RAC1 GTPase cycle

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22/11/2021
Introduction

Reactome is open-source, open access, manually curated and peer-reviewed pathway database. Pathway annotations are authored by expert biologists, in collaboration with Reactome editorial staff and cross-referenced to many bioinformatics databases. A system of evidence tracking ensures that all assertions are backed up by the primary literature. Reactome is used by clinicians, geneticists, genomics researchers, and molecular biologists to interpret the results of high-throughput experimental studies, by bioinformaticians seeking to develop novel algorithms for mining knowledge from genomic studies, and by systems biologists building predictive models of normal and disease variant pathways.

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Literature references


Reactome database release: 78

This document contains 1 pathway and 6 reactions (see Table of Contents)
RAC1 GTPase cycle

Stable identifier: R-HSA-9013149

This pathway catalogues RAC1 guanine nucleotide exchange factors (GEFs), GTPase activator proteins (GAPs), GDP dissociation inhibitors (GDIs) and RAC1 effectors (reviewed by Payapilli and Malliri 2018). RAC1 is one of the three best characterized RHO GTPases, the other two being RHOA and CDC42. RAC1 regulates the cytoskeleton and the production of reactive oxygen species (ROS) (Acevedo and Gonzalez-Billault 2018) and is involved in cell adhesion and cell migration (Marei and Malliri 2017). RAC1 is involved in neuronal development (de Curtis et al. 2014). In neurons, RAC1 activity is regulated by synaptic activation and RAC1-mediated changes in actin cytoskeleton are implicated in dendritic spine morphogenesis, which plays a role in memory formation and learning (Tajeda-Simon 2015; Costa et al. 2020). RAC1 is involved in metabolic regulation of pancreatic islet β-cells and in diabetes pathophysiology (Kowluru 2017; Kowluru et al. 2020). RAC1-mediated activation of NOX2 contributes to mitochondrial damage and the development of retinopathy in patients with diabetes (Sahajpal et al. 2019). RAC1 is important for exercise and contraction-stimulated glucose uptake in skeletal muscles (Sylow et al. 2014). RAC1 plays an important role in the maintenance of intestinal barrier integrity under physiological conditions and during tissue repair after resolution of colitis. Toxins of many diarrhea-causing bacteria target RAC1 (Kotelevets and Chastre 2020). RAC1 is important for skin homeostasis and wound healing and is involved in the pathogenesis of psoriasis (Winge and Marinkovich 2019). RAC1 is essential to vascular homeostasis and chronically elevated RAC1 signaling contributes to vascular pathology (Marinkovic et al. 2015). RAC1 hyperactivation, mutation and copy-number gain are frequently observed in solid tumors (Zou et al. 2017; De et al. 2019; De et al. 2020; Cannon et al. 2020; Kotelevets and Chastre 2020).

Literature references


Lamprecht, R., Dines, M., Costa, JF. (2020). The Role of Rac GTPase in Dendritic Spine Morphogenesis and Memory. Front Synaptic Neurosci, 12, 12.

Editions

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RAC1 GEFs activate RAC1

**Location:** RAC1 GTPase cycle

**Stable identifier:** R-HSA-9013143

**Type:** transition

**Compartments:** cytosol, plasma membrane

The following guanine nucleotide exchange factors (GEFs) were shown to bind RAC1 and catalyze GDP to GTP exchange on RAC1, resulting in formation of the active RAC1:GTP complex (the high throughput study by Bagci et al. examined binding of GEFs to inactive RAC1 mutant without testing for RAC1-directed GEF activity and is cited as supporting evidence):

