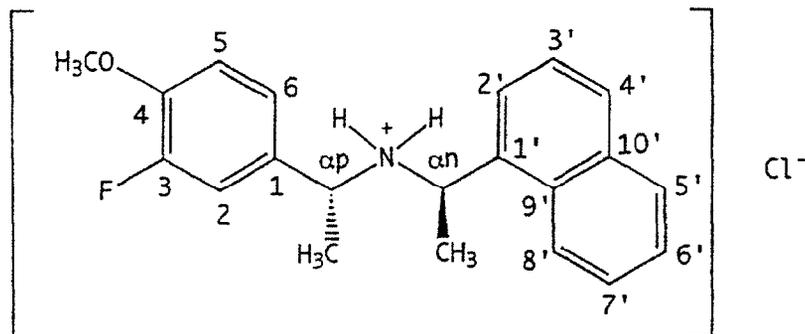


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VARIAN 75 MHz ^{13}C -NMR SPECTRAL ASSIGNMENT OF:

17 O HYDROCHLORIDE

NMR SPECTRA ARE OF THE HCl SALT IN CDCl_3 (60 mg/mL).

20.89	CH_3	aliph- CH_3
21.78	CH_3	arom- CH_3
51.26	CH	-CH-
56.12	CH_3	O- CH_3
56.19	CH	-CH-
113.44	CH	
116.27	CH	
116.52	CH	
121.31	CH	
124.39	CH	
124.43	CH	
125.24	CH	
125.97	CH	
126.03	CH	
126.45	CH	
128.35	Q	
128.43	Q	
128.98	CH	
129.10	CH	
130.05	Q	
132.45	Q	
133.61	Q	
147.96	Q	
148.10	Q	
150.26	Q	
153.55	Q	

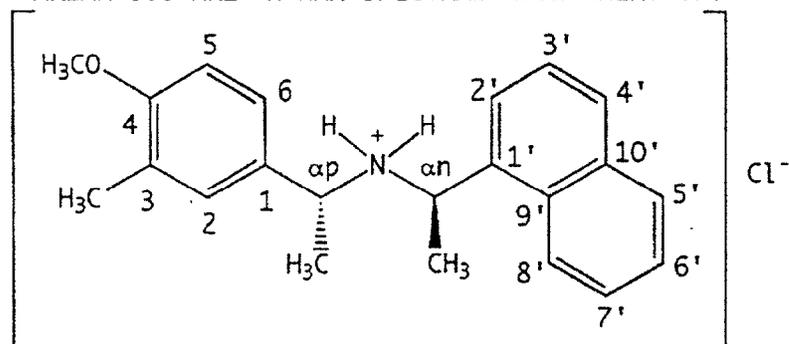
FIG. 122.

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VARIAN 300 MHz ^1H -NMR SPECTRAL ASSIGNMENT OF:

17P HYDROCHLORIDE

NMR SPECTRA ARE OF THE HCl SALT. RESONANCES FROM 0-10 PPM ARE IN 1% MeOD/ CDCl_3 (5 mg/mL). RESONANCES FROM 10-12 PPM ARE IN CDCl_3 (60 mg/mL).

# OF H's	δ (PPM)	MULTIPLICITY	COUPLING (Hz)	ASSIGNMENT
3H	1.82	d	J=6.7	phenyl- CH_3
3H	1.83	d	J=6.7	naphthyl- CH_3
3H	1.93	s	n.a.	arom- CH_3
3H	3.83	s	n.a.	- OCH_3
1H	3.90	q	J=6.9	phenyl-CH-
1H	4.74	q	J=7.0	naphthyl-CH-
1H	6.52	d	J=1.6	2
1H	6.70	d	J=8.5	5
1H	7.03	dd	$J_1=8.4, J_2=2.2$	6
1H	7.17	bd	J=9.2	8'
1H	7.34	dd	$J_1=J_2=8.4$	7'
1H	7.51	dd	$J_1=J_2=8.2$	6'
1H	7.68	dd	$J_1=J_2=7.9$	3'
1H	7.91	d	J=8.0	4' OR 5'
1H	7.92	d	J=7.8	4' OR 5'
1H	8.21	bd	J=6.6	2'
1H	8.65	bs	n.a.	aliph- NH_2^+
1H	10.58	bs	n.a.	aliph- NH_2^+

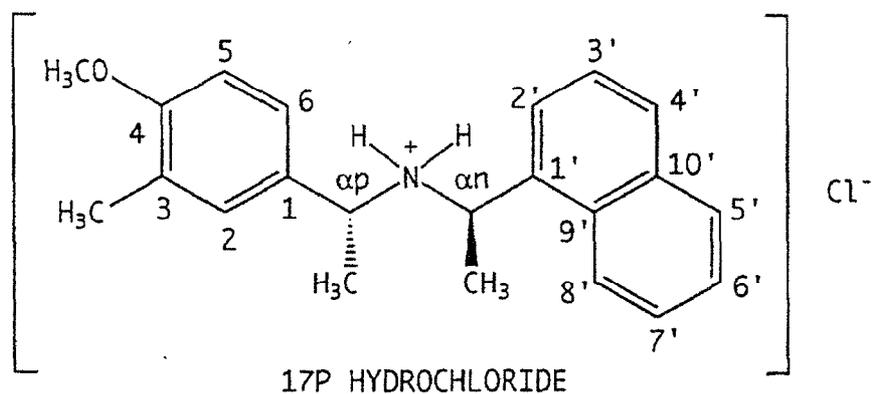
FIG. 123.

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VARIAN 75 MHz ^{13}C -NMR SPECTRAL ASSIGNMENT OF:NMR SPECTRA ARE OF THE HCl SALT IN CDCl_3 (60 mg/mL).

δ (PPM)	MULTIPLICITY	ASSIGNMENT
15.7	CH_3	arom- CH_3
20.5	CH_3	phenyl- CH_3
21.6	CH_3	naphthyl- CH_3
51.0	CH	naphthyl-CH-
55.2	CH_3	O- CH_3
56.3	CH	phenyl-CH-
110.2	CH	5
121.5	CH	8' OR 6'
124.8	CH	2'
125.8	CH	3' AND 6'
125.8	CH	3' AND 6'
126.3	CH	7'
126.5	CH	8' OR 6'
126.6	Q	
127.0	Q	
128.8	CH	4' OR 5'
129.0	CH	4' OR 5'
130.1	Q	
130.9	CH	2
132.6	Q	
133.6	Q	
158.1	Q	

FIG. 124.

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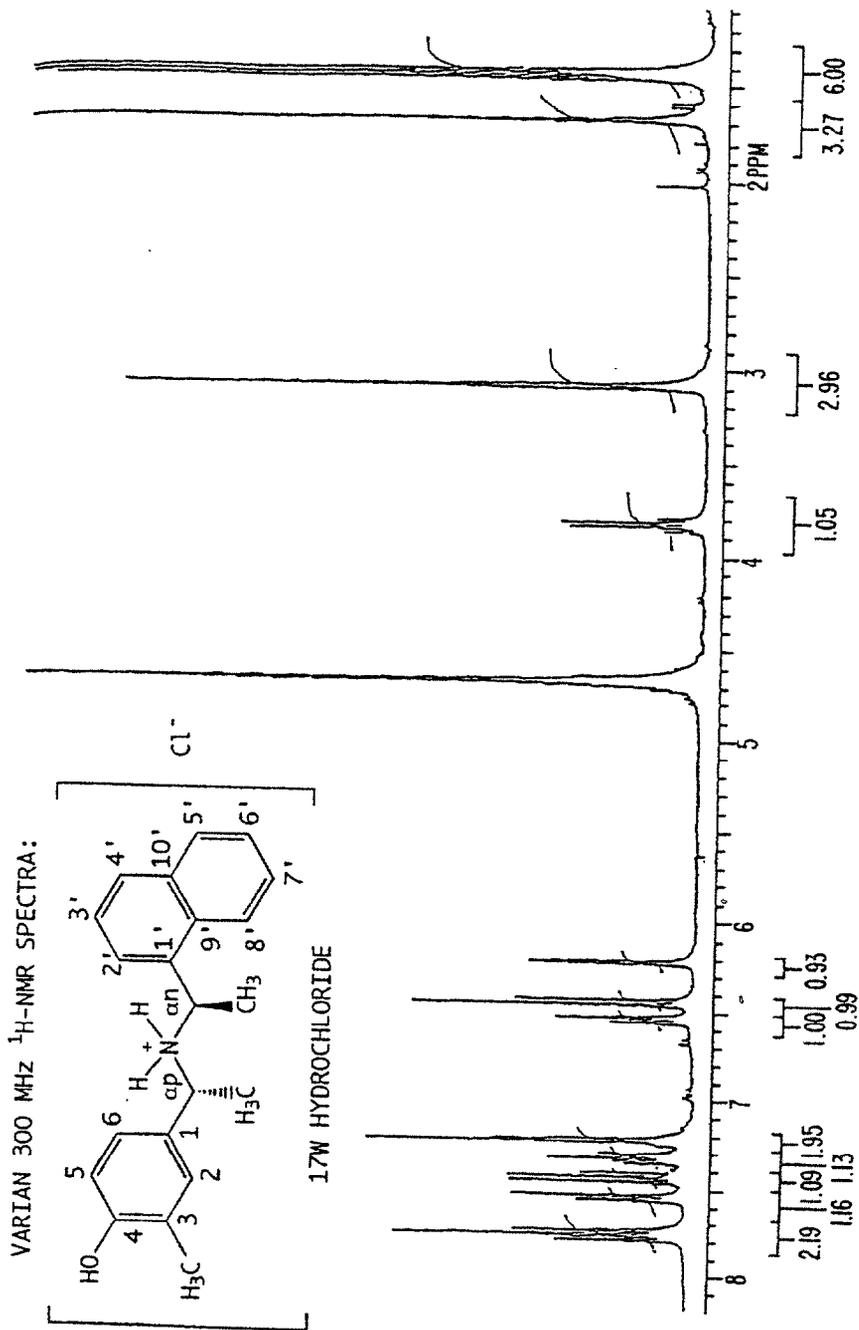


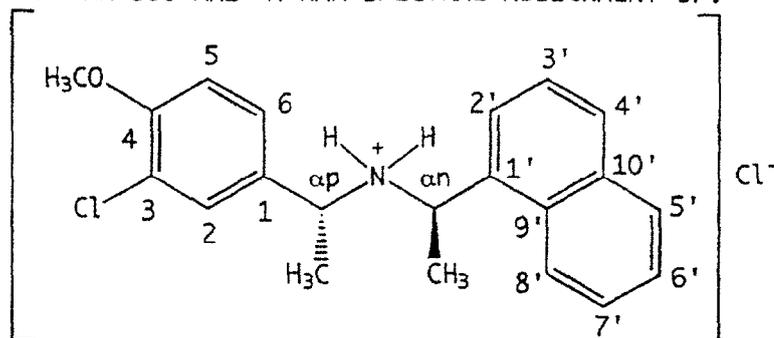
FIG. 125. NMR SPECTRA ARE OF THE HCl SALT. RESONANCES FROM 0-10 PPM ARE 1% MeOD/CDCl₃ (5 mg/mL). RESONANCES FROM 10-12 PPM IN CDCl₃ (60 mg/mL)

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VARIAN 300 MHz ^1H -NMR SPECTRAL ASSIGNMENT OF:

17X HYDROCHLORIDE

NMR SPECTRA ARE OF THE HCl SALT. RESONANCES FROM 0-10 PPM ARE IN 1% MeOD/ CDCl_3 (5 mg/mL). RESONANCES FROM 10-12 PPM ARE IN CDCl_3 (60 mg/mL).

# OF H's	δ (PPM)	MULTIPLICITY	COUPLING (Hz)	ASSIGNMENT
3H	1.86	d	J=7.0	phenyl- CHCH_3
3H	1.90	d	J=6.8	naphthyl- CHCH_3
3H	3.90	s	n.a.	- OCH_3
1H	3.91	q	J= \sim 6.4	phenyl- CHCH_3
1H	4.79	q	J=6.7	naphthyl- CHCH_3
1H	6.79	d	J=2.0	2
1H	6.84	d	J=8.5	5
1H	7.19	bd	J=7.6	8'
1H	7.26	dd	$J_1=8.4, J_2=1.7$	6
1H	7.38	dd	$J_1=J_2=7.0$	7'
1H	7.52	dd	$J_1=J_2=8.1$	6'
1H	7.69	dd	$J_1=J_2=8.1$	3'
1H	7.92	d	J=8.2	4' OR 5'
1H	7.94	d	J=8.1	4' OR 5'
1H	8.30	bd	J=5.0	2'
2H	10.72	vbs	n.a.	aliph- NH_2^+

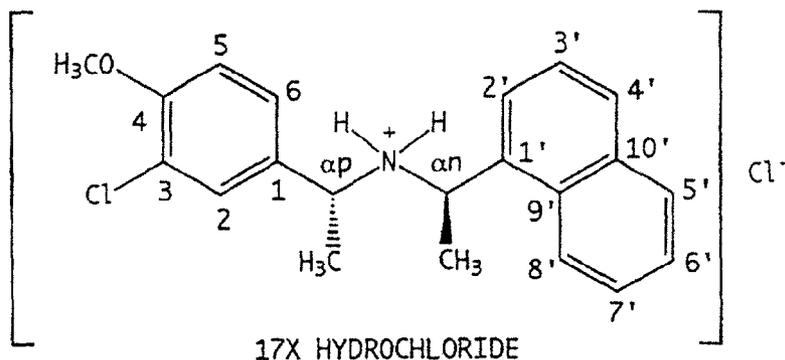
FIG. 126.

