

The Role of Calcium-Pathway in Health and Autoimmune Diseases

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ABSTRACT

Calcium (Ca^{2+}) is an essential photophore particle that controls large modifications in natural potential. Inside this framework, Ca^{2+} signaling plays an applicable feature in extremely good sorts of cell capability together with increase, cleavage, apoptosis and several cistron recordings. For the duration of a solid response on the accomplice level, microbial engagement with inside the immune gadget and Bcell receptors that sell degradation beneath Neath dynamic situations of Ca^{2+} shops, then promulgates stored Ca^{2+} fraction (SOCE) to help the awareness of Ca^{2+} critical for law, this is interfered with via the Ca^{2+} channels (CRAC) which provoke the discharge of Ca^{2+} . Ultimately, recognizable proof of vital controllers of the CRAC channel, the cooperative stromal particle (STIM) and Orai1, has broadened our understanding of the regulatory additives of Ca^{2+} signaling in white blood cells. The tedious or now not on time increase of a non-dwelling Ca^{2+} is essential for the dephosphorylating of calcineurined sports activities of the accomplice-initiated lymphoid cell atomic trouble (NFAT). Overdue statistics information that the four-way squared Ca^{2+} calcineurinNFAT1 measures the respective deregulatory sickness. In this manner, the inhibitors of calcineurin, cyclosporine and tacrolimus are used to address infections due to reactions collectively with a well-known problem with the immune device and atrophic joint ache. right here, we're capable of often assessment the art work of the calcineurin-NFAT Ca^{2+} signaling pathway in fitness and illness, we are capable of have a few on STIM and Orai1, and communicate the calcineurin NFAT-launched calcineurin NFAT pathway just like infections. Introduction Calcium (Ca^{2+}) can be a second substance playing modified roles, like an herbal cycle, commencing, growing and destroying cells in a few cells. Ca^{2+} tiers internal harmonics (ECF) and endoplasmic reticulum (emergency room) measured via square slight examine internal multi-millimolar (mM) fluctuations. Expertise, intracellular Ca^{2+} ranges measured squared or nearer inner fluctuated through one hundred nM that is ten thousand instances beneath neath humoral Ca^{2+} uptake.

Key words: Calcium, SOC, SMOC, CRAC, ROC

HOW TO CITE THIS ARTICLE: Umair Babla, Jayshri Jankar, The Role of Calcium-Pathway in Health and Autoimmune Diseases, J Res Med Dent Sci, 2022, 10 (7):55-59.

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Received: 08-June-2022, Manuscript No. JRMDs-22-66212;

Editor assigned: 10-June-2022, PreQC No. JRMDs-22-66212 (PQ);

Reviewed: 24-June-2022, QC No. JRMDs-22-66212;

Revised: 29-June-2022, Manuscript No. JRMDs-22-66212 (R);

Published: 06-July-2022

INTRODUCTION

The Ca^{2+} mind-set is installed through important Ca^{2+} storage, variable Ca^{2+} channel sorts, Ca^{2+}/H ATPase, and Na/Ca^{2+} exchangers. stages of intracellular Ca^{2+} are low in resting cells, understanding, Ca^{2+} -activated agonists, much like chemoreceptors and growth factors, bring about modifications with inside the Ca^{2+} factors gift. The immobilization of cytosolic Ca^{2+} is regulated via the efflux and influx of Ca^{2+} . The square measures essential intracellular Ca^{2+} inundation procedures: (1) from rapid

garage, much like trama and mitochondria, and from harmonic. The transfer of Ca^{2+} from the aqueous humor is needed for the sustained pinnacle of intracellular Ca^{2+} awareness and the overall functioning of the Ca^{2+} sub-cycles [1]. at the alternative hand, the efflux of Ca^{2+} takes place thru the exchangers Na/Ca^{2+} and Ca^{2+} cellular adenylyl pyrophosphatase (ATPase). various Ca^{2+} penetrable channels degree internal tension withinside the development of the Ca^{2+} organism: voltage-gated Ca^{2+} channels (VOC), active receptor channels (ROC), stored channels (SOC) collectively with the initiation channel of the Ca^{2+} discharge (CRAC) and the second courser taking walks channels (SMOC) [1].