- FGD5 (Müller et al. 2020)
- GNA13 (Radhika et al. 2004)
- PLEKHG6 (Müller et al. 2020)
- PREX2 (Joseph and Norris 2005; Müller et al. 2020)
- RASGRF2 (Schwechter et al. 2013; Müller et al. 2020)
- SWAP70 (Shinohara et al. 2002; Gupta et al. 2003; Baranov et al. 2016; Bagci et al. 2020: binding to inactive RAC1)
- TIAM2 (Matsuo et al. 2002; Müller et al. 2020)
- TRIO (Debant et al. 1996; Moshfegh et al. 2014; Peurois et al. 2017; Jaiswal et al. 2013: RAC1-directed GEF activity of the N-terminal GEF1 domain of TRIO; Müller et al. 2020: RAC1-directed GEF activity of the full-length TRIO; Bagci et al. 2020: binding of full-length TRIO to inactive RAC1)
- VAV1 (Teramoto et al. 1997; Heo et al. 2005; Aghazadeh et al. 2000; Crespo et al. 1997; Müller et al. 2020)

The following GEFs were shown to bind and activate RAC1 in some but not all studies and are annotated as candidate RAC1 GEFs (or were shown, in the high throughput screen by Bagci et al. 2020, to bind to nucleotide free RAC1 mutant, as indicated):

ABR (Chuang et al. 1995: RAC1-directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)


ARHGEF4 (Itoh et al. 2008: RAC1 directed GEF activity; Anderson and Hamann 2012, Gotthardt and Ahmadian 2007, Jaiswal et al. 2013, Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF5 (Xie et al. 2005: RAC1 directed GEF activity; Wang et al. 2009, Müller et al. 2020: no RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1)

ARHGEF6 (Manser et al. 1998, Ramakers et al. 2012: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF7 (Ten Klooster et al. 2006, Manser et al. 1998: RAC1 directed GEF activity; Bagci et al. 2020: binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF10 (Müller et al. 2020: RAC1 directed GEF activity; Mohl et al. 2006: no RAC1 directed GEF activity)

ARHGEF11 (Bagci et al. 2020: binding to inactive RAC1; Rümenapp et al. 1999; Jaiswal et al. 2011; Jaiswal et al. 2013; Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF15 (Fukushima et al. 2016: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF18 (Niu et al. 2003: RAC1 directed GEF activity; Blomquist et al. 2000, Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF19 (Wang et al. 2004: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF25 (Guo et al. 2003: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)

ARHGEF39 (Zhou et al. 2018: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)

BCR (Chuang et al. 1995: RAC1 directed GEF activity; Bagci et al. 2020 binding to inactive RAC1; Korus et al. 2002, Müller et al. 2020: no RAC1 directed GEF activity)

DEF6 (Mavrakis et al. 2004: activation of RAC1, GEF activity of DEF6 has not been examined in vitro)

DOCK1 (Cote and Vuori 2002, Li et al. 2003: RAC1 directed GEF activity; Bagci et al. 2020: binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

DOCK2 (Kulkarni et al. 2011: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)

DOCK4 (Abraham et al. 2015: RAC1-directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)
DOCK5 (Omi et al. 2008, Vives et al. 2011, Ferrandez et al. 2017: RAC1 directed GEF activity; Bagci et al. 2020: binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

DOCK6 (Miyamoto et al. 2007: RAC1 directed GEF activity; Bagci et al. 2020: binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

DOCK7 (Kukimoto Niino et al. 2019, Yamauchi et al. 2008, Majewski et al. 2012, Zhou et al. 2013: RAC1 directed GEF activity; Bagci et al. 2020: binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

DOCK8 (Wang et al. 2015: RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

DOCK9 (Bagci et al. 2020: binding to inactive RAC1; Kulkarni et al. 2011, Müller et al. 2020: no RAC1 directed GEF activity)

DOCK10 (Ruiz Lafuente et al. 2015, Müller et al. 2020: RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1)

DOCK11 (Bagci et al. 2020: binding to inactive RAC1; Lin et al. 2006, Müller et al. 2020: no RAC1 directed GEF activity)

ECT2 (Tatsumoto et al. 1999: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1)

FARP1 (Cheadle and Biederer 2012: RAC1-directed GEF activity; Bagci et al. 2020: binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

FARP2 (Kubo et al. 2002: RAC1-directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity)

KALRN (Penzes et al. 2003, Wu et al. 2013: RAC1-directed GEF activity when using the N-terminal GEF1 domain of KALRN; Müller et al. 2020: no RAC1 directed GEF activity when using full-length KALRN)

