Organellar Calcium Buffers

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Ca^{2+} is an important intracell lar messenger affecting man di erse processes. In e kar otic cells, Ca^{2+} storage is achie ed ithin speci c intracell lar organelles, especiall the endoplasmic/sarcoplasmic retic l m, in hich Ca^{2+} is b ffered b speci c proteins kno n as Ca^{2+} b ffers. Ca^{2+} b ffers are a di erse gro p of proteins, ar ing in their af nities and capacities for Ca^{2+}, b t the t picall also carr o t other f nctions ithin the cell. The ide range of organelles containing Ca^{2+} and the e idence s pporting cross-talk bet een these organelles s ggest the e istence of a d namic net ork of organellar Ca^{2+} signaling, mediated b a ariet of organellar Ca^{2+} b ffers.

[illegible]

[illegible] (B [illegible] 2003). [illegible] (ER) [illegible] (SR) [illegible]

[illegible]

[illegible] (M c [illegible] O a 2009). [illegible] 200 µM [illegible] ER [illegible] (M c [illegible] O a 2009). [illegible]

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[illegible] ER [illegible] ER.

C [illegible]

Ca[illegible], a 46-[illegible] Da ER [illegible] 50% [illegible] ER Ca^{2+} [illegible] (Na[illegible] a. 2001a; Na[illegible] a. 2001b). [illegible] N, [illegible] P-[illegible] C, [illegible] Ca^{2+} [illegible] N-[illegible] β-[illegible] (Sc[illegible] a. 2001). [illegible] X-ra[illegible] (SAXS) [illegible] N-[illegible] (N[illegible] T[illegible] a. 2008). T[illegible] N-[illegible] (Sa[illegible] a. 1999; C[illegible] a. 2007) [illegible] Ca^{2+} [illegible] (C[illegible] a. 2000; C[illegible] a. 2007), [illegible] (C[illegible] a. 2007).

T[illegible] P-[illegible] 1 a[illegible] 2, [illegible] 111222 (F[illegible] a. 1989). T[illegible] P-[illegible] β-[illegible] N-[illegible] C-[illegible] (F[illegible] a. 2001a; F[illegible] a. 2001b). T[illegible] β-[illegible] 238 [illegible] 241; [illegible] X-ra[illegible] (SAXS) [illegible] (N[illegible] T[illegible] a. 2008). TROSY-NMR [illegible] P-[illegible] ER 57, [illegible] (F[illegible] a. 2002).

T[illegible] C-[illegible] Ca^{2+}-b[illegible] (Na[illegible] a. 2001b). [illegible] Ca^{2+} [illegible] (25 [illegible] Ca^{2+} [illegible] (K_d = 2 [illegible] M) (Na[illegible] a. 2001b). T[illegible] Ca^{2+} [illegible] (C[illegible] a. 2000). SAXS [illegible] C-[illegible] (N[illegible] T[illegible] a. 2008). Ca^{2+} b[illegible] C-[illegible] α-[illegible] Ca^{2+} [illegible], 400 μM, [illegible] (V[illegible] G[illegible] a. 2009).

C [illegible] G [illegible]-F [illegible]-F [illegible]

U[illegible] Ca^{2+} [illegible] ER [illegible] Ca^{2+} [illegible] Ca^{2+} [illegible]

I[illegible] 14.5 b[illegible] (M[illegible] a. 1999). T[illegible] NF-AT3 [illegible] T-c[illegible] Ca^{2+}-[illegible] *crt*$^{-/-}$ [illegible] Ca^{2+} [illegible] IP_3 [illegible] Ca^{2+} [illegible] ER [illegible]

[illegible]

[illegible] BiP/GRP78

[illegible]

2005). B P/GRP78 ... a ... (R ... a Ka ... a 2004) a ... ER a ... (ERAD) (H b ... 2009). I ... B P/GRP78 ... ER Ca^{2+} ... ER' ... Ca^{2+} ...