Calcium channels

Voltage-operated Ca^{2+} channels

VOCs and ROCs degree squares which may be in maximum times localized in electrically sensitive cells, on the identical time as SMOCs degree squares in

advantageous pointed, non-volatile cells. In nerve and muscle fibers, electrically risky cells, VOCs and ROCs diploma predominant Ca₂ pathways [2].

Ligand-Gated, Transient Receptor Potential (TRP) channels

ROCs open inner milliseconds even as a neurochemical binds to them (three). The square degree of SOC is produced through the frequently witnessed 2d atoms of the nutrient phosphate B (PI), diacylglycerol (DAG) and arachidone corrosion and its metabolites. The rectangular degree SOC have become found over the entire eukaryote. Rectangular CRAC channels degree the quantity of Ca₂ that passes through most hairless cells, specifically solid cells. Whilst reducing the Ca₂ storage strength of 1 rectangular meter, the Ca₂ garage phase (SOCE) is interfered with via the setting out CRAC channels. The strength and the duration of the Ca₂ sign generated through the SOCE and CRAC channels truly invade the one-of-a-kind factors of the impregnable cells. Short-time period cap potential takes place inner mins. The big instructions of Ca₂ sign transduction phrases do not appear to be associated with the novel nature, understanding ever knowledge to the motility and, on this manner, to the depletion of microorganisms with inside the immune machine. Qualitatively, prolonged Ca₂ sign kinds are mounted to determine onset whether or not or not or now not the cytosolic Ca₂ degree measures squarely above baseline for a totally long term through the incessant Ca₂ fraction. The squaring of the length classes has been decided with the growth of lymphatic cells, the coupling of hobby-associated abilities, the generation of proteins or chemokines, the separation and electricity of lymphocytes (eight). Motion some of the mobile membrane and the emergency room, or a number of the center of the trama and the mitochondria is essential to guide the without delay migration of Ca₂. It has extended been identified that the nutrient B triphosphate serves to lessen Ca₂ from critical chemical stores through activating the receptor inositol1,5 triphosphate (IP₃) (IP₃). Know-how, present day discoveries on the 2 critical controllers of CRAC channel capacity have spread out new views on mobile capacity administered through Ca₂. The vital controller is stromal communicate particle one (STIM1), a Ca₂ sensing element macromolecule delivered with inside the emergency room, if you want to fail the initiation of the CRAC channel. The following controller is Orai1, a financial unit of the CRAC channels. This take a look at specializes inside the paintings of Ca₂ and on this attitude, the upward and downward signaling pathways of Ca₂ waft inner sensitive cells and its relevance in pathology and illnesses of the gastrointestinal tract of scientific depth. Calcium channels voltage actuated Ca₂ channels square degree of VOCs placed in electrically inspired cells and they may be a degree (3) of squares activated through membrane changes. Commonly, VOCs paintings due to the reality fundamental fragments of Ca₂ enter the cell. Information, their physiological significance or their regular average performance in immune cells

stays uncertain. Brief Coordinated Receptor capacity (TRP) Channels rectangular section Ca₂ channels are in maximum time's undistributed molecular channels. Amongst them, the obligatory TRP redirection of six subfamilies synchronous with the inheritance of natural compounds: TRPC group (punished), TRPV (vanilloid), TRPA (ankyrin), TRPM (melastatin), TRPML institution (mucolipin) and TRPP (polycystine) . TRPC1 has been cloned to emerge as the important class example of the TRPC channel [3].