MCF2 (Jaiswal et al. 2013, Müller et al. 2020: RAC1 directed GEF activity; Reuther et al. 2001: no RAC1 directed GEF activity)

MCF2L (Bagci et al. 2020: binding to inactive RAC1; Whitehead et al. 1999; Jaiswal et al. 2013; Müller et al. 2020: no RAC1 directed GEF activity)

NGEF (Zhang et al. 2007: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1)

PLEKHG1 (Abiko et al. 2015: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1)

PLEKHG2 (Ueda et al. 2008: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1)

PLEKHG3 (Nguyen et al. 2016: RAC1-directed GEF activity; Bagci et al. 2020: binding to inactive RAC1; Müller et al. 2020: no RAC1 directed GEF activity)

PLEKHG4 (Gupta et al. 2013: RAC1 directed GEF activity; Müller et al. 2020: no RAC1 directed GEF activity; Bagci et al. 2020: no binding to inactive RAC1)

SOS1 (Nimmual et al. 1998: RAC1 directed GEF activity; Itoh et al. 2008, Müller et al. 2020: no RAC1 directed GEF activity)
SOS2 (Nimnual et al. 1998: RAC1 directed GEF activity; Itoh et al. 2008, Müller et al. 2020: no RAC1 directed GEF activity)

SPATA13 (Kawasaki et al. 2007, Bristow et al. 2009: RAC1 directed GEF activity; Hamann et al. 2007, Müller et al. 2020: no RAC1 directed GEF activity)


The following GEFs do not act on RAC1 or were shown to not bind to nucleotide-free RAC1 in the study by Bagci et al. 2020, as indicated:

AKAP13 (Zheng et al. 1995; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

ARHGEF1 (Hart et al. 1996; Jaiswal et al. 2013; Jaiswal et al. 2011; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

ARHGEF2 (Krendel et al. 2002; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

ARHGEF3 (Arthur et al. 2002; Müller et al. 2020)

ARHGEF9 (Reid et al. 1999; Jaiswal et al. 2013; Müller et al. 2020)

ARHGEF10L (Winkler et al. 2005; Müller et al. 2020)

ARHGEF12 (Reuther et al. 2001; Jaiswal et al. 2013; Jaiswal et al. 2011; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

ARHGEF16 (Hiramoto Yamaki et al. 2010; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

ARHGEF17 (Rümenapp et al. 2002; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

ARHGEF26 (Ellerbroek et al. 2004; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)


ARHGEF40 (Curtis et al. 2004; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

DNMBP (Jaiswal et al. 2013; Müller et al. 2020; Bagci et al. 2020: no binding to inactive RAC1)

ECT2L (Müller et al. 2020)

FGD1 (Olson et al. 1996; Müller et al. 2020)

FGD2 (Huber et al. 2008; Müller et al. 2020)

FGD3 (Müller et al. 2020)

FGD4 (Umikawa et al. 1999; Müller et al. 2020)

FGD6 (Müller et al. 2020)

ITSN1 (Hussain et al. 2001; Jaiswal et al. 2013; Müller et al. 2020)

ITSN2 (Müller et al. 2020)
MCF2L2 (Müller et al. 2020)
NET1 (Alberts and Treisman 1998; Müller et al. 2020)
OBSCN (Ford Speelman et al. 2009)
PLEKHG4B (Müller et al. 2020)
PLEKHG5 (De Toledo et al. 2004; Müller et al. 2020)
PLEKHG7 (Müller et al. 2020)
RASGRF1 (Müller et al. 2020)

Followed by: RAC1 translocates to the endoplasmic reticulum membrane, RAC1 GAPs stimulate RAC1 GTPase activity, RAC1 binds effectors at the plasma membrane

Literature references


Editions

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**RAC1 GAPs stimulate RAC1 GTPase activity**

