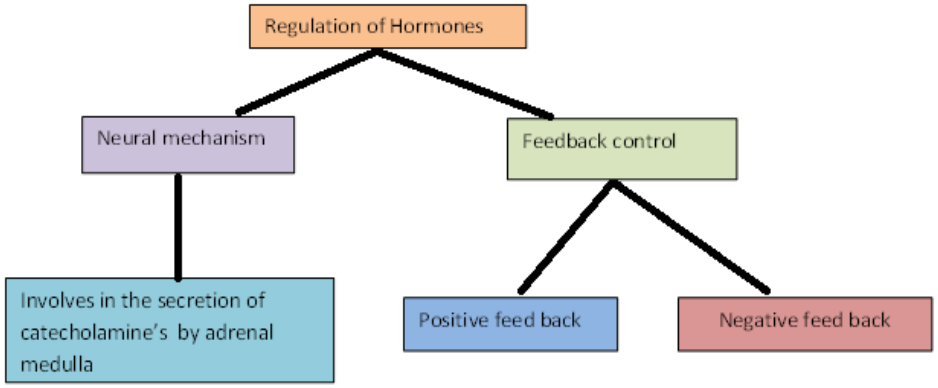

Figure 1: Flow chart showing the regulation of hormones.

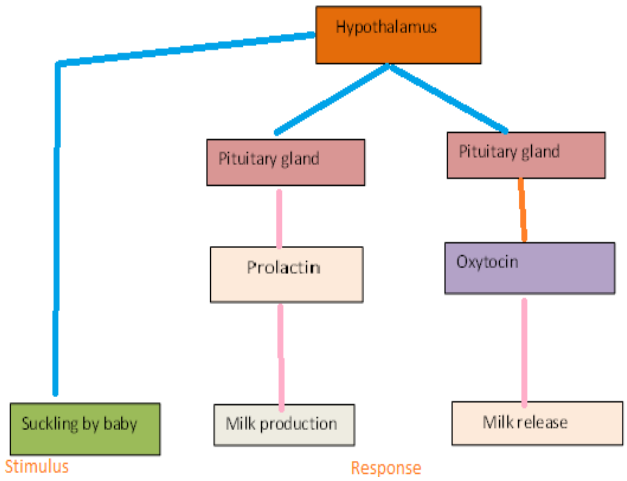

Figure 2: Postive feedback mechanism (lactation).

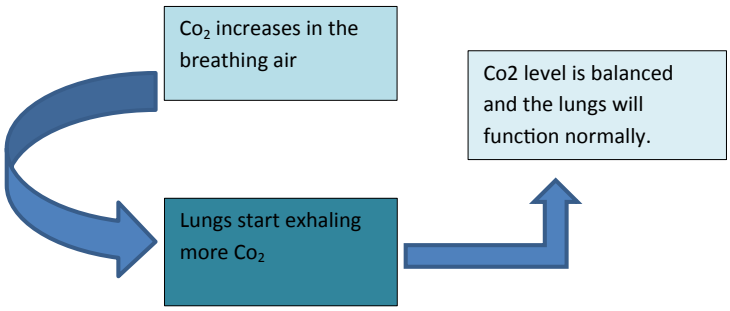

Figure 3: Negative feedback mechanism in respiratory system.

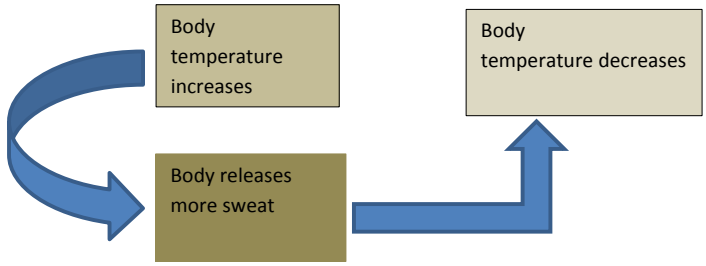

Figure 4: Thermoregulation in human system.