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VARIAN 75 MHz ^{13}C -NMR SPECTRAL ASSIGNMENT OF:NMR SPECTRA ARE OF THE HCl SALT IN $\text{CDCl}_3 + 1\% \text{ MeOD}$ (20 mg/mL).

δ (PPM)	MULTIPLICITY	ASSIGNMENT
20.6	CH_3	phenyl- CHCH_3
21.7	CH_3	naphthyl- CHCH_3
51.2	CH	naphthyl- CHCH_3
55.9	CH	phenyl- CHCH_3
56.2	CH_3	O- CH_3
112.4	CH	5
121.2	CH	8'
122.5	Q	
125.1	CH	2'
125.9	CH	3'
126.2	CH	6'
126.8	CH	6 OR 7'
127.6	CH	6 OR 7'
128.4	Q	
129.0	CH	4' OR 5'
129.3	CH	4' OR 5'
130.1	Q	
130.7	CH	2'
132.2	Q	
133.7	Q	
155.4	Q	3

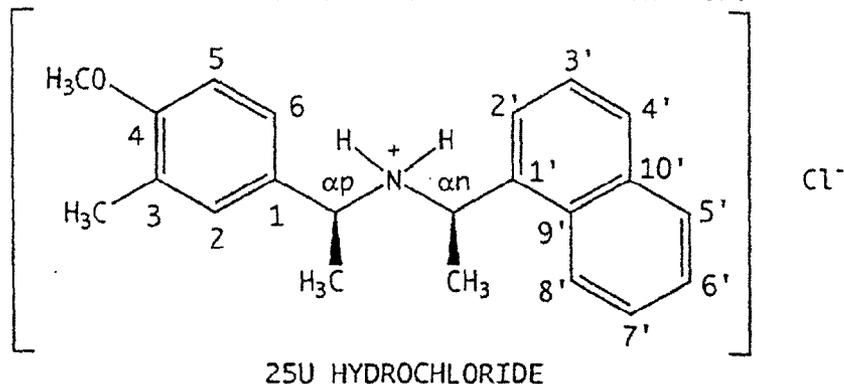
FIG. 127.

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VARIAN 300 MHz ^1H -NMR SPECTRAL ASSIGNMENT OF:

NMR SPECTRA ARE OF THE HCl SALT. RESONANCES FROM 0-10 PPM ARE IN 1% MeOD/ CDCl_3 (5 mg/mL). RESONANCES FROM 10-12 PPM ARE IN CDCl_3 (60 mg/mL).

# OF H's	δ (PPM)	MULTIPLICITY	COUPLING (Hz)	ASSIGNMENT
3H	1.74	d	J=6.7	aliph-CH ₃
3H	1.90	d	J=6.0	aliph-CH ₃
3H	2.23	s	n.a.	arom-CH ₃
3H	3.88	s	n.a.	-OCH ₃
1H	4.25	bq	J=7.3	-CH-
1H	4.90	bq	J=6.5	-CH-
1H	6.87	d	J=8.4	
1H	7.17	bs	n.a.	
1H?	7.20-7.27	m	n.a.	
2H?	7.35-7.46	m	n.a.	
1H	7.50	dd	J ₁ =J ₂ =8.1	
1H	7.59	dd	J ₁ =J ₂ =7.9	
1H	7.87	d	J=6.7	
1H	7.89	d	J=6.6	
1H	8.02	d	J=7.0	
1H	8.97	bs	n.a.	-NH ₂ ⁺⁻
1H	10.83	bs	n.a.	-NH ₂ ⁺⁻

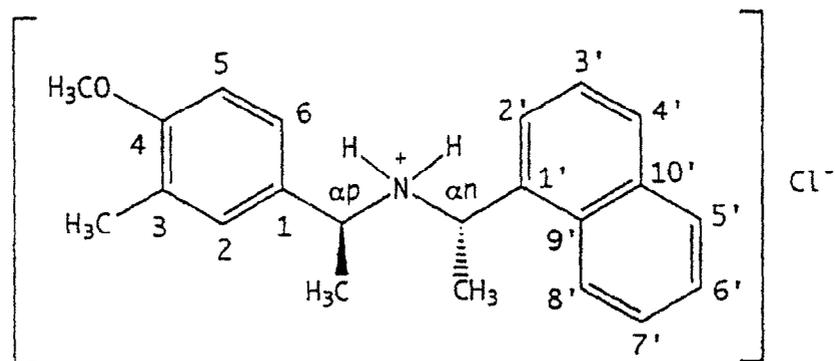
FIG. 128.

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9H	1.92	bs	n.a.	phenyl-CH ₃ naphthyl-CH ₃ arom-CH ₃
3H	3.83	s	n.a.	-OCH ₃
1H	3.95	bq	J=6.0	phenyl-CH-
1H	4.79	bq	J=5.5	naphthyl-CH-
1H	6.57	bs	n.a.	2
1H	6.71	d	J=8.2	5
2H	7.10-7.17	m	n.a.	
1H	7.30-7.35	m	n.a.	
1H	7.50	dd	J ₁ =J ₂ =7.7	6'
1H	7.70	dd	J ₁ =J ₂ =7.3	3'
1H	7.91	d	J=7.8	4' 5'
1H	7.92	d	J=8.0	4' 5'
1H	8.39	bd	J=2.8?	2'
1H	8.63	bs	n.a.	aliph-NH ₂ ⁺
1H	10.59	bs	n.a.	aliph-NH ₂ ⁺

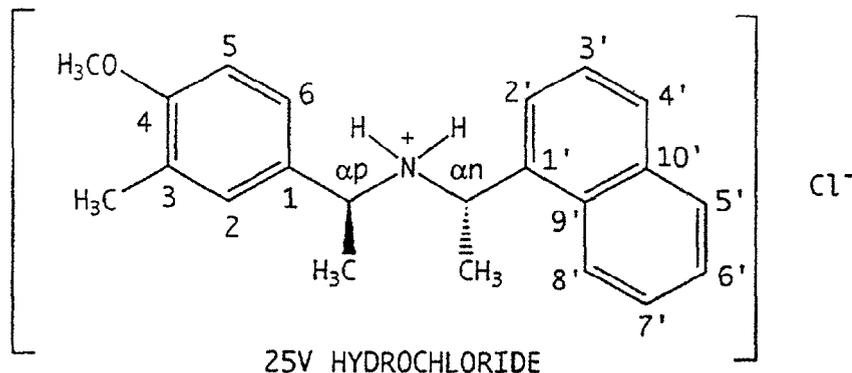
FIG. 129.

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VARIAN 75 MHz ^{13}C -NMR SPECTRAL ASSIGNMENT OF:NMR SPECTRA ARE OF THE HCL SALT IN $\text{CDCl}_3 + 1\% \text{MeOD}$ (20 mg/mL).

δ (PPM)	MULTIPLICITY	ASSIGNMENT
15.8	CH ₃	arom-CH ₃
20.97	CH ₃	aliph-CH ₃
22.0	CH ₃	aliph-CH ₃
51.2	CH	-CH-
55.4	CH ₃	-OCH ₃
56.6	CH	-CH-
110.3	?	
121.8	CH	
125.5	CH	
125.8	CH	
126.2	CH	
126.3	CH	
126.9	CH	
127.0	Q	
127.2	CH	
128.8	Q	
128.9	?	
130.3	Q	
131.2	CH	
133.0	Q	
133.7	Q	
158.1	Q	

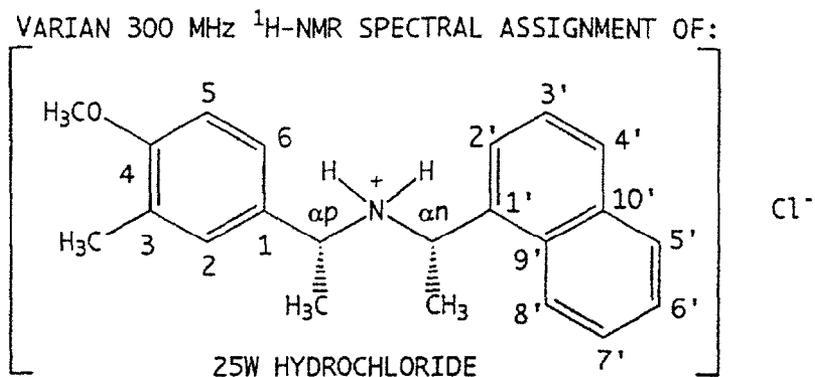
FIG. 130.

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NMR SPECTRA ARE OF THE HCl SALT. RESONANCES FROM 0-10 PPM ARE IN 1% MeOD/ CDCl_3 (5 mg/mL). RESONANCES FROM 10-12 PPM ARE IN CDCl_3 (60 mg/mL).

# OF H's	δ (PPM)	MULTIPLICITY	COUPLING (Hz)	ASSIGNMENT
3H	1.74	d	J=6.1	aliph-CH3
3H	1.89	d	J=6.0	aliph-CH3
3H	2.24	s	n.a.	arom-CH3
3H	3.89	s	n.a.	-OCH3
1H	4.27	bq	J=6.2	-CH-
1H	4.92	bq	J=5.1	-CH-
1H	6.89	d	J=7.7	
1H	7.18	bs	n.a.	
1H	7.26	bd	J=7.9	
2H?	7.36-7.47	m	n.a.	
1H	7.51	dd	J1=J2=7.6	
1H	7.61	dd	J1=J2=7.5	
1H	7.88	d	J=8.0	
1H	7.90	d	J=7.5	
1H	7.99	d	J=6.9	
1H	9.10	bs	n.a.	$-\text{NH}_2^+$
1H	10.67	bs	n.a.	$-\text{NH}_2^+$

FIG. 131.

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CALCIUM RECEPTOR-ACTIVE
COMPOUNDS

FIELD OF THE INVENTION

This invention relates to the design, development, composition and use of compounds able to modulate one or more inorganic ion receptor activities.

BACKGROUND OF THE INVENTION

Certain cells in the body respond not only to chemical signals, but also to ions such as extracellular calcium ions (Ca^{2+}). Changes in the concentration of extracellular Ca^{2+} (referred to herein as "[Ca^{2+}]") alter the functional responses of these cells. One such specialized cell is the parathyroid cell which secretes parathyroid hormone (PTH). PTH is the principal endocrine factor regulating Ca^{2+} homeostasis in the blood and extracellular fluids.

PTH, by acting on bone and kidney cells, increases the level of Ca^{2+} in the blood. This increase in [Ca^{2+}] then acts as a negative feedback signal, depressing PTH secretion. The reciprocal relationship between [Ca^{2+}] and PTH secretion forms the essential mechanism maintaining bodily Ca^{2+} homeostasis.

Extracellular Ca^{2+} acts directly on parathyroid cells to regulate PTH secretion. The existence of a parathyroid cell surface protein which detects changes in [Ca^{2+}] has been confirmed. Brown et al., 366 *Nature* 574, 1993. In parathyroid cells, this protein acts as a receptor for extracellular Ca^{2+} ("the calcium receptor"), and detects changes in [Ca^{2+}] and to initiate a functional cellular response, PTH secretion.

Extracellular Ca^{2+} can exert effects on different cell functions, reviewed in Nemeth et al., 11 *Cell Calcium* 319, 1990. The role of extracellular Ca^{2+} in parafollicular (C-cells) and parathyroid cells is discussed in Nemeth, 11 *Cell Calcium* 323, 1990. These cells have been shown to express similar Ca^{2+} receptor. Brown et al., 366 *Nature* 574, 1993; Mithal et al., 9 Suppl. 1 *J. Bone and Mineral Res.* s282, 1994; Rogers et al., 9 Suppl. 1 *J. Bone and Mineral Res.* s409, 1994; Garrett et al., 9 Suppl. 1 *J. Bone and Mineral Res.* s409, 1994. The role of extracellular Ca^{2+} on bone osteoclasts is discussed by Zaidi, 10 *Bioscience Reports* 493, 1990. In addition keratinocytes, juxtaglomerular cells, trophoblasts, pancreatic beta cells and fat/adipose cells all respond to increases in extracellular calcium which likely reflects activation of calcium receptors of these cells.

The ability of various compounds to mimic extra-cellular Ca^{2+} in vitro is discussed by Nemeth et al., (spermine and spermidine) in "Calcium-Binding Proteins in Health and Disease," 1987, Academic Press, Inc., pp. 33-35; Brown et al., (e.g., neomycin) 128 *Endocrinology* 3047, 1991; Chen et al., (diltiazem and its analog, TA-3090) 5 *J. Bone and Mineral Res.* 581, 1990; and Zaidi et al., (verapamil) 167 *Biochem. Biophys. Res. Commun.* 807, 1990. Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959, and Nemeth et al., PCT/US92/07175, International Publication Number WO 93/04373, describe various compounds which can modulate the effect of an inorganic ion on a cell having an inorganic ion receptor.