G 94

GRP94 ... 94-Da, ... CaBP4) ... a ER ... a Ca^{2+} ... (Mac ... a K c 1988); (Va ... 1989). ... Ca^{2+} ... (15 ... 28 ... Ca^{2+} ...) (Mac ... a K c 1988; Va ... 1989). Ca^{2+} ... (K = 2.0 µM) a ... (K = 600 µM) (Va ... 1989; Y ... a ... 2006). ... GRP94 ... α- ... 100 µM Ca^{2+} (Va ... 1989; Y ... a ... 2006). GRP94 b ... ER ... Ca^{2+} ... ER ... (Y ... a ... 2006; B ... a ... 2007). M ... GRP94 b ... ATP ... GRP94 ... (I ... 2004; R ... 2004). I ... GRP94 ... Ca^{2+} ... (V a ... 2003). ... GRP94 ... (V a ... 2001). GRP94 ... Ca^{2+} ... T ... C ... E2 ... GRP94: a ... GRP94 ... RNA ... GRP94 ... HCV E2 (L ... 2008). I ... GRP94 ... GRP94' ... (Pa ... 2009). H ... GRP94 ... (Pa ... 2005). GRP94 a b ... Ca^{2+} ... (Ba ... 2004) ... Ca^{2+} ... GRP94 ... -b ... (Ba ... 2003).

D ...

P ... (PDI) ... ER ... ER. ... Ca^{2+} (Mac ... a K c 1988) ... (19 ... Ca^{2+} ...) (L b c ... 1994); (I c ... 1994). H ... PDI ... C ... Ca^{2+} ... ER ... (I c ... 1998). ... PDI ... Ca^{2+} ... PDI ca b ... (I c ... a Ka ... 1999). I ... PDI ... Ca^{2+} (I c ... a Ka ... 1999) ... ER Ca^{2+} ...

E 72, ... D ...

ER 72, a ER ... CaBP2 ... -b ... 2) (Va ... 1993). ... (N ... 1994) ... (R ... 1994). T ... Ca^{2+} ... ER 72 ... Ca^{2+} ... (R ... 1994) a

ER 72 c a ER
Ca^{2+} , ac-
a a Ca^{2+} b
(L a. 1997).

T ER, a c a ac a Ca^{2+}
a c c a
ca ab b
Ca^{2+} a ab ca ac a a
M Ca^{2+}-b a a
a , b a
a ca c ac
c , a
ac , a B P/GRP78, a a
. I a
Ca^{2+} b a ca ab ac c
a a ER Ca^{2+} , a a
c c a . J
a a ER Ca^{2+} b ca ac
cab J c a c a
a b ER.

ca ac , ca a a
Ca^{2+} b ca ac ca
a 18 (S J a. 1987) 60 (Pa J
a. 2004). S a c ca b
Ca^{2+} a ca ac c a :
80 Ca^{2+}
J a c ca c a
60 ca ac
ca a a c c a
Ca^{2+} (Pa J a. 2004); (W a. 2009b).
Ca^{2+} b b ca
ca a c a
or81306366 di eric4.5467 -1.

A C A C E C
C^{2+} E

T a c a c (SR) a a
ER, a
ca ac, J a, a (M c a a
a O a 2009). I a a-
Ca^{2+} b a
c ac b a c a ac
a Ca^{2+} c ; a SR
Ca^{2+} , a ER, a
a a (M c a a O a 2009).

T ab a Ca^{2+}-b
SR ca , a ca ac
Ca^{2+} b . T a
ca , J a (ca -
1, Ca 1) a ca ac (ca -
2, Ca 2) (M a. 2009). I ,
a a c c a a
ca -1 c
c b a c a ca -2
(M a. 2009). Ca ac -
c (>75%)
(B a a. 2004);
ac (W a.
2009b). B Ca^{2+} ca
ba c ac c ac
ac ca b a a

Ca^{2+}-b ... (Pa ... a. 2004; W ... a. 2009b). T ... c ... a- ... a ... b ... a ... Ca^{2+} ca ac ... a ... Ca^{2+} ca ac- ... c ... a (W ... a. 2009b).