Ca₂+ release-activated Ca₂+ channels

Stromal interaction molecule one

From this moment, TRPC2 and TRPC7 are determined. TRP redirects the communicated square degree in multiple cells, and the rectangular degree need to fulfill one-of-a-type natural roles. Together, TRP channels act as multimodal cell sensors, notwithstanding the fact that furthermore they upload to the physiological conditions of Ca₂. first of all, TRP channels conduct as Ca₂ crosses the semipermeable membrane [4]. 2d, as quick as activated, they create about mobile changes that strain the Ca₂ fraction and result in adjustments inner intracellular Ca₂ binding [5]. Third, TRP channels are located with inside the emergency room and mitochondria and function as intracellular Ca₂ discharge channels (thirteen). There are styles of squared measurements of research that display the connection among TRP and CRAC channels. as an example, Orai1, a CRAC channel, which binds to TRPC and acts as an incredibly fragmented financial unit, demonstrates the cap potential of STIM1 to have an effect on depletion of related stores on TRP channels . STIM1 binds tightly to TRPC1, TRPC and TRPC5 and is in SOCE. In unstimulated cells, TRPC1 displayed no constitutive mobile hobby and its level with inside the measured semipermeable movie rectangular has become in particular low. Then again, vesicles containing TRPC1 may be discovered with inside the vicinity of the paraplasmic movie near the precarious fringe of the applicable junctions of the tracheal plasma layer, in which Orai1 and STIM1 fuse with inside the emergency room. This place offers TRPC1-containing vesicles to find out Ca₂ symptoms, the invention of that incites their fulfillment to the semipermeable film internal the instance of STIM1 knockdown, endogenous TRPC1interceded SOCE and Ca₂ movement rectangular degree considerably removed [6]. In differentiation, exogenous coarticulation of STIM1 with TRPC1 will gather SOCE (sixteen). on the off risk that the store is sufficiently packed, TRPC1 is remote from STIM1, and TRPC1 is inactivated . Actuation of TRPC1 conjointly relies upon the presence of deliberate Orai1 thinking about the [6] truth that knockdown of Orai1 turns on the complete disposal of TRPC1intervened SO. With this, previous tests recommended that the semi-permeable layer coupling of TRPC1 controls all Ca₂ signaling with inside the telecell smartphone with STIM1 and Orai1. See greater data at the STIM1 and Orai1 square ruler beneath Neath.

Ca²⁺ communication in lymphocytes

Release of Ca²⁺ Activated Ca²⁺ channel Molecule interacting with stroma previous to the technology of STIM proteins thru large-scale RNA (RNAi) impedance video display gadgets [7], there have been at the least 3 SOCE manage models: coupling structural [7], solvent Ca²⁺ float issues [7] and acne coalescence [8]. Perhaps the ones fashions cannot legitimize the SOCE engine. STIM have become noted from 2 video expertise devices of RNAi circulating in melanogaster cells and the Drosophila class. Dislike drosophila melanogaster, warm-blooded organisms that right now excrete the 2 proteins STIM, STIM1 and STIM2.

Ca²⁺ upstream communication in lymphocytes

Every STIM protein is a solitary transmembrane protein with commercial agency N-coupled terminal (EF) arms located with inside the applicable lumen of the trachea [9]. The areas associated with the STIM macromolecules are observed in each lumen of the emergency room and therefore are cellular material, on the identical time as the Ca²⁺-limited EFhand lead is positioned with inside the STIM1 fragment with inside the front of the applicable lumen o the trachea [9].