The references provided in the background are not admitted to be prior art.

SUMMARY OF THE INVENTION

The present invention features compounds able to modulate one or more activities of an inorganic ion receptor and methods for treating diseases or disorders by modulating

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inorganic ion receptor activity. Preferred compounds can mimic or block the effect of extracellular calcium on a cell surface calcium receptor.

Diseases or disorders which can be treated by modulating inorganic ion receptor activity include one or more of the following types: (1) those characterized by abnormal inorganic ion homeostasis, preferably calcium homeostasis; (2) those characterized by an abnormal amount of an extracellular or intracellular messenger whose production can be affected by inorganic ion receptor activity, preferably calcium receptor activity; (3) those characterized by an abnormal effect (e.g., a different effect in kind or magnitude) of an intracellular or extracellular messenger which can itself be ameliorated by inorganic ion receptor activity, preferably calcium receptor activity; and (4) other diseases or disorders in which modulation of inorganic ion receptor activity, preferably calcium receptor activity will exert a beneficial effect, for example, in diseases or disorders where the production of an intracellular or extracellular messenger stimulated by receptor activity compensates for an abnormal amount of a different messenger. Examples of extracellular messengers whose secretion and/or effect can be affected by modulating inorganic ion receptor activity include inorganic ions, hormones, neurotransmitters, growth factors, and chemokines. Examples of intracellular messengers include cAMP, cGMP, IP3, and diacylglycerol.

Thus, a compound of this invention preferably modulates calcium receptor activity and is used in the treatment of diseases or disorders which can be affected by modulating one or more activities of a calcium receptor. Calcium receptor proteins enable certain specialized cells to respond to changes in extracellular Ca^{2+} concentration. For example, extracellular Ca^{2+} inhibits the secretion of parathyroid hormone from parathyroid cells, inhibits bone resorption by osteoclasts, and stimulates secretion of calcitonin from C-cells.

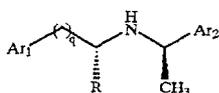
In a preferred embodiment, the compound is used to treat a disease or disorder characterized by abnormal bone and mineral homeostasis, more preferably calcium homeostasis. Extracellular Ca^{2+} is under tight homeostatic control and controls various processes such as blood clotting, nerve and muscle excitability, and proper bone formation. Abnormal calcium homeostasis is characterized by one or more of the following activities: (1) an abnormal increase or decrease in serum calcium; (2) an abnormal increase or decrease in urinary excretion of calcium; (3) an abnormal increase or decrease in bone calcium levels, for example, as assessed by bone mineral density measurements; (4) an abnormal absorption of dietary calcium; (5) an abnormal increase or decrease in the production and/or release of messengers which affect serum calcium levels such as parathyroid hormone and calcitonin; and (6) an abnormal change in the response elicited by messengers which affect serum calcium levels. The abnormal increase or decrease in these different aspects of calcium homeostasis is relative to that occurring in the general population and is generally associated with a disease or disorder.

Diseases and disorders characterized by abnormal calcium homeostasis can be due to different cellular defects such as a defective calcium receptor activity, a defective number of calcium receptors, or a defective intracellular protein acted on by a calcium receptor. For example, in parathyroid cells, the calcium receptor is coupled to the G_i protein which in turn inhibits cyclic AMP production. Defects in G_i protein can affect its ability to inhibit cyclic AMP production.

Thus, a first aspect the invention features an inorganic ion receptor modulating compound having the formula:

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STRUCTURE I



where Ar₁ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy, N(CH₃)₂, phenyl, phenoxy, benzyl, benzyloxy, α,α-dimethylbenzyl, NO₂, CHO, CH₃CH(OH), acetyl, ethylene dioxy;

Ar₂ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, and acetoxy;

q is 0, 1, 2, or 3; and

R is either H, or lower alkyl;

and pharmaceutically salts and complexes thereof.

Compounds of this invention have preferred stereochemistry. The CH₃ shown in Structure I is at a chiral center and provides an a-(R)-methyl structure. When R is CH₃, the R shown in Structure I is also at chiral center which provides an (R)-methyl structure. Thus, when R is CH₃, the Structure I compound has (R,R) stereochemistry.

Inorganic ion receptor activities are those processes brought about as a result of inorganic ion receptor activation. Such processes include the production of molecules which can act as intracellular or extracellular messengers.

Inorganic ion receptor-modulating compound include ionomimetics, ionolytics, calcimimetics, and calcilytics. Ionomimetics are compounds which bind to an inorganic ion receptor and mimic (i.e., evoke or potentiate) the effects of an inorganic ion at an inorganic ion receptor. Preferably, the compound affects one or more calcium receptor activities. Calcimimetics are ionomimetics which effects one or more calcium receptor activities and bind to a calcium receptor.

Ionolytics are compounds which bind to an inorganic ion receptor and block (i.e., inhibit or diminish) one or more activities caused by an inorganic ion at an inorganic ion receptor. Preferably, the compound affects one or more calcium receptor activities. Calcilytics are ionolytics which block one or more calcium receptor activities evoked by extracellular calcium and bind to a calcium receptor.

Ionomimetics and ionolytics may bind at the same receptor site as the native inorganic ion ligand binds or can bind at a different site (e.g., allosteric site). For example, NPS R-467 binding to a calcium receptor results in calcium receptor activity and, thus, NPS R-467 is classified as a calcimimetic. However, NPS R-467 binds to the calcium receptor at a different site (i.e., an allosteric site) than extracellular calcium.

A measure of a compounds effectiveness can be determined by calculating the EC₅₀ or IC₅₀ for that compound. The EC₅₀ is the concentration of a compound which causes a half maximal mimicking effect. The IC₅₀ is the concentration of compound which causes a half-maximal blocking effect. EC₅₀ and IC₅₀ for compounds at a calcium receptor can be determined by assaying one or more of the activities of extracellular calcium at a calcium receptor. Examples of assays for measuring EC₅₀, and IC₅₀ are described Nemeth

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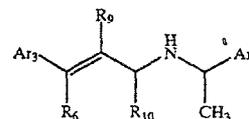
et al., PCT/US93/01642, International Publication Number WO 94/18959, and Nemeth et al., PCT/US92/07175, International Publication Number WO 93/04373, (both of these publications are hereby incorporated by reference here) and below. Such assays include oocyte expression assays and measuring increases in intracellular calcium ion concentration ([Ca²⁺]_i) due to calcium receptor activity. Preferably, such assays measure the release or inhibition of a particular hormone associated with activity of a calcium receptor.

An inorganic ion receptor-modulating compound preferably selectively targets inorganic ion receptor activity in a particular cell. For example, selective targeting of a calcium receptor activity is achieved by a compound exerting a greater effect on a calcium receptor activity in one cell type than at another cell type for a given concentration of compound. Preferably, the differential effect is 10-fold or greater as measured in vivo or in vitro. More preferably, the differential effect is measured in vivo and the compound concentration is measured as the plasma concentration or extracellular fluid concentration and the measured effect is the production of extracellular messengers such as plasma calcitonin, parathyroid hormone, or plasma calcium. For example, in a preferred embodiment, the compound selectively targets PTH secretion over calcitonin secretion.

Preferably, the compound is either a calcimimetic or calcilytic having an EC₅₀ or IC₅₀ at a calcium receptor of less than or equal to 5 μM, and even more preferably less than or equal to 1 μM, 100 nmolar, 10 nmolar, or 1 nmolar using one of the assays described below. More preferably, the assay measures intracellular Ca²⁺ in HEK 293 cells transformed with nucleic acid expressing the human parathyroid calcium receptor and loaded with fura-2. Lower EC₅₀'s or IC₅₀'s are advantageous since they allow lower concentrations of compounds to be used in vivo or in vitro. The discovery of compounds with low EC₅₀'s and IC₅₀'s enables the design and synthesis of additional compounds having similar or improved potency, effectiveness, and/or selectivity.

Another aspect of the present invention features an inorganic ion receptor modulating compound having the formula:

STRUCTURE II



where Ar₃ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy, benzyl, benzyloxy, α,α-dimethylbenzyl, NO₂, CHO, CH₃CH(OH), N(CH₃)₂, acetyl, ethylene dioxy.

Ar₄ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, and acetoxy;

R₈ is either hydrogen or phenyl;

R₉ is either hydrogen or methyl; and

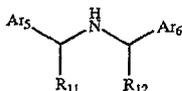
R₁₀ is either hydrogen, methyl, or phenyl; or pharmaceutically acceptable salts and complexes thereof.

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Another aspect of the present invention features an inorganic ion receptor modulating compound having the formula:

STRUCTURE III



where Ar_5 is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, acetoxy, benzyl, benzyloxy, α, α -dimethylbenzyl, NO_2 , CHO, $CH_3CH(OH)$, acetyl, ethylene dioxy, $-CH=CH-$ phenyl;

Ar_6 is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, acetyl, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, carbomethoxy, $OCH_2C(O)C_2H_5$ and acetoxy;

R_{11} is hydrogen or methyl; and

R_{12} is hydrogen or methyl.

Another aspect of the present invention features a pharmaceutical composition made up of an inorganic ion receptor-modulating compound described herein and a physiologically acceptable carrier. A "pharmacological composition" refers to a composition in a form suitable for administration into a mammal, preferably a human. Preferably, the pharmaceutical composition contains a sufficient amount of a calcium receptor modulating compound in a proper pharmaceutical form to exert a therapeutic effect on a human.

Considerations concerning forms suitable for administration are known in the art and include toxic effects, solubility, route of administration, and maintaining activity. For example, pharmacological compositions injected into the blood stream should be soluble.

Pharmaceutical compositions can also be formulated as pharmaceutically acceptable salts (e.g., acid addition salts) and complexes thereof. The preparation of such salts can facilitate the pharmacological use of a compound by altering its physical characteristics without preventing it from exerting a physiological effect.

Another aspect the present invention features a method for treating a patient by modulating inorganic ion receptor activity using inorganic ion receptor modulating compounds described herein. The method involves administering to the patient a pharmaceutical composition containing a therapeutically effective amount of an inorganic ion receptor-modulating compound. In a preferred embodiment, the disease or disorder is treated by modulating calcium receptor activity by administering to the patient a therapeutically effective amount of a calcium receptor-modulating compound.

Inorganic ion receptor-modulating compounds, and compositions containing the compounds, can be used to treat patients. A "patient" refers to a mammal in which modulation of an inorganic ion receptor will have a beneficial effect. Patients in need of treatment involving modulation of inorganic ion receptors can be identified using standard techniques known to those in the medical profession.

Preferably, a patient is a human having a disease or disorder characterized by one more of the following: (1)

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abnormal inorganic ion homeostasis, more preferably abnormal calcium homeostasis; (2) an abnormal level of a messenger whose production or secretion is affected by inorganic ion receptor activity, more preferably affected by calcium receptor activity; and (3) an abnormal level or activity of a messenger whose function is affected by inorganic ion receptor activity, more preferably affected by calcium receptor activity.

Diseases characterized by abnormal calcium homeostasis include hyperparathyroidism, osteoporosis and other bone and mineral-related disorders, and the like (as described, e.g., in standard medical text books, such as "Harrison's Principles of Internal Medicine"). Such diseases are treated using calcium receptor-modulating compounds which mimic or block one or more of the effects of extracellular Ca^{2+} on a calcium receptor and, thereby, directly or indirectly affect the levels of proteins or other compounds in the body of the patient.

By "therapeutically effective amount" is meant an amount of a compound which relieves to some extent one or more symptoms of the disease or disorder in the patient; or returns to normal either partially or completely one or more physiological or biochemical parameters associated with or causative of the disease or disorder.

In a preferred embodiment, the patient has a disease or disorder characterized by an abnormal level of one or more calcium receptor-regulated components and the compound is active on a calcium receptor of a cell selected from the group consisting of: parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune cell, GI tract cell, skin cell, adrenal cell, pituitary cell, hypothalamic cell and cell of the subfornical organ.

More preferably, the cells are chosen from the group consisting of: parathyroid cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting duct in the kidney, parafollicular cell in the thyroid (C-cell), intestinal cell, GI tract cell, pituitary cell, hypothalamic cell and cell of the subfornical organ.

In a preferred embodiment, the compound is a calcimimetic acting on a parathyroid cell calcium receptor and reduces the level of parathyroid hormone in the serum of the patient. More preferably, the level is reduced to a degree sufficient to cause a decrease in plasma Ca^{2+} . Most preferably, the parathyroid hormone level is reduced to that present in a normal individual.

In another preferred embodiment, the compound is a calcilytic acting on a parathyroid cell calcium receptor and increases the level of parathyroid hormone in the serum of the patient. More preferably, the level is increased to a degree sufficient to cause an increase in bone mineral density of a patient.

Patients in need of such treatments can be identified by standard medical techniques, such as blood or urine analysis. For example, by detecting a deficiency of protein whose production or secretion is affected by changes in inorganic ion concentrations, or by detecting abnormal levels of inorganic ions or hormones which effect inorganic ion homeostasis.

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Various examples are used throughout the application. These examples are not intended in any way to limit the invention.