Ca ... a ... ac ... R R. T ... ac ... a ... b ... a ... b a ... c- ... a ... a ... c ... a ... a b c ... a- ... R R ... b ca ... a ... (W ... a. 2009a). I ... ac ... b ... ca ... a ... R R ... a Ca^{2+} c c ... (G ... a. 2004). I ca ac ... ca ... -2 ... ac ... a ... b R R2 c a ... b ... b SR ... Ca^{2+} (T ... a. 2007). I ... ac ... b ... ca ... a R R ... a ... a ... ca Ca^{2+} c c ... (Q ... a. 2008). T ... ca ... ac ... R R ... a ... a ... c ... a ... a ... ca ac ... Ca- ... -1 ... b. ... Ca^{2+} c c ... SR Ca^{2+} ... P ... a ca ... ac ... c b ... R R1 c a ... (B a ... a. 2008). ... b ... a ... ca ... R R1 c a (W ... a. 2009a). A ... SR Ca^{2+} ... ca ... b R R1; b c ... a ... ca ac ca- ... ac ... b R R1 a R R2 (W ... a. 2009b).

M c ... *Casq2* ... a ... 11% ... SR Ca^{2+} ... ca ac ... c ... (K ... a ... a. 2006). T ... a ... c ... a c a ... SR Ca^{2+} ... ca ... a ... ca c ... c ... ca ... a a ... a (K ... a ... a. 2006). S ... a ... a ... ca- ac ca ... ca ... c ... a ... CPVT (ca c ... c ... c- ... a ac ca a), a ... a a c ... c ... ac ca a ... a ... c ... a ... c ...

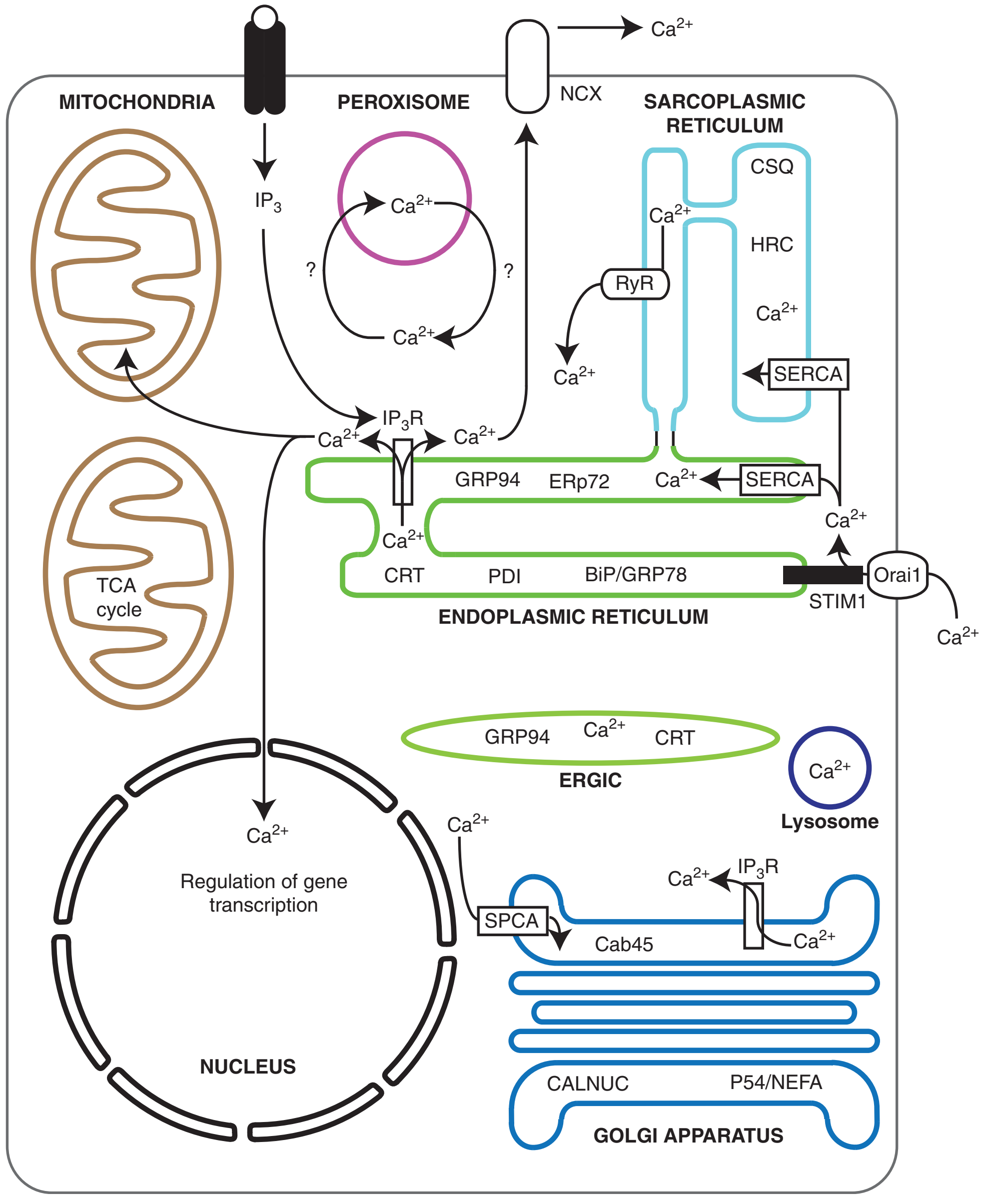
... a ... (T ... a. 2006). T ... ac c a ... ca ac ... c ca ... a Ca^{2+} a ... a ... a ... . O ... a ... a ... ca ... G^{112}+5X, a ac ... a ... ca a- b ... b Ca^{2+} (Ba ... a ... a. 2006) ... (T ... a. 2008). A ... a ... ca ac ca ... a c a ... CPVT, $R^{33}Q$, ... Ca^{2+} b ... b ... a ... ca ab ... b R R ... SR Ca^{2+} ... b ... a a ... (T ... a. 2006; T ... a. 2008). T $R^{33}Q$ ... a ... c a ... a ab ... (V ... a. 2008); b c ... a ... $L^{167}H$ ... c ... (V ... a. 2008). T $D^{307}H$ ... Ca^{2+} ... ca ... c ... a ... a ... b ... c ... ac ... R R c a (H ... a. 2004; V a c ... Ka ... a. 2004; Ka a a ... a ac ... a. 2009). F ... c a ... ca ... a c ... b ... Ca^{2+} b ... ac ... a ... c ... Ca^{2+} ... a ... a a. T c ... c b ... ac ... a 25% ... ca ... a ... SR Ca^{2+} ... b ... c a Ca^{2+} a ... a R R c a ... a ... ca ... R R (C ... a ... a. 2007).