Ca²⁺ downstream communication pathway when Ca²⁺ inflow

Alteration of Ca²⁺ limits salt assemble-up, and aspartate initiates SOCE and CRAC channels unbiased of situations for filling Ca²⁺ stores withinside the emergency room [10,11], suggesting that STEM proteins act with sensors. degree of Ca²⁺ withinside the tracheal center. The STIM1 and STIM2 will discover the depleted Ca²⁺ reserves with inside the emergency room and purpose initiation of SOCE through Orai1. information, the RNA-regulated knockdown of STIM2 thru desire reduces the usual level of cellular Ca and immobilizes Ca withinside the emergency room. kind Hora and buddies [12]. Screen that leukemia cells and fibroblasts with random abrogation of STIM1 can bring about a huge cut fee in direct software program application of SOCE and CRAC in C57BL/6 mice, which can be certainly repaired via STIM1, expertise not simply recovered thru STIM2. The creators could not manage that the microorganisms withinside the STIM1 full Immune system exhibited handiest a transient atomic restrict of NFAT, on the same time because the STIM2 white blood cells could not manage it, know knowledge, uncontrollably, the essential fraction of containment. atomic of NFAT. Additionally, leukemia cells reliably missing in STIM2 carry out every day SOCE and make protein [12,13]. They concluded that STIM1, understanding no longer STIM2, is the primary intentional investigator of Ca²⁺ at the trachea center which can activate SOCE through redirecting CRAC into sensitized cells.

Ca²⁺ communication in alternative immune cells

Neutrophils

After depletion of Ca²⁺ reserves, migration and accumulation of STIM1 structures merge into small clusters ("dots") withinside the ED film [14]. While the relevant Ca²⁺ is depleted, STIM1 initiates isomerization

or oligomerization, for this reason forming mobile department bundles. STIM1 constructs homomultimes and heteromultimes with itself and STIM2 [14]. These macromolecular-protein cooperators are inserted via the protein binding regions of STIM1; collectively with a sterile mission depend vicinity (SAM), ezrin helix, radixin and moesin (ERM), a serine and prolinerich area. , and a lysinerich area The association of punctuation marks in or near the mobile divider suggests knowledge that STIM1 may also furthermore characteristic with CRAC channels [14,15]. Honestly, STIM1 is simultaneously restricted to the Ca²⁺ fraction and, on this way, to the funding unit of the CRAC Orai1 channel. to distinguish it from STIM1, that would spark off SOCE, STIM2 has all the hallmarks of aid and emergency stem cellular Ca²⁺ level tension Parvez et al. and Bema Erro et al. had counseled that overexpression of STIM2 in illuminated HEK293 cells may also growth resting Ca²⁺ tiers, in spite of the reality that neurons in plant tissues, lacking in STIM2, may additionally degrade them. Verbal exchange Ca²⁺ in Lymphocytes among the severa Ca²⁺ channels, CRAC sincerely directs the implementation in invulnerable cells, specifically lymphocytes. The CRAC channels are open in [16] all times on the concept of an extended interactive journey. Quick-lived volumes are commonly resolved internal minutes. They have been involved about the law of white blood cellular motility, and consequently the depletion of cytotoxic microorganism's withinside the CD8 immune machine. The binding of the T lymphocyte receptor (TCR) or the lymphocyte receptor (BCR) to peptides sporting antibiotics (APC) induces a short growth withinside the notice of Ca in dwelling organisms. As Ca²⁺ stages growth, lymphocytes save you growing and nerve connections become clinically solid. Elongation competencies encompass cell replication, coupling interest-associated competencies, cytokine/chemokine technology, and lymphocyte cleavage [16].

Osteoclasts

A everyday Ca²⁺ float is wanted because of the reality this prolonged-time period common ordinary overall performance takes vicinity while the Ca²⁺ consciousness keeps tempo with the higher baseline over an prolonged period of time. Ca²⁺ corresponds upstream in lymphocytes because the regularly crucial antigen/naturalness (MHC) binds to TCR, aminoalkanoic macromolecule-ingesting kinases are enacted. This problem activates phosphorylation via aminoalkanoic corrosion and because of this produces phospholipase C, gamma one %γ1 catalyzes the increase of IP3 and DAG from the lipid membrane phosphatidylinositol ,5bisphosphate (PIP2). IP3 opens the IP3 receivers (IP3R) and lets in Ca²⁺ to glide from the Ca²⁺ supply to the emergency room. The STEM proteins recognize reduced Ca²⁺ uptake withinside the emergency room thru their observed EF fingers located withinside the lumen of the tracheal center, performing as Ca²⁺ sensors withinside the tracheal middle [17]. at the same time as Ca²⁺ is isolated from EFhands, the STEM shape will cluster withinside the emergency room layer. This adjustment troubles the unit