Other features and advantages of the invention will be apparent from the following figures, detailed description of the invention, examples, and the claims.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. 1a-1r, show the chemical structures of different compounds.

FIGS. 2-131 provided physical data for representative compounds herein described.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention features compounds able to modulate one or more inorganic ion receptor activities, preferably the compound can mimic or block an effect of an extracellular ion on a cell having an inorganic ion receptor, more preferably the extracellular ion is Ca^{2+} and the effect is on a cell having a calcium receptor. Publications concerned with the calcium activity, calcium receptor and/or calcium receptor modulating compounds include the following: Brown et al., *Nature* 366: 574, 1993; Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959; Nemeth et al., PCT/US92/07175, International Publication Number WO 93/04373; Shoback and Chen, *J. Bone Mineral Res.* 9: 293 (1994); and Racke et al., *FEBS Lett.* 333: 132, (1993). These publications are not admitted to be prior art to the claimed invention.

I. CALCIUM RECEPTORS

Calcium receptors are present on different cell types and can have different activities in different cell types. The pharmacological effects of the following cells, in response to calcium, is consistent with the presence of a calcium receptor: parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune cell, GI tract cell, skin cell, adrenal cell, pituitary cell, hypothalamic cell and cell of the subfornical organ. In addition, the presence of calcium receptors on parathyroid cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting duct in the kidney, parafollicular cell in the thyroid (C-cell), intestinal cell, GI tract cell, pituitary cell, hypothalamic cell and cell of the subfornical organ, has been confirmed by physical data.

The calcium receptor on these different cell types may be different. It is also possible that a cell can have more than one type of calcium receptor. Comparison of calcium receptor activities and amino acid sequences from different cells indicate that distinct calcium receptor types exist. For example, calcium receptors can respond to a variety of di- and trivalent cations. The parathyroid calcium receptor responds to calcium and Gd^{3+} , while osteoclasts respond to divalent cations such as calcium, but do not respond to Gd^{3+} . Thus, the parathyroid calcium receptor is pharmacologically distinct from the calcium receptor on the osteoclast.

On the other hand, the nucleic acid sequences encoding calcium receptors present in parathyroid cells and C-cells

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indicate that these receptors have a very similar amino acid structure. Nevertheless, calcimimetic compounds exhibit differential pharmacology and regulate different activities at parathyroid cells and C-cells. Thus, pharmacological properties of calcium receptors may vary significantly depending upon the cell type or organ in which they are expressed even though the calcium receptors may have similar or even identical structures.

Calcium receptors, in general, have a low affinity for extracellular Ca^{2+} (apparent K_d generally greater than about 0.5 mM). Calcium receptors may include a free or bound effector mechanism as defined by Cooper, Bloom and Roth, "The Biochemical Basis of Neuropharmacology", Ch. 4, and are thus distinct from intracellular calcium receptors, e.g., calmodulin and the troponins.

Calcium receptors respond to changes in extracellular calcium levels. The exact changes depend on the particular receptor and cell line containing the receptor. For example, the *in vitro* effect of calcium on the calcium receptor in a parathyroid cell includes the following:

1. An increase in internal calcium. The increase is due to the influx of external calcium and/or to mobilization of internal calcium. Characteristics of the increase in internal calcium include the following:

(a) A rapid (time to peak <5 seconds) and transient increase in $[Ca^{2+}]_i$ that is refractory to inhibition by 1 μM La^{3+} or 1 μM Gd^{3+} and is abolished by pretreatment with ionomycin (in the absence of extracellular Ca^{2+});

(b) The increase is not inhibited by dihydropyridines;

(c) The transient increase is abolished by pretreatment for 10 minutes with 10 mM sodium fluoride;

(d) The transient increase is diminished by pretreatment with an activator of protein kinase C (PKC), such as phorbol myristate acetate (PMA), mezerein or (-)-indolactam V. The overall effect of the protein kinase C activator is to shift the concentration-response curve of calcium to the right without affecting the maximal response; and

(e) Pretreatment with pertussis toxin (100 ng/ml for >4 hours) does not affect the increase.

2. A rapid (<30 seconds) increase in the formation of inositol-1,4,5-triphosphate or diacylglycerol. Pretreatment with pertussis toxin (100 ng/ml for >4 hours) does not affect this increase;

3. The inhibition of dopamine- and isoproterenol-stimulated cyclic AMP formation. This effect is blocked by pretreatment with pertussis toxin (100 ng/ml for >4 hours); and

4. The inhibition of PTH secretion. Pretreatment with pertussis toxin (100 ng/ml for >4 hours) does not affect the inhibition in PTH secretion.

Using techniques known in the art, the effect of calcium on other calcium receptors in different cells can be readily determined. Such effects may be similar in regard to the increase in internal calcium observed in parathyroid cells. However, the effect is expected to differ in other aspects, such as causing or inhibiting the release of a hormone other than parathyroid hormone.

II. INORGANIC ION RECEPTOR MODULATING COMPOUNDS

Inorganic ion receptor modulating compounds modulate one or more inorganic ion receptor activities. Preferred calcium receptor modulating compounds are calcimimetics and calcilytics. Inorganic ion receptor modulating compounds can be identified by screening compounds which are

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modelled after a compound shown to have a particular activity (i.e., a lead compound).

A preferred method of measuring calcium receptor activity is to measure changes in $[Ca^{2+}]_i$. Changes in $[Ca^{2+}]_i$ can be measured using different techniques such as by using HEK 293 cells transfected with nucleic acid expressing the human parathyroid calcium receptor and loaded with fura-2; and by measuring an increase in Cl^- current in a *Xenopus* oocyte injected with nucleic acid coding for a calcium receptor. (See Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959.) For example, poly(A)⁺ mRNA can be obtained from cells expressing a calcium receptor, such as a parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, central nervous cell, peripheral nervous system cell, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune cell, and GI tract cell. Preferably, the nucleic acid is from a parathyroid cell, C-cell, or osteoclast. More preferably, the nucleic acid encodes a calcium receptor and is present on a plasmid or vector.

In preferred embodiments the calcium receptor modulating compound is a calcimimetic which inhibits bone resorption *in vivo* by an osteoclast; inhibits bone resorption *in vitro* by an osteoclast; stimulates calcitonin secretion *in vitro* or *in vivo* from a c-cell; inhibits parathyroid hormone secretion from a parathyroid cell *in vitro* and decreases PTH secretion *in vivo*; elevates calcitonin levels *in vivo*; or blocks osteoclastic bone resorption *in vitro* and inhibits bone resorption *in vivo*.

In another preferred embodiment the calcium receptor modulating compound is a calcilytic which evokes the secretion of parathyroid hormone from parathyroid cells *in vitro* and elevates the level of parathyroid hormone *in vivo*.

Preferably, the compound selectively targets inorganic ion receptor activity, more preferably calcium receptor activity, in a particular cell. By "selectively" is meant that the compound exerts a greater effect on inorganic ion receptor activity in one cell type than at another cell type for a given concentration of compound. Preferably, the differential effect is 10-fold or greater. Preferably, the concentration refers to blood plasma concentration and the measured effect is the production of extracellular messengers such as plasma calcitonin, parathyroid hormone or plasma calcium. For example, in a preferred embodiment, the compound selectively targets PTH secretion over calcitonin secretion.

In another preferred embodiment, the compound has an EC_{50} or IC_{50} less than or equal to 5 μM at one or more, but not all cells chosen from the group consisting of: parathyroid cell, bone osteoclast, juxtaglomerular kidney cell, proximal tubule kidney cell, distal tubule kidney cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting duct, keratinocyte in the epidermis, parafollicular cell in the thyroid (C-cell), intestinal cell, platelet, vascular smooth muscle cell, cardiac atrial cell, gastrin-secreting cell, glucagon-secreting cell, kidney mesangial cell, mammary cell, beta cell, fat/adipose cell, immune cell, GI tract cell, skin cell, adrenal cell, pituitary cell, hypothalamic cell and cell of the subfornical organ. More preferably, the cells are chosen from the group consisting of parathyroid cell, central nervous system cell, peripheral nervous system cell, cell of the thick ascending limb of Henle's loop and/or collecting

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duct in the kidney, parafollicular cell in the thyroid (C-cell), intestinal cell, GI tract cell, pituitary cell, hypothalamic cell and cell of the subfornical organ. The presence of a calcium receptor in this group of cells has been confirmed by physical data such as *in situ* hybridization and antibody staining.

Preferably, inorganic ion receptor modulating compounds mimic or block the effects of an extracellular ion on a cell having an inorganic ion receptor, such that the compounds achieve a therapeutic effect. Inorganic ion receptor modulating compounds may have the same, or different, effects on cells having different types of inorganic ion receptor morphology (e.g., such as cells having normal inorganic ion receptors, a normal number of inorganic ion receptor, an abnormal inorganic ion receptor, and an abnormal number of inorganic ion receptors).

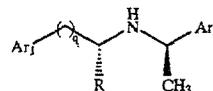
Calcium receptor modulating compounds preferably mimic or block all of the effects of extracellular ion in a cell having a calcium receptor. However, calcimimetics need not possess all the biological activities of extracellular Ca^{2+} . Similarly, calcilytics need not block all of the activities caused by extracellular calcium. Additionally, different calcimimetics and different calcilytics do not need to bind to the same site on the calcium receptor as does extracellular Ca^{2+} to exert their effects.

Inorganic modulating compounds need not effect inorganic receptor activity to the same extent or in exactly the same manner as the natural ligand. For example, a calcimimetic may effect calcium receptor activity to a different extent, to a different duration, by binding to a different binding site, or by having a different affinity, compared to calcium acting at a calcium receptor.

A. Calcimimetics

1. Structure I Compounds

Structure I compounds able to modulate calcium receptor activity have the following formula:



where, Ar_1 is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, acetoxy, $N(CH_3)_2$, phenyl, phenoxy, benzyl, benzyloxy, α, α -dimethylbenzyl, NO_2 , CHO, $CH_3CH(OH)$, acetyl, ethylene dioxy, preferably each substituent is independently selected from the group consisting of, CH_3 , CH_3O , CH_3CH_2O , methylene dioxy, Br, Cl, F, I, CF_3 , CHF_2 , CH_2F , CF_3O , CF_3CH_2O , CH_3S , OH, CH_2OH , $CONH_2$, CN, NO_2 , CH_3CH_2 , propyl, isopropyl, butyl, isobutyl, t-butyl, and acetoxy. More preferably, Ar_1 is either a naphthyl or a phenyl having 1-5 substituents each independently selected from the group consisting of isopropyl, CH_3O , CH_3S , CF_3O , I, Cl, F, CF_3 , and CH_3 , more preferably CF_3O , I, Cl, F, and CF_3 ;

Ar_2 is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, and acetoxy, preferably each substituent is independently selected from the group consisting of, CH_3 , CH_3O , CH_3CH_2O , methylene dioxy, Br, Cl, F, I, CF_3 , CHF_2 , CH_2F , CF_3O , CF_3CH_2O ,

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CH₃, OH, CH₂OH, CONH₂, CN, NO₂, CH₃CH₂, propyl, isopropyl, butyl, isobutyl, t-butyl, and acetoxy. More preferably, Ar₂ is either a naphthyl or a phenyl having 1-5 substituents each independently selected from the group consisting of isopropyl, CH₃O, CH₃S, CF₃O, I, Cl, F, CF₃, and CH₃, more preferably CF₃O, I, Cl, F, CH₃O, and CF₃.

q is 0, 1, 2, or 3; and

R is either H, or CH₃;

and pharmaceutically salts and complexes thereof.

"Lower alkyl" refers to a saturated hydrocarbon having 1-4 carbons, preferably 1-3 carbon atoms, which may be straight chain or branched.

"Lower alkoxy" refers to "O-lower alkyl". Where "O" is an oxygen joined to a lower alkyl.

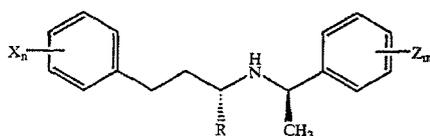
"Lower thioalkyl" refers to "S-lower alkyl". Where "S" is a sulfur joined to a lower alkyl.

"Lower haloalkyl" refers to a lower alkyl substituted with at least one halogen. Preferably, only the terminal carbon of the lower haloalkyl is substituted with a halogen and 1 to 3 halogens are present. More preferably, the lower haloalkyl contains 1 carbon. Preferably, the halogen substitutions are either Cl or F.