**Location:** RAC1 GTPase cycle

**Stable identifier:** R-HSA-9013144

**Type:** transition

**Compartments:** cytosol, plasma membrane

The following GTPase activating proteins (GAPs) were shown to bind RAC1 and stimulate its GTPase activity, resulting in GTP to GDP hydrolysis and conversion of the active RAC1:GTP complex into the inactive RAC1:GDP complex (the high throughput screen by Bagci et al. 2020 examined binding of GAPs to constitutively active RAC1 mutant without testing for activation of RAC1 GTPase activity and is cited as supporting evidence, as indicated):

ARHGAP4 (Vogt et al. 2007; Müller et al. 2020)

ARHGAP9 (Furukawa et al. 2001; Müller et al. 2020)

ARHGAP15 (Seoh et al. 2003; Zamboni et al. 2016; Müller et al. 2020)

ARHGAP20 (Müller et al. 2020)

ARHGAP22 (Mori et al. 2014; Müller et al. 2020)

ARHGAP23 (Martin Vilchez et al. 2017; Müller et al. 2020)

ARHGAP27 (Sakakibara et al. 2004; Müller et al. 2020)

ARHGAP30 (Naji et al. 2011; Müller et al. 2020)

ARHGAP31 (Tcherkezian et al. 2006; Müller et al. 2020; supported by Bagci et al. 2020)

ARHGAP39 (Lundström et al. 2004; Müller et al. 2020; supported by Bagci et al. 2020)

ARHGAP44 (Raynaud et al. 2014; Müller et al. 2020)

CHN1 (Ahmed et al. 1994; Caloca et al. 2008; Müller et al. 2020)

CHN2 (Canagarajah et al. 2004; Caloca et al. 2003; Müller et al. 2020)

FAM13A (Müller et al. 2020)
FAM13B (Müller et al. 2020)
HMHA1 (de Kreuk et al. 2013)
RALBP1 (Jullien Flores et al. 1995; Müller et al. 2020)
SH3BP1 (Müller et al. 2020)
SRGAP2 (Mason et al. 2011; Guo and Bao 2010; Müller et al. 2020; supported by Bagci et al. 2020)
SRGAP3 (Endris et al. 2002; Müller et al. 2020)
SYDE2 (Müller et al. 2020)
TAGAP (Bauer et al. 2005; Müller et al. 2020)

The following GAPs were shown to bind RAC1 and stimulate its GTPase activity in some but not all studies and are annotated as candidate RAC1 GAPs (the high throughput screen by Bagci et al. 2020 examined binding of GAPs to constitutively active RAC1 mutant without testing for activation of RAC1 GTPase activity and is cited as supporting evidence, as indicated):

ABR (Chuang et al. 1995, Um et al. 2014, Amin et al. 2016; Müller et al. 2020: RAC1 directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

ARAP1 (Müller et al. 2020: RAC1-directed GAP activity; Miura et al. 2002: no RAC1-directed GAP activity)

ARAP2 (Müller et al. 2020: RAC1 directed GAP activity; Bagci et al. 2020: binding to active RAC1; Yoon et al. 2006: no RAC1 directed GAP activity)

ARAP3 (Krugmann et al. 2002, Müller et al. 2020: RAC1 directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

ARHGAP1 (Amin et al. 2016: RAC1 directed GAP activity; Li et al. 2009, Yang et al. 2006, Müller et al. 2020: no RAC1 directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

ARHGAP5 (Burbelo et al. 1995: RAC1-directed GAP activity; Bagci et al. 2020: binding to active RAC1; Müller et al. 2020: no RAC1-directed GAP activity)

ARHGAP10 (Shibata et al. 2001: RAC1-directed GAP activity; Müller et al. 2020: no RAC1-directed GAP activity)

ARHGAP12 (Müller et al. 2020: RAC1-directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

ARHGAP17 (Richnau and Aspenstrom 2001, Amin et al. 2016: RAC1 directed GAP activity; Müller et al. 2020: no RAC1 directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

ARHGAP21 (Bagci et al. 2020: binding to active RAC1; Sousa et al. 2005, Müller et al. 2020: no RAC1 directed GAP activity)

ARHGAP24 (Lavelin and Geiger 2005, Ohta et al. 2006: RAC1 directed GAP activity; Su et al. 2004, Müller et al. 2020: no RAC1 directed GAP activity)