associated with the pre-channel loss Orai1, placing SOCE [18]. Ca₂ Corresponding channel downstream of the Ca₂ inlet while the influx of Ca₂ will boom the attention of Ca₂, Ca₂ speedy turns on the corresponding channel which selects and stores the elements. The pathway widely recognized withinside the worldwide to date is [17] the calmodulin-calcineurin pathway, with definitive activation of NFAT1 to [18] the calmodulin Ca₂-following kinase (CaMK), and (18) the etiologic hassle.. Calmodulin can be a Ca₂-restrained exploratory super molecule transfected through eukaryotic cells. at the same time as Ca₂ binds to calmodulin, it forms disrupted calmodulin Ca₂. This mistakenly activates the Ca₂ siphon which, at this element, every gets rid of Ca₂ from living rely amount or stores Ca₂ withinside the emergency room. The synthesized Calmodulin Ca₂ furthermore produces the corresponding chemical calmodulin (CAMK), which phosphorylates many proteins that artwork thru migrating phosphates from adenosine triphosphate to corroding amines and corrosive basal amine accumulators on proteins (first). Calcineurin may be a serine/threonine compound belonging to the elegance of calmodulins. Calcineurin consists of a investment unit for the restrictive synthesis of calmodulin, calcineurin A, and an associated pre-regulatory unit, calcineurin B [1]. In vertebrates, there are 3 isoforms of calcineurin A (calcineurin A α , calcineurin A β and calcineurin A γ) and more than one isoforms of calcineurin B (calcineurin B1 and calcineurin B2). as the invigorating Ca₂ focus creates calmodulin thru restricting to calcineurin, NFAT shifts to the nucleus [19] which then adjusts, at this aspect, the profile of its goal skills, which can be the muse of herbal sensitivity and edition. All NFAT1 to NFAT, besides NFAT5, are launched via calcineurin. They need to shield the Nterminal place containing the languages constrained to calcineurin [20].

Rheumatoid inflammatory disease

NFAT1, NFAT2 and NFAT absolute detail lymphocytes. Particular excessive quality thymocyte cells in particular speak NFAT1. NFAT2 is communicated in thymocyte and instances horrific B cells, and NFAT is communicated in times stable thymocyte [21], suggesting that the NFAT isoforms of NFAT surely take over from one-of-a-type sports on the event level and internal boom. Microorganisms belonging to the immune device withinside the thymus. Such concept is supported through a modern document showing that NFAT1 and NFAT require unmistakable InsP3 and Ca₂ subcellular signs and symptoms for physiologically sustained hobby [22]. Ca₂ fit in cells Selective security Neutrophils it's miles normally believed that Ca₂ signaling is critical for the spread of neutrophils collectively with lymphocytes from cells. In neutrophils, Ca₂ matching begins off evolved with limit of looked after receptors on the ground of cells, further to Fc γ receptors (Fc γ R), G protein coupled receptors (GPCR) and integrin's [23]. Binding of neutrophils induces an influx of Ca₂, which controls the exocytosis identified with the development of neutrophils [23]. The elevated Ca₂ produced through