"Lower haloalkoxy" refers to "O-lower haloalkyl". Where "O" is an oxygen joined to a lower haloalkyl.

a. Ar₁ and Ar₂ are Both Optionally Substituted Phenyls

In a preferred embodiment both Ar₁ and Ar₂ are optionally substituted phenyls and the compound has following formula:



where R is hydrogen or methyl

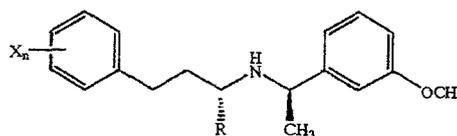
m and n are each independently 0, 1, 2, 3, 4, or 5;

each X is independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy, N(CH₃)₂, phenyl, phenoxy, benzyl, benzyloxy, α,α-dimethylbenzyl, NO₂, CHO, CH₃CH(OH), acetyl, ethylene dioxy. Preferably each X is independently selected from the group consisting of, CH₃, CH₃O, CH₃CH₂O, methylene dioxy, Br, Cl, F, I, CF₃, CHF₂, CH₂F, CF₃O, CF₃CH₂O, CH₃S, OH, CH₂OH, CONH₂, CN, NO₂, CH₃CH₂, propyl, isopropyl, butyl, isobutyl, t-butyl, and acetoxy. More preferably, each X is independently selected from the group consisting of isopropyl, CH₃O, CH₃S, CF₃O, I, Cl, F, CF₃, and CH₃, more preferably CF₃O, I, Cl, F, and CF₃;

each Z is independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, and acetoxy. Preferably each Z is independently selected from the group consisting of, CH₃, CH₃O, CH₃CH₂O, methylene dioxy, Br, Cl, F, I, CF₃, CHF₂, CH₂F, CF₃O, CF₃CH₂O, CH₃S, OH, CH₂OH, CONH₂, CN, CH₃CH₂, propyl, isopropyl, butyl, isobutyl, t-butyl, and acetoxy. More preferably, each Z is independently selected from the group consisting of, isopropyl, CH₃O, CH₃S, CF₃O, CF₃, I, Cl, F, and CH₃.

In a more preferred embodiment, at least one of the Z substituents is in the meta position. More preferably, the compound has the follow formula:

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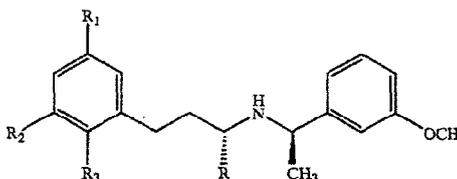


where R is either hydrogen or methyl;

m is 0, 1, 2, 3, 4, or 5, preferably 1 or 2;

and each X is independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy, N(CH₃)₂, phenyl, phenoxy, benzyl, benzyloxy, α,α-dimethylbenzyl, NO₂, CHO, CH₃CH(OH), acetyl, ethylene dioxy, preferably each substituent is independently selected from the group consisting of, CH₃, CH₃O, CH₃CH₂O, methylene dioxy, Br, Cl, F, I, CF₃, CHF₂, CH₂F, CF₃O, CF₃CH₂O, CH₃S, OH, CH₂OH, CONH₂, CN, NO₂, CH₃CH₂, propyl, isopropyl, butyl, isobutyl, t-butyl, and acetoxy, more preferably, isopropyl, CH₃O, CH₃S, CF₃O, CF₃, I, Cl, F, and CH₃.

More preferably, the compound has the formula:



where R is either hydrogen or methyl;

R₁ is either halogen or hydrogen, preferably R₁ is either F, or hydrogen;

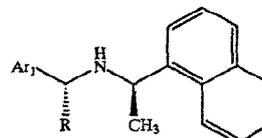
R₂ is either hydrogen, halogen, lower alkyl, lower haloalkyl, or lower haloalkoxy, preferably, R₂ is either hydrogen, CF₃, CH₃, OCF₃, or F, and

R₃ is either hydrogen, halogen, or alkoxy, preferably, R₃ is either Cl, F, hydrogen, or methoxy, more preferably methoxy.

In alternative more preferred combinations; at least two of R₁, R₂, and R₃ is halogen, preferably F and R is hydrogen or CH₃; R is hydrogen or CH₃, R₂ is either lower haloalkyl, or lower haloalkoxy, preferably OCF₃ or CF₃, and R₁ and R₃ is hydrogen; and R is CH₃, R₃ is halogen, preferably Cl, R₁ is either halogen or hydrogen, preferably F or hydrogen, and R₂ is either hydrogen, lower alkyl, lower haloalkyl, or lower haloalkoxy, preferably, hydrogen, CF₃, CH₃, OCF₃, or F.

b. Ar₁ is Naphthyl and q is 0

In another preferred embodiment, Ar₂ is naphthyl, q is 0, and the compound has the formula:



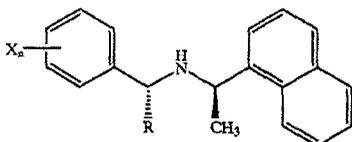
where Ar₁ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy,

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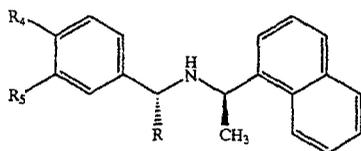
$N(CH_3)_2$, phenyl, phenoxy, benzyl, benzyloxy, α,α -dimethylbenzyl, NO_2 , CHO , $CH_2CH(OH)$, acetyl, ethylene dioxy, preferably each substituent is independently selected from the group consisting of, CH_3 , CH_3O , CH_2CH_2O , methylene dioxy, Br, Cl, F, I, CF_3 , CHF_2 , CH_2F , CF_3O , CF_3CH_2O , CH_3S , OH, CH_2OH , $CONH_2$, CN, NO_2 , CH_3CH_2 , propyl, isopropyl, butyl, isobutyl, t-butyl, and acetoxy. More preferably, Ar_1 is either a naphthyl or a phenyl having 1-5 substituents each independently selected from the group consisting of isopropyl, CH_3O , CH_3S , CF_3 , CF_3O , I, Cl, F, and CH_3 .

More preferably, Ar_1 is an optional substituted phenyl where the compound has the formula:



where X_n represents the optional substituents for the optionally substituted phenyl as described above (with the preferred substituents and number of substituents as described above).

Even more preferably the compound has the formula:



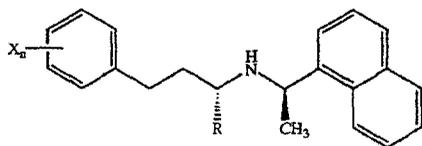
where R is either CH_3 or hydrogen;

R_4 is either lower alkyl, halogen, or alkoxy, preferably isopropyl, chlorine, or methoxy; and

R_5 is either hydrogen, lower alkyl, or halogen, preferably methyl, CH_3 , Br, or Cl.

c. Ar_2 is Naphthyl and q is 2

In another preferred embodiment, Ar_1 is a substituted phenyl, Ar_2 is naphthyl, q is 2 and the compound has the formula:



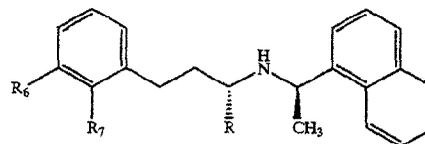
where R is either hydrogen or CH_3 ;

n is 0, 1, 2, 3, 4, or 5, preferably 1 or 2; and

each X is independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, acetoxy, $N(CH_3)_2$, phenyl, phenoxy, benzyl, benzyloxy, α,α -dimethylbenzyl, NO_2 , CHO , $CH_2CH(OH)$, acetyl, ethylene dioxy, preferably each substituent is independently selected from the group consisting of, CH_3 , CH_3O , CH_2CH_2O , methylene dioxy, Br, Cl, F, I, CF_3 , CHF_2 , CH_2F , CF_3O , CF_3CH_2O , CH_3S , OH, CH_2OH , $CONH_2$, CN, NO_2 , CH_3CH_2 , propyl, isopropyl, butyl, isobutyl, t-butyl, and acetoxy, more preferably, isopropyl, CH_3O , CH_3S , CF_3O , CF_3 , I, Cl, F, and CH_3 .

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More preferably, the compound has the formula:

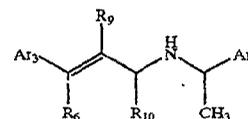


where R_6 is either is either hydrogen, lower haloalkyl, or lower haloalkoxy, preferably hydrogen, OCF_3 or CF_3 ; and R_7 is either halogen or hydrogen, preferably chlorine or hydrogen.

In other embodiments R, R_6 and R_7 are as described above (with the preferred substituents as described above), provided that when both R and R_6 are hydrogen, R is not Cl; and R is CH_3 , and R_6 and R_7 is as described above (with the preferred substituents as described above).

2. Structure II Compounds

Structure II compounds have the formula:



where Ar_3 is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, acetoxy, benzyl, benzyloxy, α,α -dimethylbenzyl, NO_2 , CHO , $CH_2CH(OH)$, $N(CH_3)_2$, acetyl, ethylene dioxy, preferably $N(CH_3)_2$, lower alkoxy, or lower alkyl;

Ar_4 is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, and acetoxy, preferably lower alkoxy, more preferably methoxy;

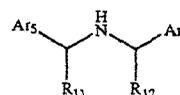
R_8 is either hydrogen or phenyl, preferably hydrogen;

R_9 is either hydrogen or methyl; and

R_{10} is either hydrogen, methyl, or phenyl, more preferably when R_{10} is methyl the chiral carbon it is attached to is the (R) stereoisomer.

Preferably, the α -methyl in Structure II is an (R) α -methyl.

3. Structure III Compounds Structure III compounds have the formula:



where Ar_5 is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH_2OH , $CONH_2$, CN, acetoxy, benzyl, benzyloxy, α,α -dimethylbenzyl, NO_2 , CHO , $CH_2CH(OH)$, acetyl, ethylene dioxy, $—CH=CH$ -phenyl, preferably, lower alkyl, phenoxy, $—CH=CH$ -phenyl, dimethylbenzyl, methoxy, methylene, or ethylene;

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Ar₆ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, acetyl, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, carbomethoxy, OCH₂C(O)C₂H₅ and acetoxy, preferably methoxy, lower alkyl, phenyl, halogen, CF₃, CN, carbomethoxy or, OCH₂C(O)C₂H₅;

R₁₁ is hydrogen or methyl, preferably when R₁₁ is methyl the carbon to which it is attached is an (R) stereoisomer; and

R₁₂ is hydrogen or methyl, preferably when R₁₂ is methyl the carbon to which it is attached is an (R) stereoisomer.

4. Calcimimetic Activity

The ability of compounds to mimic the activity of Ca²⁺ at calcium receptors can be determined using procedures known in the art and described by Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959. For example, calcimimetics possess one or more and preferably all of the following activities when tested on parathyroid cells in vitro:

1. The compound causes a rapid (time to peak <5 seconds) and transient increase in intracellular calcium concentration that is refractory to inhibition by 1 μM La³⁺ or 1 μM Gd³⁺. The increase in [Ca²⁺]_i persists in the absence of extracellular Ca²⁺, but is abolished by pretreatment with ionomycin (in the absence of extracellular Ca²⁺);

2. The compound potentiates increases in [Ca²⁺]_i elicited by submaximal concentrations of extracellular Ca²⁺;

3. The increase in [Ca²⁺]_i elicited by extracellular Ca²⁺ is not inhibited by dihydropyridines;

4. The transient increase in [Ca²⁺]_i caused by the compound is abolished by pretreatment for 10 minutes with 10 mM sodium fluoride;

5. The transient increase in [Ca²⁺]_i caused by the compound is diminished by pretreatment with an activator of protein kinase C (PKC), such as phorbol myristate acetate (PMA), mezerein or (-)-indolactam V. The overall effect of the protein kinase C activator is to shift the concentration-response curve of the compound to the right without affecting the maximal response;

6. The compound causes a rapid (<30 seconds) increase in the formation of inositol-1,4,5-triphosphate and/or diacylglycerol;

7. The compound inhibits dopamine- or isoproterenol-stimulated cyclic AMP formation;

8. The compound inhibits PTH secretion;

9. Pretreatment with pertussis toxin (100 ng/ml for >4 hours) blocks the inhibitory effect of the compound on cyclic AMP formation, but does not effect increases in [Ca²⁺]_i, inositol-1,4,5-triphosphate, or diacylglycerol, nor decreases in PTH secretion;

10. The compound elicits increases in Cl⁻ current in Xenopus oocytes injected with poly(A)⁺-enriched mRNA from bovine or human parathyroid cells, but is without effect in Xenopus oocytes injected with water, or liver mRNA; and

11. Similarly, using a cloned calcium receptor from a parathyroid cell, the compound will elicit a response in Xenopus oocytes injected with the specific cDNA or mRNA encoding the receptor.

Different calcium activities can be measured using available techniques. (See, Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959.) Parallel definitions of compounds mimicking Ca²⁺ activity on other calcium responsive cell, preferably at a calcium receptor, are evident from the examples provided herein and Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959.

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Preferably, the compound as measured by the bioassays described herein, or by Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959, has one or more, more preferably all of the following activities: evokes a transient increase in internal calcium, having a duration of less than 30 seconds (preferably by mobilizing internal calcium); evokes a rapid increase in [Ca²⁺]_i, occurring within thirty seconds; evokes a sustained increase (greater than thirty seconds) in [Ca²⁺]_i (preferably by causing an influx of external calcium); evokes an increase in inositol-1,4,5-triphosphate or diacylglycerol levels, preferably within less than 60 seconds; and inhibits dopamine- or isoproterenol-stimulated cyclic AMP formation.

The transient increase in [Ca²⁺]_i is preferably abolished by pretreatment of the cell for ten minutes with 10 mM sodium fluoride, or the transient increase is diminished by brief pretreatment (not more than ten minutes) of the cell with an activator of protein kinase C, preferably, phorbol myristate acetate (PMA), mezerein or (-) indolactam V.