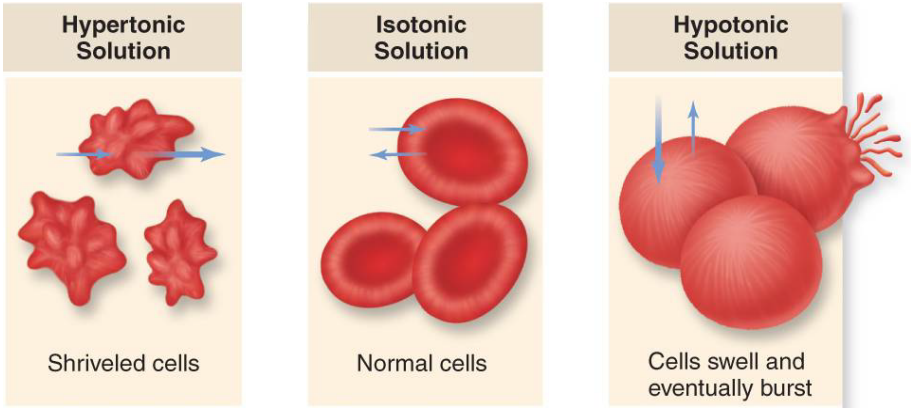

Figure 5: Osmoregulation in cells.

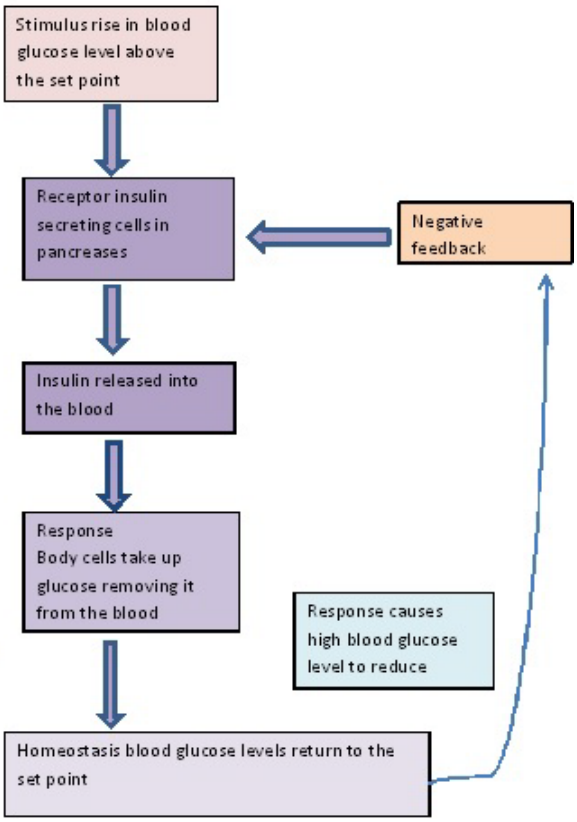

Figure 6: Flow chart of chemical regulation in blood.

Chemical Regulation

Control of blood glucose level is an example of negative feedback. Blood glucose concentration rises after a meal (the stimulus). The hormone insulin [33-37] is released by the pancreas, and it speeds up the transport of glucose from the blood and into selected tissues (the response). Blood glucose concentrations then decrease, which then decreases the original stimulus. The secretion of insulin into the blood is then decreased (Figure 6) [64].