ARHGAP25 (Csépányi Kömi et al. 2016, Csépányi Kömi et al. 2012: RAC1-directed GTPase activity; Müller et al. 2020: no RAC1-directed GAP activity)

ARHGAP26 (Amin et al. 2016: RAC1 directed GAP activity; Sheffield et al. 1999, Müller et al. 2020: no RAC1 directed GAP activity)

ARHGAP29 (Saras et al. 1997: RAC1 directed GAP activity; Müller et al. 2020: no RAC1 directed GAP activ-
ity; Bagci et al. 2020: no binding to active RAC1)

ARHGAP32 (Nakazawa et al. 2003: RAC1-directed GAP activity; Bagci et al. 2020: binding to active RAC1; Müller et al. 2020: no RAC1-directed GAP activity)

ARHGAP33 (Müller et al. 2020: RAC1-directed GAP activity; Liu et al. 2006: no RAC1-directed GAP activity)

ARHGAP35 (Lévay et al. 2009, Amin et al. 2016, Müller et al. 2020: RAC1 directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

ARHGAP42 (Bagci et al. 2020: binding to active RAC1; Bai et al. 2013: no RAC1 directed GAP activity)

BCR (Um et al. 2014, Chuang et al. 1995, Müller et al. 2020: RAC1 directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

DEPDC1B (Wu et al. 2015: RAC1-directed GAP activity; Bagci et al. 2020: binding to active RAC1; Müller et al. 2020: no RAC1-directed GAP activity)

DLC1 (Amin et al. 2016: RAC1 directed GAP activity; Homma and Emori 1995, Müller et al. 2020: no RAC1 directed GAP activity)

GMIP (Müller et al. 2020: RAC1-directed GAP activity; Aresta et al. 2002: no RAC1-directed GAP activity)

MYO9B (Müller et al. 2020: RAC1-directed GAP activity; Post et al. 1998, Kong et al. 2015: no RAC1-directed GAP activity; Bagci et al. 2020: no binding to active RAC1)


PIK3R1 (Bagci et al. 2020: binding to active RAC1; Müller et al. 2020: no RAC1-directed GAP activity)

PIK3R2 (Bagci et al. 2020: binding to active RAC1; Müller et al. 2020: no RAC1-directed GAP activity)

RACGAP1 (Touré et al. 1998, Amin et al. 2016, Müller et al. 2020: RAC1 directed GAP activity; Bagci et al. 2020: no binding to active RAC1)

SRGAP1 (Müller et al. 2020: RAC1-directed GAP activity; Wong et al. 2001: no RAC1-directed GAP activity

The following GAPs do not act on RAC1 or were shown by Bagci et al. 2020 to not bind constitutively active RAC1 mutant, as indicated:

ARHGAP6 (Prakash et al. 2000; Müller et al. 2020)

ARHGAP8 (Lua and Low 2004; Müller et al. 2020)

ARHGAP11A (Lawson et al. 2016; Müller et al. 2020)

ARHGAP11B (Florio et al. 2015; Müller et al. 2020)

ARHGAP18 (Maeda et al. 2011; Müller et al. 2020)

ARHGAP19 (David et al. 2014; Müller et al. 2020)

ARHGAP28 (Yeung et al. 2014; Müller et al. 2020)

ARHGAP36 (Rack et al. 2014; Müller et al. 2020)

ARHGAP40 (Müller et al. 2020)

ARHGAP45 (Müller et al. 2020)
DEPDC1 (Müller et al. 2020)
INPP5B (Müller et al. 2020)
MYO9A (Müller et al. 2020; Bagci et al. 2020: no binding to active RAC1)
OCRL (Erdmann et al. 2007; Lichter Konecki et al. 2006; Müller et al. 2020; Bagci et al. 2020: no binding to active RAC1)
STARD8 (Kawai et al. 2007; Amin et al. 2016; Müller et al. 2020)
STARD13 (Ching et al. 2003; Amin et al. 2016; Müller et al. 2020)
SYDE1 (Müller et al. 2020; Bagci et al. 2020: no binding to active RAC1)