C. Calcilytics

The ability of a compound to block the activity of extracellular calcium at a calcium receptor can be determined using standard techniques based on the present disclosure. (See, also Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959.) For example, compounds which block the effect of extracellular calcium, when used in reference to a parathyroid cell, possess one or more, and preferably all of the following characteristics when tested on parathyroid cells in vitro:

1. The compound blocks, either partially or completely, the ability of increased concentrations of extracellular Ca²⁺ to:
 - (a) increase [Ca²⁺]_i,
 - (b) mobilize intracellular Ca²⁺,
 - (c) increase the formation of inositol-1,4,5-triphosphate,
 - (d) decrease dopamine- or isoproterenol-stimulated cyclic AMP formation, and
 - (e) inhibit PTH secretion;

2. The compound blocks increases in Cl⁻ current in Xenopus oocytes injected with poly(A)⁺-mRNA from bovine or human parathyroid cells elicited by extracellular Ca²⁺ or calcimimetic compounds, but not in Xenopus oocytes injected with water or liver mRNA;

3. Similarly, using a cloned calcium receptor from a parathyroid cell, the compound will block a response in Xenopus oocytes injected with the specific cDNA, mRNA or cRNA encoding the calcium receptor, elicited by extracellular Ca²⁺ or a calcimimetic compound.

Parallel definitions of compounds blocking Ca²⁺ activity on a calcium responsive cell, preferably at a calcium receptor, are evident from the examples provided herein and Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959.

III. TREATMENT OF DISEASES OR DISORDERS

Diseases or disorders which can be treated by modulating calcium receptor activity are known in the art. For example, diseases or disorders which can be treated by modulating calcium receptor activity can be identified based on the functional responses of cells regulated by calcium receptor activity. Functional responses of cells regulated by calcium receptor are known in the art, including PTH secretion by parathyroid cells, calcitonin secretion by C-cells, and bone resorption by osteoclasts.

Such functional responses are associated with different diseases or disorders. For example, hyperparathyroidism results in elevated levels of PTH in the plasma. Decreasing

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the plasma levels of PTH offers an effective means of treating hyperparathyroidism. Likewise, increasing plasma levels of calcitonin is associated with an inhibition of bone resorption. Inhibiting bone resorption is an effective treatment for osteoporosis. Thus, modulation of calcium receptor activity can be used to treat diseases such as hyperparathyroidism, and osteoporosis.

Those compounds modulating inorganic ion receptor activity, preferably calcium receptor activity, can be used to confer beneficial effects to patients suffering from a variety of diseases or disorders. For example, osteoporosis is an age-related disorder characterized by loss of bone mass and increased risk of bone fracture. Compounds can be used to block osteoclastic bone resorption either directly (e.g., an osteoclast ionomimetic compound) or indirectly by increasing endogenous calcitonin levels (e.g., a C-cell calcimimetic). Alternatively, a calcilytic active on the parathyroid cell calcium receptor will increase circulating levels of parathyroid hormone, stimulating bone formation. All three of these approaches will result in beneficial effects to patients suffering from osteoporosis.

In addition, it is known that intermittent low dosing with PTH results in an anabolic effect on bone mass and appropriate bone remodeling. Thus, compounds and dosing regimens evoking transient increases in parathyroid hormone (e.g., intermittent dosing with a parathyroid cell ionolytic) can increase bone mass in patients suffering from osteoporosis.

Additional diseases or disorders can be identified by identifying additional cellular functional responses, associated with a disease or disorder, which are regulated by calcium receptor activity. Diseases or disorder which can be treated by modulating other inorganic ion receptors can be identified in an analogous manner.

The inorganic ion receptor-modulating compounds of the present invention can exert an affect at an inorganic ion receptor causing one or more cellular effects ultimately producing a therapeutic effect. Calcium receptor-modulating compounds of the present invention can exert an effect on calcium receptor causing one or more cellular effects ultimately producing a therapeutic effect. Different diseases can be treated by the present invention by targeting cells having a calcium receptor.

For example, primary hyperparathyroidism (HPT) is characterized by hypercalcemia and abnormal elevated levels of circulating PTH. A defect associated with the major type of HPT is a diminished sensitivity of parathyroid cells to negative feedback regulation by extracellular Ca^{2+} . Thus, in tissue from patients with primary HPT, the "set-point" for extracellular Ca^{2+} is shifted to the right so that higher than normal concentrations of extracellular Ca^{2+} are required to depress PTH secretion. Moreover, in primary HPT, even high concentrations of extracellular Ca^{2+} often depress PTH secretion only partially. In secondary (uremic) HPT, a similar increase in the set-point for extracellular Ca^{2+} is observed even though the degree to which Ca^{2+} suppresses PTH secretion is normal. The changes in PTH secretion are paralleled by changes in $[\text{Ca}^{2+}]_i$; the set-point for extracellular Ca^{2+} -induced increases in $[\text{Ca}^{2+}]_i$ is shifted to the right and the magnitude of such increases is reduced.

Patients suffering from secondary HPT may also have renal osteodystrophy. Calcimimetics appear to be useful for treating both abnormal PTH secretion and osteodystrophy in such patients.

Compounds that mimic the action of extracellular Ca^{2+} are beneficial in the long-term management of both primary and secondary HPT. Such compounds provide the added

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impetus required to suppress PTH secretion which the hypercalcemic condition alone cannot achieve and, thereby, help to relieve the hypercalcemic condition. Compounds with greater efficacy than extracellular Ca^{2+} may overcome the apparent nonsuppressible component of PTH secretion which is particularly troublesome in the major form of primary HPT caused by adenoma of the parathyroid gland. Alternatively or additionally, such compounds can depress synthesis of PTH, as prolonged hypercalcemia has been shown to depress the levels of preproPTH mRNA in bovine and human adenomatous parathyroid tissue. Prolonged hypercalcemia also depresses parathyroid cell proliferation in vitro, so calcimimetics can also be effective in limiting the parathyroid cell hyperplasia characteristic of secondary HPT.

Cells other than parathyroid cells can respond directly to physiological changes in the concentration of extracellular Ca^{2+} . For example, calcitonin secretion from parafollicular cells in the thyroid (C-cells) is regulated by changes in the concentration of extracellular Ca^{2+} .

Isolated osteoclasts respond to increases in the concentration of extracellular Ca^{2+} with corresponding increases in $[\text{Ca}^{2+}]_i$ that arise partly from the mobilization of intracellular Ca^{2+} . Increases in $[\text{Ca}^{2+}]_i$ in osteoclasts are associated with the inhibition of bone resorption. Release of alkaline phosphatase from bone-forming osteoblasts is directly stimulated by calcium.

Renin secretion from juxtaglomerular cells in the kidney, like PTH secretion, is depressed by increased concentrations of extracellular Ca^{2+} . Extracellular Ca^{2+} causes the mobilization of intracellular Ca^{2+} in these cells. Other kidney cells respond to calcium as follows: elevated Ca^{2+} inhibits formation of $1,25(\text{OH})_2$ -vitamin D by proximal tubule cells, stimulates production of calcium-binding protein in distal tubule cells, and inhibits tubular reabsorption of Ca^{2+} and Mg^{2+} and the action of vasopressin on the thick ascending limb of Henle's loop (MTAL), reduces vasopressin action in the cortical collecting duct cells, and affects vascular smooth muscle cells in blood vessels of the renal glomerulus.

Calcium also promotes the differentiation of intestinal goblet cells, mammary cells, and skin cells; inhibits atrial natriuretic peptide secretion from cardiac atria; reduces cAMP accumulation in platelets; alters gastrin and glucagon secretion; acts on vascular smooth muscle cells to modify cell secretion of vasoactive factors; and affects cells of the central nervous system and peripheral nervous system.

Thus, there are sufficient indications to suggest that Ca^{2+} , in addition to its ubiquitous role as an intracellular signal, also functions as an extracellular signal to regulate the responses of certain specialized cells. Compounds of this invention can be used in the treatment of diseases or disorders associated with disrupted Ca^{2+} responses in these cells.

Specific diseases and disorders which might be treated or prevented, based upon the affected cells, also include those of the central nervous system such as seizures, stroke, head trauma, spinal cord injury, hypoxia-induced nerve cell damage such as in cardiac arrest or neonatal distress, epilepsy, neurodegenerative diseases such as Alzheimer's disease, Huntington's disease and Parkinson's disease, dementia, muscle tension, depression, anxiety, panic disorder, obsessive-compulsive disorder, post-traumatic stress disorder, schizophrenia, neuroleptic malignant syndrome, and Tourette's syndrome; diseases involving excess water reabsorption by the kidney such as syndrome of inappropriate ADH secretion (SIADH), cirrhosis, congestive heart failure, and nephrosis; hypertension; preventing and/or

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decreasing renal toxicity from cationic antibiotics (e.g., aminoglycoside antibiotics); gut motility disorders such as diarrhea, and spastic colon; GI ulcer diseases; GI diseases with excessive calcium absorption such as sarcoidosis; and autoimmune diseases and organ transplant rejection.

While calcium receptor-modulating compounds of the present invention will typically be used in therapy for human patients, they may also be used to treat similar or identical diseases in other warm-blooded animal species such as other primates, farm animals such as swine, cattle, and poultry; and sports animals and pets such as horses, dogs and cats.

IV. ADMINISTRATION

The different compounds described by the present invention can be used to treat different diseases or disorders by modulating inorganic ion receptor activity, preferably calcium receptor activity. The compounds of the invention can be formulated for a variety of modes of administration, including systemic and topical or localized administration. Techniques and formulations generally may be found in *Remington's Pharmaceutical Sciences*, Mack Publishing Co., Easton, Pa. Administration of ionomimetics and ionolytics is discussed by Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959.

Suitable dosage forms, in part, depend upon the use or the route of entry, for example oral, transdermal, or by injection. Such dosage forms should allow the compound to reach a target cell whether the target cell is present in a multicellular host or in culture. For example, pharmacological compounds or compositions injected into the blood stream should be soluble. Other factors are known in the art, and include considerations such as toxicity and dosage form which retard the compound or composition from exerting its effect.

Compounds can also be formulated as pharmaceutically acceptable salts (e.g., acid addition salts) and complexes thereof. Pharmaceutically acceptable salts are non-toxic salts at the concentration at which they are administered. The preparation of such salts can facilitate the pharmacological use by altering the physical characteristic of the compound without preventing it from exerting its physiological effect. Useful alterations in physical properties include lowering the melting point to facilitate transmucosal administration and increasing the solubility to facilitate administering higher concentrations of the drug.

Pharmaceutically acceptable salts include acid addition salts such as those containing sulfate, hydrochloride, maleate, phosphate, sulfamate, acetate, citrate, lactate, tartrate, methanesulfonate, ethanesulfonate, benzenesulfonate, p-toluenesulfonate, cyclohexylsulfamate and quinate. (See e.g., PCT/US92/03736, hereby incorporated by reference herein.) Pharmaceutically acceptable salts can be obtained from acids such as hydrochloric acid, maleic acid, sulfuric acid, phosphoric acid, sulfamic acid, acetic acid, citric acid, lactic acid, tartaric acid, malonic acid, methanesulfonic acid, ethanesulfonic acid, benzenesulfonic acid, p-toluenesulfonic acid, cyclohexylsulfamic acid, and quinic acid.

Pharmaceutically acceptable salts can be prepared by standard techniques. For example, the free base form of a compound is dissolved in a suitable solvent, such as an aqueous or aqueous-alcohol solution, containing the appropriate acid and then isolated by evaporating the solution. In another example, a salt is prepared by reacting the free base and acid in an organic solvent.

Carriers or excipients can also be used to facilitate administration of the compound. Examples of carriers and excipients include calcium carbonate, calcium phosphate, various sugars such as lactose, glucose, or sucrose, or types of

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starch, cellulose derivatives, gelatin, vegetable oils, polyethylene glycols and physiologically compatible solvents. The compositions or pharmaceutical composition can be administered by different routes including intravenously, intraperitoneal, subcutaneous, and intramuscular, orally, topically, or transmucosally.

For systemic administration, oral administration is preferred. Alternatively, injection may be used, e.g., intramuscular, intravenous, intraperitoneal, and subcutaneous. For injection, the compounds of the invention are formulated in liquid solutions, preferably in physiologically compatible buffers such as Hank's solution or Ringer's solution. In addition, the compounds may be formulated in solid form and redissolved or suspended immediately prior to use. Lyophilized forms can also be produced.

Systemic administration can also be by transmucosal or transdermal means, or the compounds can be administered orally. For transmucosal or transdermal administration, penetrants appropriate to the barrier to be permeated are used in the formulation. Such penetrants are generally known in the art, and include, for example, for transmucosal administration, bile salts and fusidic acid derivatives. In addition, detergents may be used to facilitate permeation. Transmucosal administration may be through nasal sprays, for example, or using suppositories. For oral administration, the compounds can be formulated into conventional oral administration dosage forms such as capsules, tablets, and liquid preparations.

For topical administration, the compounds of the invention can be formulated into ointments, salves, gels, or creams, as is generally known in the art.