References

1. Yadav H, Jain S, Bissi L, Marotta F (2016) Gut Microbiome Derived Metabolites to Regulate Energy Homeostasis: How Microbiome Talks to Host. Metabolomics 6: e150.
2. Rodova M, Kim S, Abdul Mottaleb M, Rafiq Islam M (2016) Hepcidin Regulation by Bone Morphogenetic Protein Signaling and Iron Homeostasis. J Nutr Food Sci 6: 521.
3. Singh M, Mansuri MS, Parasrampuria MA, Begum R (2016) Interleukin 1-α: A Modulator of Melanocyte Homeostasis in Vitiligo. Biochem Anal Biochem 5: 273.
4. Andrey ZM, Vladimir ZM (2016) An Integral Concept of Regulating Immune Homeostasis. J Clin Exp Pathol 6: 267.
5. Cohen E (2012) Roles of Aquaporins in Osmoregulation, Desiccation and Cold Hardiness in Insects. Entomol Ornithol Herpetol S1: 001.
6. Kurazumi Y, Sakoi T, Tsuchikawa T, Fukagawa K, Bolashikov ZD, et al. (2014) Behavioral Thermoregulation Model for Evaluation of Outdoor Thermal Environment. J Ergonomics 4: 125.
7. Xiaoxiao S, Prince JA, Sun DD (2016) Relating Water/Solute Permeability Coefficients to the Performance of Thin-Film Nanofiber Composite Forward Osmosis Membrane. J Membra Sci Technol 6: 167.
8. Fischbarg J (2014) Textbook Corrections are Required: Electro osmosis Causes Epithelial Fluid Transport, Not Osmosis. J Mol istol Med Physiol 1: 101
9. Singh V, Das A, Das C, Pugazhenthi G, Srinivas M, et al. (2015) Fouling and Cleaning Characteristics of Reverse Osmosis (RO) Membranes. J Chem Eng Process Technol 6: 244.
10. Rodríguez-Calvo A, Silva-Castro GA, Osorio F, González-López J, Calvo C (2014) Novel Membrane Materials for Reverse Osmosis Desalination. Hydrol Current Res 5: 167.
11. Abdulghaffara W, Nasr M, Shahin W (2017) 3-T Magnetic Resonance Diffusion-Weighted Imaging (DWI) for Characterization of Hepatic Masses. OMICS J Radiol 6: 249.
12. Direkel S, Uzunoglu E, Uzalp C, Findik E, Tontak S, et al. (2017) Determination of Piperacillin/Tazobactam and Ticarcillin/Clavulanate Susceptibilities in Pseudomonas aeruginosa Isolates in Hospitalised Patients by E-test Gradient Method and Comparison of Results with Disk Diffusion Tests. Clin Microbiol 6: 273.
13. Latunde-Dada S (2016) Theoretical Comparisons of the Concentration-Dependent Diffusion Coeffi-cients from Dynamic Light Scattering and Taylor Dispersion Analysis. J Anal Bioanal Tech 7: 340.
14. Pichiecchio A, Carigi T, Bergsland N, Gianfelice S, Palesi F, et al. (2016) Brain Diffusion Tensor Imaging and Volumetric Analysis: Grey and White Matter Changes in Preschool Children with Autism Spectrum Disorder. Autism Open Access 6: 161.
15. Ochi S, Yoshifuji K, Watanabe T, Mikuni M (2016) Infant Motor Development Recovery after Surgery of Post Traumatic Epilepsy (PTE)-Meaningful Change of Fractional Anisotropy (FA) of MRI Diffusion Tensor Imaging (DTI) in a Case of Growing Skull Fracture. J Neurol Disord 4: 284.
16. Schaefer E (2016) Micronutrient Deficiency in Women Living in Industrialized Countries During the Reproductive Years: Is there a Basis for Supplementation with Multiple Micronutrients? J Nutr Disorders Ther 6: 199.
17. Sumi ES, Vijayan DK, Jayarani R, Navaneethan R, Anandan R, et al. (2016) Biochemical Composition of Indian Common Small Pelagic Fishes Indicates Richness in Nutrients Capable of Ameliorating Malnutrition and Age-Associated Disorders. J Chem Biol Ther 2: 112.
18. Casas R, Estruch R (2016) Dietary Patterns, Foods, Nutrients and Chronic Inflammatory Disorders. Immunome Res 12: 122.
19. Jenzer H, Marty I, Büsser S, Silva M, Balmer FS, et al. (2016) Know-how and Know-why Nutrients may be Less Bioaccessible and Less Bioavailable due to Proton Pump Inhibitor-Food Interactions and Incompatibilities Involving Metal-Aquo Complexes. J Nutr Disord Ther 6: 191.
20. Louis R, Louis E, Stinkens K, Mesotten L, de Jonge E, et al. (2016) Metabolic Phenotyping of Blood Plasma by Proton Nuclear Magnetic Resonance to Discriminate between Colorectal Cancer, Breast Cancer and Lung Cancer. Metabolomics (Los Angel) 6: 187.
21. Ginneken VV, Ham L, de Vries E, Verheij E, van der Greef J, et al. (2016) Comparison of Hormones, Lipoproteins and Substrates in Blood Plasma in a C57bl6 Mouse Strain after Starvation and a High Fat Diet: A Metabolomics Approach. Anat Physiol 6: 233.
22. Smirnov IV, Gryazeva IV, Samoylovich MP, Terekhina LA, Pinevich AA, et al. (2016) Different Pairs of Monoclonal Antibodies Detect Variable Amounts of Soluble Endoglin in Human Blood Plasma. Immunochem Immunopathol 2: 121.
23. Matejovicová B, Vondráková M, Boledovicová M, Pobisova A, Žatko T, et al. (2016) Reproductive Behavior of Female University Students in Relation to Endocrine Regulators Concentration in Blood Plasma during Ovarian Cycle Phases. Reprod Syst Sex Disord 5: 158.
24. Ali FHH, Ranneh Y (2013) Angiopoietin-like Protein 4 and the level of Free Fatty Acids in Human Blood Plasma: Is there a link? Med Chem 3: 276-281.
25. Holmes RS (2017) Comparative and Evolutionary Studies of Vertebrate Extracellular Sulfatase Genes and Proteins: SULF1 and SULF2. J Proteomics Bioinform 10: 32-40.
26. Menezes-Rodrigues FS, Tavares JGP, Errante PR, Vasques ER, do Carmo MRM, et al. (2017) Role of the Extracellular Ca^{2+}/cyclic AMP-Adenosine Signaling Pathways in Cardioprotection. J Thrombo Cir 3: e106.
27. Tangudu NK, Vujic Spasic M (2017) Heme Activates Macrophage Hepcidin Expression via Toll like Receptor 4 and Extracellular Signal-Regulated Kinases Signaling Pathway. Clin Pharmacol Biopharm 6: 166.
28. Kano H, Huq MA, Tsuda M, Noguchi H, Takeyama N (2016) Sandwich ELISA for Circulating Myeloperoxidase- and Neutrophil Elastase-DNA Complexes Released from Neutrophil Extracellular Traps. Adv Tech Biol Med 5: 196.
29. Tiwari V, Solanki V, Roy R, Biswas D, Tiwari M (2017) Significances of OMV and Extracellular Vesicle Proteomics . J Data Mining Genomics Proteomics 8: 208.
30. Boisnic S, Branchet MC, Gaillard E, Lamour I (2016) Miliacin Associated with Polar Lipids: Effect on Growth Factors Excretion and Extracellular Matrix of the Dermal Papilla Hair Follicle Model Maintained in Survival Conditions. Hair Ther Transplant 6: 143.
31. Ahmad A (2017) Carvedilol can Replace Insulin in the Treatment of Type 2 Diabetes Mellitus. J Diabetes Metab 8: 726.
32. Takahashi P, Matsubara A, Saitoh A, Phomvisith O, Shiga A, et al. (2016) Higher Intake of Milk-Replacer Pre-Weaning Enhances Post-Weaning Insulin-Like Growth Factor 1 Levels in Japanese Black Cattle. J Vet Sci Technol 8: 409.
33. Islam MN (2016) Insulinotropic Effect of Herbal Drugs for Management of Diabetes Mellitus: A Congregational Approach. Biosens J 5: 142.
34. Abuzaid AA, Osman MO, Elkhawad AO (2016) Quercetin Curtails Obesity and Dyslipidemia, but Not Insulin Resistance in Long-Term Type 2 Diabetic Male Wistar Rats Fed the High-Fat, High-Sucrose Diet. Adv Pharmacoepidemiol Drug Saf 5: 213.
35. Yamada H, Suzuki D, Kakei M, Kusaka I, Ishikawa S (2016) Close Association of Hypoadiponectinemia and Increased Insulin Resistance in Non- Obese Japanese Type 2 Diabetes with Visceral Adiposity. J Metabolic Synd 5: 215.
36. Ponizovskiy MR (2013) The Central Regulation of all Biophysical and Biochemical Processes as the Mechanism of Maintenance Stability of Internal Energy and Internal Medium both in a Human Organism and in Cells of an Organism. Mod Chem Appl 1: e101.
37. Pisoschi AM (2013) Studies on Biochemical Processes for Elucidation of Disease Mechanisms and Ensuring Food Security. Biochem Anal Biochem 2: 131.
38. Salama AK (2017) Lactational Exposure to Pesticides: A Review. Toxicol Open Access 3: 122.