**Preceded by:** RAC1 GEFs activate RAC1

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https://reactome.org
RAC1 GDIs block activation of RAC1

Location: RAC1 GTPase cycle

Stable identifier: R-HSA-9013147

Type: binding

Compartments: plasma membrane, cytosol

The following GDP dissociation inhibitors (GDIs) bind to RAC1 and inhibit its activation:

ARHGDI A (Boulter et al. 2010; Gupta et al. 2013; Ando et al. 1992)


ARHGDI G does not act on RAC1 (Zalcman et al. 1996, Adra et al. 1997)

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https://reactome.org
RAC1 binds effectors at the plasma membrane

Location: RAC1 GTPase cycle

Stable identifier: R-HSA-9013145

Type: binding

Compartments: cytosol, plasma membrane

In its GTP bound active form, plasma membrane associated RAC1 binds to the following cytosolic and plasma membrane effectors:

BAIAP2 (Lewis Saravalli et al. 2013, Bagci et al. 2020)
CAV1 (Nethe et al. 2010, Bagci et al. 2020)
CDC42BPA (Schwarz et al. 2012)
CIT (Madaule et al. 1995)
CIT 3 (Di Cunto et al. 1998)
CYFIP1 (Schneck et al. 2003, Bagci et al. 2020)
FMNL1 (Yayoshi Yamamoto et al. 2000)
IQGAP1 (Kuroda et al. 1996, Pelikan Conchaudron et al. 2011)
IQGAP2 (Brill et al. 1996, Ozdemir et al. 2018)
IQGAP3 (Wang et al. 2007)
KIAA0355 (Bagci et al. 2020: interaction studied in detail)
NISCH (Reddig et al. 2005)
NOX1 complex (Cheng et al. 2006, Miyano et al. 2006, Kao et al. 2008)
NOX2 complex (Ushio Fukai et al. 2002)
NOX3 complex (Ueyama et al. 2006, Miyano and Sumimoto 2007, Kao et al. 2008)
PAK1 (Parrini et al. 2002)
PAK2 (Manser et al. 1994, Manser et al. 1995, Bagci et al. 2020)
PAK3 (Manser et al. 1995)
PAK4 (Abo et al. 1998, Bagci et al. 2020)

PAK5 (Dan et al. 2002)

PAK6 (Lee et al. 2002)

PARD6A (Qiu et al. 2000)

PI3K alpha (Bokoch et al. 1996, Murga et al. 2002)

PKN1 (Owen et al. 2003, Modha et al. 2008)

PKN2 (Zong et al. 1999)

PLD1 (Hammond et al. 1997)

PLD2 (Hiroyama and Exton 2005)

WAVE complex (Miki et al. 1998, Suetsugu et al. 2006, Bagci et al. 2020)

The following RAC1 effectors are annotated as candidate effectors either because of opposing finding reported in different studies or because they have only been reported in the high throughput screen by Bagci et al. 2020:

ABI1 (Bagci et al. 2020)

ABL2 (Bagci et al. 2020)

AMIGO2 (Bagci et al. 2020)

ARAP2 (Bagci et al. 2020)

BAIAP2L1 (Bagci et al. 2020)

BRK1 (Bagci et al. 2020)

CDC42 (Bagci et al. 2020)

CDC42EP1 (Bagci et al. 2020: binding to activated RAC1; Joberty et al. 1999: no binding to activated RAC1)

CDC42EP4 (Bagci et al. 2020: binding to activated RAC1; Joberty et al. 1999: no binding to activated RAC1)

DEPDC1B (Bagci et al. 2020)

DIAPH3 (Bagci et al. 2020)

EPHA2 (Bagci et al. 2020)

ERBIN (Bagci et al. 2020)

FERMT2 (Bagci et al. 2020)

GIT1 (Bagci et al. 2020)

GIT2 (Bagci et al. 2020)

ITGB1 (Bagci et al. 2020)

JAG1 (Bagci et al. 2020)