A ... c ... ca ... (*Casq1*) a ... b ... (Pa ... a. 2007). T ab c ... ca ... -1 ... a a ... a ... a ... c ac ... (Pa ... a. 2007). Ab c ... ca ... c ... c Ca^{2+} ... a ... SR (b ca ... a Ca^{2+} ac ... a R R; a ... c ... b ... c a ... a c a) a ... c Ca^{2+} ... b SR (b ca ... a Ca^{2+} b ...) (Pa ... a. 2007). *Casq1* ... c a ... 20% ... SR Ca^{2+} ...

[illegible]

C 2+ B

[illegible]



F[illegible] 1. O[illegible] Ca2+ [illegible] Ca2+ [illegible] Ca2+ [illegible] (ER), ERGIC, [illegible] G[illegible] [illegible] A[illegible] Ca2+ [illegible] *top*: [illegible] IP_3 [illegible] IP_3R [illegible] ER [illegible] Ca^{2+} [illegible] ER [illegible] N[illegible] G[illegible] IP_3R [illegible] Ca^{2+} [illegible] G[illegible] Ca^{2+} [illegible] SPCA [illegible] A[illegible] *left*, Ca^{2+} [illegible] ER [illegible] ER [illegible] Ca^{2+} [illegible] Na^+/Ca^{2+} [illegible] P[illegible] Ca^{2+} [illegible] Ca^{2+} [illegible] ER, [illegible] SR, [illegible] ERGIC, [illegible] G[illegible] Ca^{2+} [illegible]. (*See facing page for legend.*)

. 2000). I a ca ac a Ca^{2+}-b (T . 2000); SR Ca^{2+} (D . 2007). I a Ca^{2+} ER, IP$_3$R a TRPC3 a) c a Ca^{2+} a , b a (T . 2004). I SR ca SERCA2a, Ca^{2+} a (K a K 2009). O a a Ca^{2+} a ca ac a a a (H . 2008).