The amounts of various compounds of this invention to be administered can be determined by standard procedures. Generally, a therapeutically effective amount is between about 1 nmole and 3 μ mole of the compound, preferably 0.1 nmole and 1 μ mole depending on its EC_{50} or IC_{50} and on the age and size of the patient, and the disease or disorder associated with the patient. Generally, it is an amount between about 0.1 and 50 mg/kg, preferably 0.01 and 20 mg/kg of the animal to be treated.

V. EXAMPLES

Examples are provided below illustrating different aspects and embodiments of the present invention. These examples are not intended to limit the claimed invention.

Example 1

Cloning of Human Parathyroid Calcium Receptor From a Human Parathyroid Gland Adenoma Tumor

This example describes the cloning of a human parathyroid calcium receptor from a human parathyroid gland adenoma tumor using pBoPCaR1 as a hybridization probe (See, Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959). The probe was used to identify nucleic acid encoding human parathyroid gland calcium receptor by cross-hybridization at reduced stringency.

Messenger RNA was prepared from a human parathyroid gland adenoma tumor removed from a 39-year-old Caucasian male diagnosed with primary hyperparathyroidism. Northern blot analysis of this mRNA using pBoPCaR1 as a hybridization probe identified calcium receptor transcripts of about 5 Kb and about 4 Kb. A cDNA library was constructed from the mRNA. Double-stranded cDNA larger than 3 Kbp were size-selected on an agarose gel and ligated into the cloning vector lambda ZapII. Five hundred thousand primary recombinant phage were screened with the 5.2 Kbp

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cDNA insert of pBoPCaR1 as a hybridization probe. The pBoPCaR1 insert was labeled by random-primed synthesis using [³²P]-dCTP to a specific activity of 1×10⁹ cpm/μg.

Library screening was performed at a hybridization stringency of 400 mM Na⁺, 50% formamide at a temperature of 38° C. Plaque lift filters were hybridized at a probe concentration of 500,000 cpm/ml for 20 hours. Following hybridization, filters were washed in 1 x SSC at 40° C. for 1 hr.

The primary screen identified about 250 positive clones identified by hybridization to pBoPCaR1. Seven of these clones were taken through secondary and tertiary screens to isolate single clones that hybridized to the pBoPCaR1 probe. These seven clones were analyzed by restriction enzyme mapping and Southern blot analysis. Three of the clones contained cDNA inserts of about 5 Kbp and appear to be full-length clones corresponding to the 5 Kb mRNA. Two of the clones contain cDNA inserts of about 4 Kbp and appear to be full-length clones corresponding to the 4 Kb mRNA.

Restriction enzyme mapping of the two different sized inserts indicate that they share regions of sequence similarity in their 5' ends, but diverge in their 3' end sequences. DNA sequence analyses indicate that the smaller insert may result from alternative polyadenylation upstream of the polyadenylation site used in the larger insert.

Representative cDNA inserts for both size classes were subcloned into the plasmid vector pBluescript SK. Linearization followed by in vitro transcription using T7 RNA polymerase produced cRNA transcripts. The cRNA transcripts were injected into *Xenopus* oocytes (150 ng/μl RNA; 50 nl/oocyte) for functional analysis. Following incubation periods of 2-4 days, the oocytes were assayed for the presence of functional calcium receptors. Both clone types gave rise to functional calcium receptors as assessed by the stimulation of calcium-activated chloride currents upon addition of appropriate calcium receptor agonists. Known calcium receptor agonists, including NPS R-467 and NPS R-568 (see, Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959), activated the oocyte-expressed receptor at about the same concentrations known to be effective for the native parathyroid cell receptor. Thus, both clones encode a functional, human parathyroid cell calcium receptor.

Plasmids were prepared by subcloning each size class of insert into pbluescript thereby producing pHuPCaR 5.2 and pHuCaR 4.0. The nucleic acid sequence, and amino acid sequence, of the inserts are shown in SEQ. ID. Nos. 1 and 2.

Several differences were observed between the nucleic acid sequences of the two cDNA inserts. Sequence analyses of the two cDNA inserts indicate the existence of at least two sequence variants differing in the 3' untranslated region and which may result from alternative polyadenylation. In addition, sequence variation exists at the 5' end of the inserts. These distinct sequences correspond to untranslated regions and may have arisen due to alternative transcriptional initiation and/or splicing.

Three additional sites of sequence variation are observed within the coding regions of cDNA clones pHuPCaR5.2 and pHuPCaR4.0 (see SEQ. ID. NOS. 1 and 2) demonstrating that these cDNA clones encode distinct proteins. Sequence analysis of the human CaR gene indicates that the additional 30 base pairs of DNA in cDNA clone pHuPCaR5.2, as compared to the pHuPCaR 4.0 cDNA clone, results from alternative mRNA splicing. The alternative mRNA splicing is predicted to insert 10 additional amino acids into the CaR

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polypeptide encoded by the pHuPCaR5.2 cDNA at a site between aa#536 and aa#537 in polypeptide encoded by pHuPCaR4.0 cDNA. In addition, pHuPCaR4.0 encodes glutamine (Gln) at aa#925 and glycine (Gly) at position 990 whereas pHuPCaR5.2 encodes arg (Arg) at both equivalent positions. The human CaR gene encodes for Gln and Arg, respectively, at these positions. The difference between the pHuPCaR4.0 cDNA compared to human DNA appears to represent a true sequence polymorphism within the human population while the single base change in pHuPCaR5.2 probably reflects a mutation which occurred during its cloning. Both cDNAs encode functional calcium receptors as demonstrated by the ability of *Xenopus* oocytes injected with cRNA prepared from these cDNA clones to respond to 10 mM extracellular calcium as ascertained by Cl⁻ conductance. However, it is possible that these two receptor isoforms are functionally and/or pharmacologically distinct.

Example 2

Selection of Stable Recombinant Cells Expressing the Calcium Receptor

Clonal cell lines that stably express the two human and the bovine calcium receptors have been isolated. Calcium receptor cDNAs were subcloned in two different, commercially available expression vectors; pMSG (obtained from Pharmacia) and Cep4B (obtained from Invitrogen). The first vector contains the selectable marker gene for xanthine-guanine phosphoribosyltransferase (gpt) allowing stably transfected cells to overcome the blockade of the purine biosynthetic pathway imposed by addition of 2 μg/ml aminopterin and 25 μg/ml mycophenolic acid. The second vector encodes a gene conferring resistance to the antibiotic hygromycin (used at 200 μg/ml). HuPCaR 5.2 and HuPCaR 4.0 cDNAs (SEQ. ID. NOS. 1 and 2, respectively) were removed from the parent bluescript plasmid with Not I and Hind III restriction enzymes and then either ligated directly into Not I+Hind III digested Cep4B or treated with the klenow fragment of DNA polymerase prior to blunt-end ligation into Sma I digested pMSG.

The pMSG subclone containing the HuPCaR 5.2 insert was transfected into CHO cells as discussed above. Selection has resulted in 20 resistant clones which are being characterized. The Cep4B subclone containing the HuPCaR 5.2 insert was transfected into HEK 293 cells as described above. Selection with hygromycin resulted in a pool of stable clones. Clones expressing the HuPCaR 4.0 receptor isoform were prepared similarly.

Cells obtained from the pool of hygromycin selected HEK 293 cells transfected with Cep4B containing the HuPCaR 5.2 insert were plated on collagen coated Aklar squares which had been placed into individual wells of 12-well tissue culture plates. Two to six days later, medium was removed and the cells washed with balanced salt solution and 1 ml of buffer containing 1 μM fura2-AM, 1 mM CaCl₂ and 0.1% BSA and 1 mM CaCl₂. Measurements of fluorescence in response to calcium receptor agonists were performed at 37° C. in a spectrofluorimeter using excitation and emission wavelengths of 340 and 510 nm, respectively. For signal calibration, Fmax was determined after addition of ionomycin (40 μM) and the apparent Fmin was determined by addition of 0.3 M EGTA, 2.5 M Tris-HCl; pH 10. Robust increases in [Ca²⁺]_i were observed in response to the addition of the following calcium receptor agonists: Ca²⁺ (10 mM), Mg²⁺ (20 mM) and NPS R-467. Control cells expressing functional substance K receptors did not respond to these calcimimetic compounds.

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Additional clonal isolates of HEK 293 cells transfected with pHuPCaR4.0 sequence were obtained. These were tested for responsiveness to calcimimetics as described above except that the cells were tested while in suspension.

Example 3

Using Fura-2 Loaded Parathyroid cells To Measure to Calcium Receptor Activity

This section describes procedures used to obtain parathyroid cells from calves and humans, and to use the parathyroid cells to measure calcium receptor activity.

Parathyroid glands were obtained from freshly slaughtered calves (12–15 weeks old) at a local abattoir and transported to the laboratory in ice-cold parathyroid cell buffer (PCB) which contains (mM): NaCl, 126; KCl, 4; MgCl₂, 1; Na-HEPES, 20; pH 7.4; glucose, 5.6, and variable amounts of CaCl₂, e.g., 1.25 mM. Human parathyroid glands, were obtained from patients undergoing surgical removal of parathyroid tissue for primary or uremic hyperparathyroidism (uremic HPT), and were treated similarly to bovine tissue.

Glands were trimmed of excess fat and connective tissue and then minced with fine scissors into cubes approximately 2–3 mm on a side. Dissociated parathyroid cells were prepared by collagenase digestion and then purified by centrifugation in Percoll buffer. The resultant parathyroid cell preparation was essentially devoid of red blood cells, adipocytes, and capillary tissue as assessed by phase contrast microscopy and Sudan black B staining. Dissociated and purified parathyroid cells were present as small clusters containing 5 to 20 cells. Cellular viability, as indexed by exclusion of trypan blue or ethidium bromide, was routinely 95%.

Although cells can be used for experimental purposes at this point, physiological responses (e.g., suppressibility of PTH secretion and resting levels of [Ca²⁺]_i) should be determined after culturing the cells overnight. Primary culture also has the advantage that cells can be labeled with isotopes to near isotopic equilibrium, as is necessary for studies involving measurements of inositol phosphate metabolism.

After purification on Percoll gradients, cells were washed several times in a 1:1 mixture of Ham's F12-Dulbecco's modified Eagle's medium (GIBCO) supplemented with 50 μg/ml streptomycin, 100 U/ml penicillin, 5 μg/ml gentamicin and ITS+. ITS+ is a premixed solution containing insulin, transferrin, selenium, and bovine serum albumin (BSA)-linolenic acid (Collaborative Research, Bedford, Mass.). The cells were then transferred to plastic flasks (75 or 150 cm²; Falcon) and incubated overnight at 37° C. in a humid atmosphere of 5% CO₂. No serum is added to these overnight cultures, since its presence allows the cells to attach to the plastic, undergo proliferation, and dedifferentiate. Cells cultured under the above conditions were readily removed from the flasks by decanting, and show the same viability as freshly prepared cells.

Purified parathyroid cells were resuspended in 1.25 mM CaCl₂-2% BSA-PCB containing 1 μM fura-2-acetoxymethylester and incubated at 37° C. for 20 minutes. The cells were then pelleted, resuspended in the same buffer, but lacking the ester, and incubated a further 15 minutes at 37° C. The cells were subsequently washed twice with PCB containing 0.5 mM CaCl₂ and 0.5% BSA and maintained at room temperature (about 20° C.). Immediately before use, the cells were diluted five-fold with prewarmed 0.5 mM

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CaCl₂-PCB to obtain a final BSA concentration of 0.1%. The concentration of cells in the cuvette used for fluorescence recording was 1–2×10⁶/ml.

The fluorescence of indicator-loaded cells was measured at 37° C. in a spectrofluorimeter (Biomedical Instrumentation Group, University of Pennsylvania, Philadelphia, Pa.) equipped with a thermostated cuvette holder and magnetic stirrer using excitation and emission wavelengths of 340 and 510 nm, respectively. This fluorescence indicates the level of cytosolic Ca²⁺. Fluorescence signals were calibrated using digitonin (50 μg/ml, final) to obtain maximum fluorescence (F_{max}), and EGTA (10 mM, pH 8.3, final) to obtain minimal fluorescence (F_{min}), and a dissociation constant of 224 nM. Leakage of dye is dependent on temperature and most occurs within the first 2 minutes after warming the cells in the cuvette. Dye leakage increases only very slowly thereafter. To correct the calibration for dye leakage, cells were placed in the cuvette and stirred at 37° C. for 2–3 minutes. The cell suspension was then removed, the cells pelleted, and the supernatant returned to a clean cuvette. The supernatant was then treated with digitonin and EGTA to estimate dye leakage, which is typically 10–15% of the total Ca²⁺-dependent fluorescent signal. This estimate was subtracted from the apparent F_{min}.

Example 4

Using Fura-2 Loaded HEK 293/pHuPCaR4.0 Cells To Measure to Calcium Receptor Activity

This section describes procedures used to assay calcium receptor activity using fura-2 loaded HEK 293/pHuPCaR4.0 cells. HEK 293 cells transfected with pHuPCaR4.0 were loaded with fura-2 by incubating the cells in Dulbecco's modified Eagle's media buffered with 20 mM HEPES containing about 5 μM fluo-3/AM for one hour at room temperature. Cell were then rinsed with Hank's balanced salt solution buffered with 20 mM HEPES containing 1 mM CaCl₂ and 1 mM MgCl₂. Compounds to be tested were then added to the cells and fluorescence was measured (excitation and emission wavelengths of 340 and 510 nm, respectively).