integrative engagement triggers a brief extrade in leukocyte morphology and speeds up the spread of leukocytes. Likewise, Ca₂ is likewise concerned with the smooth assembly and migration of proteins via leukocyte adhesion and basal techniques (). similarly, Ca₂ signaling seems to intervene with extracellular approach as confirmed through studies displaying that the release of numerous granules is based totally upon at the awareness of Ca₂ in neutrophils real to form, the 2 CRAC channels, STIM1 and Orai1, are concerned in leukocyte potential. as an example, SOCE-introduced on siRNA obstruction brought on thru STIM1 led to a marked lower withinside the interest of the compound NADPH in HL60 neutrophils, on the identical time as STIM2 siRNA had no effect (24). in addition, STIM1 siRNAs reduce the polarization of HL60 cells most probably through the Akt/Src/Rac pathways [24]. Similarly, STIM1 binds to Ca₂ channels on phasomes to unique a restrained pinnacle of Ca₂ promoting regular duplicate in neutrophils [24]. Moreover, Orai1's abusive siRNA knockdown decreased SOCE and ROS technology in HL60 cells [24,25], suggesting that Orai1 moreover injects SOCE into neutrophils. Collectively this possibly information that the Ca₂ conversion interfered with STIM1 and Orai1 is wanted for neutrophil satiety factors, in addition to for bodily techniques. not like the regular method, there can be a difference in whether or not or now not or now no longer STIM1 directs the migration of leukocytes. In a psoriatic irritant organism version, STIM1-poor knockout mice protected a good buy an awful lot much less leukocyte infiltration into the nail pores and pores and skin than controls [26], suggesting that STIM1 is large for taxi. Zhang et al. [27] confirmed that neutrophils from mouse stimuli showed no malformation withinside the direction of attachment and migration. Similarly, in a human research of extensively unwell patients with challenge loss, variation in ORAI1 and STIM1 capabilities, the influx of Ca₂ have become essentially accompanied thru a modest decrease in ORAI1 and STIM1 leukocytes [28-32].

REFERENCES

1. Feske S, Wulff H, Skolnik EY. Ion channels in innate and adaptive immunity. *Annu Rev Immunol* 2015; 33:291.
2. Gwack Y, Feske S, Srikanth S, et al. Signalling to transcription: Store-operated Ca₂⁺ entry and NFAT activation in lymphocytes. *Cell Calcium* 2007; 42:145-156.
3. Maki BA, Popescu GK. Extracellular Ca₂⁺ ions reduce NMDA receptor conductance and gating. *J Gen Physiol* 2014; 144:379-392.
4. Putney JW. Formation and actions of calcium-mobilizing messenger, inositol 1, 4, 5-trisphosphate. *Am J Physiol Gastrointest Liver Physiol* 1987; 252:149-157.
5. Negulescu PA, Krasieva TB, Khan A, et al. Polarity of T cell shape, motility, and sensitivity to antigen. *Immunity* 1996; 4:421-430.