39. Ahmed SI, Ali TO, Elsheikh AS, Attia GA, Abdalla AM, et al. (2017) Testicular Changes in Male Albino Rat Pups Exposed to Medroxy-Progesterone Acetate during Lactational Period. J Steroids Horm Sci 8: 184.

40. Ruoff J, Borchardt S, Mahrt A, Heuwieser W (2016) Effects of Hyperketonemia within the First Six Weeks of Lactation on Milk Production and Reproductive Performance. J Adv Dairy Res 4: 165.

41. Flagg JS, Balbier E, Blakey C (2016) Impact of Mother's Breastfeeding Support: Lactation Support Provided in a Group Setting. J Preg Child Health 3: 274.

42. Johnson AN (2016) Can Skin-to-Skin Holding in the NICU Support Lactation? J Nurs Care 5: 360.

43. Yang SY, Ningrat RWS, Eun JS, Min BR (2016) Effects of Supplemental Virgin Coconut Oil and Condensed Tannin Extract from Pine Bark in Lactation Dairy Diets on Ruminal Fermentation in a Dual-flow Continuous Culture System. J Adv Dairy Res 4: 160.

44. Gu W, Chen Y, Liu C, Liu Q, Liu F, et al. (2017) Sex Difference in the Expression and Gene Network of Epidermal Growth Factor Receptor in Pituitary Gland in Mice. Mol Biol 6: 179.