G G C 2+ E

A ER a SR a acc a a Ca^{2+} b a a G a a a , c a, a , a a J a a Ca^{2+} ca a c a .

T G a a a a c a Ca^{2+} a a 1990 (C a a . 1994; P . 1997). G Ca^{2+} ca b a I P$_3$ a a a b b G a b ca a a Ca^{2+}- c ER (P . 1998). Ca^{2+} b G b ; Cab45, P54/NEFA, a CALNUC (b). c

Ca^{2+} b ca ab CALNUC a a a b Cab45 a 45-J Da Ca^{2+}-b EF- a a b a G (Sc . 1996), Cab45 a a a (La . 2007) a c b a c a c ca c (G b . 2006). P54/NEFA (DNA b /EF a /ac c a ac c) c a EF- a , b a a a a a Ca^{2+} b (M -H . 2002). A G Ca^{2+}-b CALNUC, ca a a c b a G a a (L . 1998). CALNUC c a EF- a Ca^{2+}, a ca ac , -a Ca^{2+} b (L . 1999). CALNUC ab a G (a 0.4% G), a a b c G Ca^{2+} (L . 1999). T a a a CALNUC Ca^{2+} a b a 6 7 μM (L . 1999; Ka . 2009). CALNUC c Ca^{2+} a Ca^{2+} a b c ac (A ba a T a a 2004). T ac ac a a a b a Ca^{2+} b a a Ca^{2+} (A ba a T a a 2004). CALNUC a b b c (La . 2002) a a a a b (P . 2004).

F . 1. (*Continued*) T a Ca^{2+} (SOC) . I ER Ca^{2+} , a ER Ca^{2+} , STIM1, a b a a O a 1. O a 1 a a a a a b a Ca^{2+} c a a Ca^{2+} ac a a b SERCA ER . B P/GRP78 b 78-J Da; CRT, ca ; ERGIC, a c /G c ; GRP94, 94-J Da; IP$_3$, ; IP$_3$R, c ; NCX, Na^+/Ca^{2+} c a ; P54/NEFA, DNA b /EF a /ac c a ac c ; PDI, a ; SERCA, a c a c/ a c Ca^{2+}-ATPa ; SPCA, c a Ca^{2+}- a ATPa ; STIM1, ac 1.

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[illegible]

[illegible]

[illegible]

C C

E a c c Ca^{2+} a a ac a a a a c b Ca^{2+} a c . T a c b c c ca ac a a a c Ca^{2+} a c ac . O c a ac c a a Ca^{2+} b c a c a Ca^{2+} b a Ca^{2+}, c . I a b a a Ca^{2+} ac a a , Ca^{2+}-b a b a a c a Ca^{2+} a a . I a b Ca^{2+} b , a ac c a ca a a Ca^{2+} b a c . F Ca^{2+} a a c Ca^{2+} c a a Ca^{2+} bc a a , a F 1.

AC EDG E

W ab b a Ca a a I H R a c H a (MOP-53050. MOP-15415, MOP-15291) a E A b a, A b a I H Sc c . D. P b Ca a a I H R a c F Ba a C a B Ca a a G a Sc a Ma A a a a A a A b a I H Sc c .

ABB E A ED

ER, a c ; IP_3, 1,4,5- ; IP_3R, -1,4,5- c ; PDI, a , R R, a c ; SERCA, a c a c/ a c Ca^{2+} ATPa ; SOCE, a Ca^{2+} ; SR, a c a c ; STIM1, a ac c -1.

EFE E CE

A NN, S Y, B J JL, H LM, I AE. 2005. T c a c a B P- a S c61 a c a c . *J Cell Biol* **168:** 389 399.

A a DA, Sa D, K J a F, Va a a E, Pa a V, K a -K a A, T a GN, Pa a J a IA, A a S, D GWII, a . 2008. T S 96A a a a c ca c b a c a a a a a c a ca . *Eur Heart J* **29:** 2514 2525.

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[redacted]

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