LAMTOR1 (Bagci et al. 2020)
MCAM (Bagci et al. 2020)
MPP7 (Bagci et al. 2020)
NCKAP1 (Bagci et al. 2020)
NHS (Bagci et al. 2020)
PLEKHG3 (Bagci et al. 2020)
PLEKHG4 (Bagci et al. 2020)
RAB7A (Bagci et al. 2020)
SLC1A5 (Bagci et al. 2020)
SNAP23 (Bagci et al. 2020)
SWAP70 (Bagci et al. 2020)
TAOK3 (Bagci et al. 2020)
TFRC (Bagci et al. 2020)
TMPO (Bagci et al. 2020)
VAMP3 (Bagci et al. 2020)
VANGL1 (Bagci et al. 2020)

WIP WASP complex (WAS, also known as WASP, a component of the WIP WASP complex, was reported to interact with active RAC1 by Aspenstrom et al. 1996 and Vastrik et al. 1999, but no interaction has been reported between RAC1 and WIP components of the complex, WIPF1, WIPF2 or WIPF3)

Active RAC1 does not bind the following RHO GTPase effectors:
ANKLE2 (Bagci et al. 2020)
ARFGAP3 (Bagci et al. 2020)
ARMCX3 (Bagci et al. 2020)
CDC42EP2 (Joberty et al. 1999)
CDC42EP3 (Joberty et al. 1999)
CDC42EP5 (Joberty et al. 1999)
DSG2 (Bagci et al. 2020)
DIAPH1 (Higashi et al. 2008)
DOCK1 (Bagci et al. 2020)
DOCK5 (Bagci et al. 2020)
ELMO2 (Bagci et al. 2020)
FMNL2 (Block et al. 2012)
HSPE1 (Bagci et al. 2020)
IL32 (Bagci et al. 2020)
LETM1 (Bagci et al. 2020)
LMAN1 (Bagci et al. 2020)
NDUFA5 (Bagci et al. 2020)
NDUFS3 (Bagci et al. 2020)
PGRMC2 (Bagci et al. 2020)
RAPGEF1 (Bagci et al. 2020)
ROCK1 (Leung et al. 1996)
ROCK2 (Leung et al. 1996)
RTKN (Reid et al. 1996)
SHMT2 (Bagci et al. 2020)
SLK (Yamada et al. 2000)
SLITRK3 (Bagci et al. 2020)
SLITRK5 (Bagci et al. 2020)
STBD1 (Bagci et al. 2020)
STX5 (Bagci et al. 2020)
VAPB (Bagci et al. 2020)

Preceded by: RAC1 GEFs activate RAC1

**Literature references**


**Editions**

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**RAC1 translocates to the endoplasmic reticulum membrane**

**Location:** RAC1 GTPase cycle

**Stable identifier:** R-HSA-9691168

**Type:** uncertain

**Compartments:** endoplasmic reticulum membrane, plasma membrane

RAC1 mainly localizes to the plasma membrane but it also localizes to endomembranes, such as endoplasmic reticulum (Michaelson et al. 2001).

**Preceded by:** RAC1 GEFs activate RAC1

**Followed by:** RAC1 binds effectors at the ER membrane

**Literature references**


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RAC1 binds effectors at the ER membrane

**Location:** RAC1 GTPase cycle

**Stable identifier:** R-HSA-9691174

**Type:** binding

**Compartments:** endoplasmic reticulum membrane

In its GTP bound active form, endoplasmic reticulum membrane associated RAC1 binds to and activates KTN1 (Hotta et al. 1996).

The following endoplasmic reticulum proteins have been identified as putative RAC1 effectors in the high throughput screen by Bagci et al. 2020 and are annotated as candidate RAC1 effectors:

- EMD (Bagci et al. 2020)
- ESYT1 (Bagci et al. 2020)
- LBR (Bagci et al. 2020)
- LEMD3 (Bagci et al. 2020)
- VRK2 (Bagci et al. 2020)
- YKT6 (Bagci et al. 2020)

**Preceded by:** RAC1 translocates to the endoplasmic reticulum membrane

**Literature references**


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