45. Richard J, Lucky E, Anthony O (2016) Efficacy of Osteolaemus tetraspis Pituitary Gland (APG) Hormone on Induced Spawning of Clarias gariepinus. J Fisheries Livest Prod 4: 177.

46. Peter YMW, Ronald L, Yung C, Timothy SKC, Peter KHP, et al. (2015) Symptomatic Metastasis to the Pituitary Gland: A Report of Three Cases and Review of the Literature. J Neurol Disord 3: 236.

47. Dhara K, Saha NC (2013) Controlled Breeding of Asian Catfish Clarias batrachus using Pituitary Gland Extracts and Ovaprim at different Temperatures, Latency Periods and their Early Development. J Aquac Res Dev 4: 186.

48. Noor ul A, Rehman HA, Abdullah FE (2017) Correlation of Prolactin and Thyroid Hormone Levels in Infertile Women: A Cross- Sectional Study in Pakistan. J Clin Exp Pathol 7: 304.

49. Ach MT, Kacem NM, Abed EYH, Beizig AM, Chadli CM, et al. (2017) Rare Association of Macroprolactinemia and Empty Sella Syndrome. Anat Physiol 7: 249.

50. Maria M (2016) The Role of Prolactin in Men. Endocrinol Metab Syndr 5: 222.

51. Jain D (2015) Macroprolactinoma in Pregnancy-Successful Outcome and Follow Up. Clinics Mother Child Health 12: 208.

52. Shalaby ME, Hassan HM, Aref MI, Ebeid AD (2015) Serum Prolactin and ImmunoglobulinE Levels in Psoriasis Vulgaris before and after NB-UVB Therapy. Med Chem 5: 432-436.

53. Zieba DA, Kirsz K, Szczesna M, Molik E, Romanowicz K, et al. (2015) Photoperiod Influences the Effects of Ghrelin and Serotonin Receptor Agonist on Growth Hormone and Prolactin Secretion in Sheep. J Neurol Neurophysiol 6: 301.

54. Vanita P, Jhansi K (2011) Metabolic Syndrome in Endocrine System. J Diabetes Metab 2: 163.

55. Ibtisham F, Nawab A, Zhao Y, Li G, Xiao M, et al. (2016) Effect of Antimicrobial Triclosan on Reproductive System of Male Rat. Pharm Anal Acta 7: 516.

56. Cemile MS, Çigdem E (2016) The Effects of Oxidative Stress and Some of the Popular Antioxidants on Reproductive System: A Mini Review. J Nutr Food Sci 6: 464.

57. Soundarapandian P, Varadharajan D, Anand T (2013) Male Reproductive System of Blue Swimming Crab, *Portunus pelagicus* (Linnaeus, 1758). J Cytol Histol 5: 206.

58. Zappa F, Ward T, Pedrinis E, Butler J, McGown A (2013) NAD(P) H:Quinone Oxidoreductase 1 Expression in Human Reproductive System and Mitomycin-C Cytotoxicity: A New Chapter for Old Compounds? J Cytol Histol 5: 209.

59. Piloni EN, Puntarulo S (2016) A Simple Kinetic Model to Estimate Ascorbyl Radical Steady State Concentration in Rat Central Nervous System. Effect of Subchronic Fe Overload. Bioenergetics 5: e125.

60. Serra DS, Brito KBPD, Oliveira KL, Oliveira MLM, Cavalcante FSA (2017) Respiratory System of Rats Exposed to Pollutants arising out of Heating Residual Glycerol. J Fund Renew Energ Appl 7: 220.

61. Saadeh R (2014) Child's Development and Respiratory System Toxicity. J Environ Anal Toxicol 4: 233.

62. Jois T, Sleeman MW, Ambardekar VV (2017) The regulation and role of carbohydrate response element binding protein in metabolic homeostasis and disease.

63. Wakaskar RR, Bathena SPR, Tallapaka SB, Ambardekar VV, Gautam N (2014) Peripherally cross-linking the shell of core-shell polymermi celles decreases premature release of physically loaded combretastatin A4 in wholeblood and increases its mean res0069dence time and subsequent potency against primary murine breast tumors after IV administration. Pharm Res 32: 1028

64. Ambardekar VV, Wakaskar RR, Sharma B, Bowman J (2013) The efficacy of nuclease-resistant Chol-siRNA in primary breast tumors following complexation with PLL-PEG(5K). Biomaterials 34: 4839-4848.