6. Turner H, Kinet JP. Signalling through the high-affinity IgE receptor FcεRI. *Nature* 1999; 402:24-30.
7. Pipkin ME, Lieberman J. Delivering the kiss of death: progress on understanding how perforin works. *Curr Opin Immunol* 2007; 19:301-308.
8. Feske S. Calcium signalling in lymphocyte activation and disease. *Nat Rev Immunol* 2007; 7:690-702.
9. Ambudkar IS, de Souza LB, Ong HL. TRPC1, orai1, and STIM1 in SOCE: Friends in tight spaces. *Cell Calcium* 2017; 63:33-39.
10. Minke B. TRP channels and Ca²⁺ signaling. *Cell Calcium* 2006; 40:261-275.
11. Wes PD, Chevesich J, Jeromin A, et al. TRPC1, a human homolog of a Drosophila store-operated channel. *Proc Natl Acad Sci USA* 1995; 92:9652.
12. Chung MK, Guler AD, Caterina MJ. TRPV1 shows dynamic ionic selectivity during agonist stimulation. *Nat Neurosci* 2008; 11:555-564.
13. Dong XP, Wang X, Xu H. TRP channels of intracellular membranes. *J Neurochem* 2010; 113:313-328.
14. Fenninger F, Jefferies WA. What's bred in the bone: Calcium channels in lymphocytes. *J Immunol* 2019; 202:1021.
15. Cheng KT, Liu X, Ong HL, et al. Local Ca²⁺ entry via orai1 regulates plasma membrane recruitment of TRPC1 and controls cytosolic Ca²⁺ signals required for specific cell functions. *PLoS Biol* 2011; 9:e1001025.
16. Huang GN, Zeng W, Kim JY, et al. STIM1 carboxyl-terminus activates native SOC, I(crac) and TRPC1 channels. *Nat Cell Biol* 2006; 8:1003.
17. Yuan JP, Zeng W, Huang GN, et al. STIM1 heteromultimerizes TRPC channels to determine their function as store-operated channels. *Nat Cell Biol* 2007; 9:636-45.
18. Liou J, Kim ML, Heo WD, et al. STIM is a Ca²⁺ sensor essential for Ca²⁺-store-depletion-triggered Ca²⁺ influx. *Curr Biol* 2005; 15:1235.
19. Putney JW. A model for receptor-regulated calcium entry. *Cell Calcium* 1986; 7:1-12.
20. Randriamampita C, Tsien RY. Emptying of intracellular Ca²⁺ stores releases a novel small messenger that stimulates Ca²⁺ influx. *Nature* 1993; 364:809-814.
21. Patterson RL, van Rossum DB, Gill DL. Store-operated Ca²⁺ entry: Evidence for a secretion-like coupling model. *Cell* 1999; 98:487-99.
22. Roos J, DiGregorio PJ, Yeromin AV, et al. STIM1, an essential and conserved component of store-operated Ca²⁺ channel function. *J Cell Biol* 2005; 169:435-445.
23. Williams RT, Manji SS, Parker NJ, et al. Identification and characterization of the STIM (stromal interaction molecule) gene family: Coding for a novel class of transmembrane proteins. *Biochem J* 2001; 357:673-685.
24. Zhang SL, Yu Y, Roos J, et al. STIM1 is a Ca²⁺ sensor that activates CRAC channels and migrates from the Ca²⁺ store to the plasma membrane. *Nature* 2005; 437:902.
25. Oh-Hora M, Yamashita M, Hogan PG, et al. Dual functions for the endoplasmic reticulum calcium sensors STIM1 and STIM2 in T cell activation and tolerance. *Nat Immunol* 2008; 9:432.
26. Liou J, Fivaz M, Inoue T, et al. Live-cell imaging reveals sequential oligomerization and local plasma membrane targeting of stromal interaction molecule 1 after Ca²⁺ store depletion. *Proc Natl Acad Sci USA* 2007; 104:9301-9306.
27. Manji SS, Parker NJ, Williams RT, et al. STIM1: A novel phosphoprotein located at the cell surface. *Biochem Biophys Acta* 2000; 1481:147-55.
28. Gajjar AK, Shah VD. Development and validation of a stability-indicating reversed-phase HPLC method for simultaneous estimation of rosuvastatin and ezetimibe from their combination dosage forms. *Eurasian J Anal Chem* 2010; 5:265-283.
29. Butola LK, Kute PK, Anjankar A, et al. Vitamin B12-do you know everything. *J Evol Med Dent Sci* 2020; 9:3139-3147.
30. Dhok A, Butola LK, Anjankar A, et al. Role of vitamins and minerals in improving immunity during Covid-19 pandemic-A review. *J Evol Med Dent Sci* 2020; 9:2296-2301.
31. Butola LK, Jha RK, Ambad R, et al. Vitamin B12 deficit status among type 2 diabetes mellitus patients-A review. *J Evol Med Dent Sci* 2021.
32. Ali W, Ahmad I, Srivastava VK, et al. Serum zinc levels and its association with vitamin A levels among tuberculosis patients. *J Natural Sci Biol Med* 2014; 5:130.