Example 5

Measuring the Ability of Compounds to Modulate Calcium Receptor Activity

The ability of different compounds to modulate calcium receptor activity was assayed by measuring increases in [Ca²⁺]_i in HEK 293 cells transfected with nucleic acid encoding pHuPCaR4.0 using fura-2 loaded cells or using parathyroid cells loaded with using fura-2 loaded cells. Results of different experiments are summarized in Tables 1.a, 1.b.1, 1.b.2, 1.c., and 2. Tables 1.a, 1.b.1, 1.b.2, and 1.c summarizes the effects of compounds, at different concentrations, on calcium receptor activity assayed as described in Example 4 (i.e., using HEK 293 cells transfected with nucleic acid encoding pHuPCaR4.0, which were loaded with fura-2).

Table 2, summarizes the results of different experiments where the EC₅₀ was calculated either parathyroid cells, or HEK 293/pHuPCaR4.0, loaded with fura-2. Cells were loaded with fura-2 and assayed as described in Example 2 (for parathyroid cells) or Example 3 (for HEK 293/pHuPCaR4.0 cells).

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TABLE 1.a

Calcimimetic compounds which produce greater than 40% response at 3.3 ng/mL in HEK-293 cells expressing the human calcium receptor				
Compound	% activity at four concentrations (ng/mL)			
	3300	330	33	3.3
reference compounds				
R-568		95	69	24
17P		101	86	54
17X		105	93	51
24X	126	109	124	109
24Y	119	120	127	102
17J	116	118	122	102
25A	122	120	114	92
17E	116	110	110	92
24Z	138	138	135	90
14S	116	106	105	88
25E	132	129	122	85
17G	125	128	119	77
14T	126	125	117	77
17H	126	124	111	74
14O	119	119	102	74
25I	119	113	114	74
12J	131	130	113	68
12I	115	111	93	68
25G	130	115	99	66
9R		108	101	64
12F	118	110	101	63
12O	110	117	94	62
23Z	129	126	100	61
17M		115	99	59
16V		114	102	58
25O	126	115	96	57
25J	119	123	105	56
16L	146	138	98	56
12N	115	106	102	55
16T		97	88	55
25U	107	107	95	55
17P		101	86	54
16Q		110	88	53
23E	137	113	102	53
17C	113	120	99	52
25L	97	97	85	52
8Z		101	97	52
17X		105	93	51
13R		132	98	51
17O		112	96	51
23Q	122	114	98	51
16X		111	96	51
24V	127	98	71	50
13O		115	94	50
17N		108	86	49
21V	122	116	99	48
24M	132	134	99	48
13U		108	79	47
24P	140	138	110	46
17Y	109	94	79	46
11X		100	76	45
25H	115	107	89	45
22J		99	71	45
9C		104	82	45
13S		102	87	45
10Q	103	100	84	44
13P		110	83	44
8K		98	81	44
13N		114	88	43
10N	106	97	77	43
12H	114	115	94	43
25P	90	81	75	41
18A		111	88	40
14L		109	78	40

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TABLE 1.b.1

Calcimimetic compounds which produce greater than 40% response at 33 ng/mL in HEK-293 cells expressing the human calcium receptor				
Compound	% activity at four concentrations (ng/mL)			
	3300	330	33	3.3
reference compounds				
R-568		95	69	24
17P		101	86	54
17X		105	93	51
12C	134	125	98	39
16I	121	117	96	36
17D		108	91	38
17F		111	90	28
24C	116	113	87	32
25K	124	107	86	35
13F	125	122	85	38
21F		109	85	36
21S	132	131	85	24
10F		96	84	27
14R	106	107	84	37
13G	111	128	82	29
14Z	118	103	82	20
16N	122	159	82	8
8U	123	129	82	11
23W	117	97	81	25
12G	139	139	81	35
15G		113	80	32
25M	118	100	79	25
13V		110	79	33
14P	112	103	78	30
6T	123	129	78	15
14Q		101	78	35
17L	111	104	78	31
24K		106	78	30
24U	106	106	78	25
25Q	116	95	77	20
8J		104	77	39
23H	121	114	77	28
21C = 4U	134	114	76	17
25F	97	85	76	28
16R		100	76	25
17I	118	97	76	18
24J		103	75	31
21O		109	75	37
24G	109	94	75	22
15I	111	93	75	24
21D		104	75	17
20Y	117	95	74	24
10P		102	74	8
23M	113	97	74	26
14Y		109	73	17
17K	98	97	73	37
12E	117	121	73	23
17Z		99	73	37
16W		102	73	4
23K	106	107	72	24
25X	96	94	72	22
13W		109	71	12
23P	125	99	70	22
18B	111	96	69	26
21Y		100	68	36
17W		92	67	13
23A		103	67	24
23G	127	93	67	13
13M		92	66	15
21U	104	104	66	18
21R		100	66	15
10S/10T		86	65	13
17R		98	65	13
13X		102	65	13
4N		100	65	13
21E		94	64	4
15J	80	75	64	13
22Y		114	64	28

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TABLE 1.b.1-continued

Calcimimetic compounds which produce greater than 40% response at 33 ng/mL in HEK-293 cells expressing the human calcium receptor.

Compound	% activity at four concentrations (ng/mL)			
	3300	330	33	3.3
Code				
21G		88	63	18
24L		105	62	10
10V		99	62	8
10W/10X		98	61	9
17B		92	61	19
23Y	106	87	61	16
11Y		103	61	20

TABLE 1.b.2

Calcimimetic compounds which produce greater than 40% response at 33 ng/mL in HEK-293 cells expressing the human calcium receptor.

Compound	% activity at four concentrations (ng/mL)			
	3300	330	33	3.3
Code				
reference compounds				
R-568		95	69	24
17P		101	86	54
17X		105	93	51
18C	99	87	60	18
23T	102	74	60	31
4V		93	59	
8G		84	59	6
23I		102	58	3
21M		102	58	17
24O	137	114	58	8
3U		89	57	
9A		82	56	6
12M	98	86	56	11
12B	130	110	56	4
21P		92	56	13
8T		85	55	13
10L/10M		99	55	4
24I	109	84	55	11
14N		89	55	15
23R	104	86	54	13
23S		97	53	3
21T	133	112	53	3
10W/10X		81	53	4
13T		90	53	6
6R		94	52	7
20I		87	52	12
24A	122	85	52	9
12D	128	109	52	5
6X		84	52	10
18T	99	74	52	14
21X	119	101	51	2
23J	102	61	51	29
10Z		96	51	5
16Z		88	51	9
23N		96	50	2
16U		85	50	4
11D		96	50	4
23X		94	49	1
17A		88	49	7
20J		80	48	8
22X		86	48	10
23U		87	48	3
9Z		74	48	4
16J	92	76	47	31
25N	94	73	46	8
4P		81	46	8

TABLE 1.b.2-continued

Calcimimetic compounds which produce greater than 40% response at 33 ng/mL in HEK-293 cells expressing the human calcium receptor.

Compound	% activity at four concentrations (ng mL)			
	3300	330	33	3.3
Code				
23O	111	79	46	13
13O		95	46	5
4G		83	46	
12Y		80	46	10
12L		88	45	10
23F		82	45	5
11W		81	44	2
8H		88	44	7
25V	89	59	43	26
25W	95	69	42	8
10R		82	42	7
21N	124	98	42	4
8S		73	42	7
8X		75	40	19
13E	123	94	40	2

TABLE 1.c

Calcimimetic compounds which produce greater than 40% response at 330 ng/mL in HEK-293 cells expressing the human calcium receptor.

Compound	% activity at four concentrations (ng mL)			
	3300	330	33	3.3
Code				
reference compounds				
R-568		95	69	24
17P		101	86	54
17X		105	93	51
7X		85		
3H		84		
3L		81	28	
16O	129	81	21	2
8O/8Q	124	80	14	0
14A	98	78	10	7
23L	107	77	37	9
1T		76		
7W		76		
4H		77	37	
8D		75		
5M		73	21	
4U		72		
24E	94	71	35	6
16M	130	68	11	4
4M		68	34	
2S		67	29	
17V	91	66	27	-1
2X		66	15	
23D	91	66	35	13
4D		65	32	
5B/5C		65	20	
3M		64	19	
16K	78	62	36	8
5D		62	18	
4P		61	13	
24B	76	61	34	11
24H	81	60	32	13
5L		60	16	
2Y		59	10	
5G		58	16	
3V		56	14	
2Q		56	4	
14B	75	55	11	4
13Z	93	54	22	5

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TABLE 1.c-continued

Calcimimetic compounds which produce greater than 40% response at 330 ng/mL in HEK-293 cells expressing the human calcium receptor				
Compound Code	% activity at four concentrations (ng/mL)			
	3300	330	33	3.3
8A		54		
24D	87	53	34	39
1D		53		
13I	85	52	3	1
3B		52	15	
8C		51		
14H	112	49	5	5
7U		49		
5E		48	7	
13H	88	48	36	12
13Y	106	47	2	4
4J		47	8	
14I	80	45	11	7
4B		45	8	
3D		45	4	
3R		45	2	
3A		41	7	
14J	55	41	6	5
4I		40	9	

TABLE 2

Arylalkylamine Calcimimetics from FIG. 1 Active at the Parathyroid Cell Calcium Receptor In Vitro ($EC_{50} \leq 5 \mu M$)			
Compound Code (from FIG. 1)	EC_{50} (μM)	Compound Code (from FIG. 1)	EC_{50} (μM)
NPS R-467	2.0	11X	0.83
NPS R-568	0.60	11Y	2.8
3U	0.64	12L	1.7
3V	1.8	12U	1.2
4A	1.4	12V	0.42
4B	2.0	12W	3.2
4C	2.0	12Y	2.0
4D	4.4	12Z	0.11
4G	1.8	13Q	ca. 0.8
4H	≥ 3.0	13R	0.25
4J	2.2	13S	<0.13
4M	2.1	13U	0.19
4N	0.8	13X	<0.75
4P	1.6	14L	0.26
4R/6V	4.2	14Q	0.47
4S	3.3	14U	0.13
4T/4U	1.6	14V	1.7
4V	2.5	14Y	0.38
4W	2.3	15G	ca. 0.5
4Y	1.3	16Q	0.04
4Z/5A	4.4	16R	0.36
5B/5C	2.8	16T	0.04
5W/5Y	3.6	16V	<0.13
6E	2.7	16W	0.59
6F(R,R-)	0.83	16X	0.10
6R	3.4	17M	0.15
6T	2.9	17O	0.04
6X	2.5	17P	0.04
7W	3.2	17R	0.39
7X	1.1	17W	0.43
8D	2.5	17X	0.02
8J	0.78	20F	<1.0
8K	1.3	20I	>1.0
8R	2.6	20J	>3.0
8S	1.7	20R	2.4
8T	1.8	20S	4.2
8U	0.44	21D	3.0
8X	0.76	21F	0.38
8Z	0.40	21G	1.1

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TABLE 2-continued

Arylalkylamine Calcimimetics from FIG. 1 Active at the Parathyroid Cell Calcium Receptor In Vitro ($EC_{50} \leq 5 \mu M$)			
Compound Code (from FIG. 1)	EC_{50} (μM)	Compound Code (from FIG. 1)	EC_{50} (μM)
9C	0.60	21O	0.26
9D	1.4	21P	0.43
9R	0.25	21Q	1.4
9S	4.8	21R	0.37
10F	0.89	25C	>2
11D	1.8	25D	0.019

Examples 6-17

Synthesis of Compounds

The compounds described herein can be synthesized using standard techniques such as those described by Nemeth et al., PCT/US93/01642, International Publication Number WO 94/18959. Examples describing representative syntheses of compounds described in the text are provided below.

Synthesis of compounds 9R, 14U, and 17P were prepared by reductive amination of a commercially available aldehyde or ketone with a primary amine in the presence of sodium cyanoborohydride or sodium triacetoxyborohydride. Compounds 11Y, 12H, 12K, 12M, 14S, 14T, 16L-O, 17E, 17G, 17J, 24X, 24Y, 25A, 25E-25K, and 25O were prepared in a similar manner.

It was found for the syntheses of these three compounds (9R, 14U, and 16P) that sodium triacetoxyborohydride afforded the desired diastereoisomers with greater diastereoselectivity than using sodium cyanoborohydride. The enriched mixtures were further purified to a single diastereomer by normal-phase HPLC or by recrystallization from organic solvents.

Compounds 8J, 8U, 11X, 17M, and 25Y were prepared from the condensation of a primary amine with an aldehyde or ketone in the presence of titanium(IV) isopropoxide. The resulting intermediate imines were then reduced in situ by the action of sodium cyanoborohydride, sodium borohydride, or sodium triacetoxyborohydride. The intermediate enamine for the synthesis of compound 8U was catalytically reduced using or palladium dihydroxide on carbon.

Compounds 12U, 12V and 12Z were prepared by a diisobutylaluminum hydride (DIBAL-H) mediated condensation of an amine with a nitrile. The resulting intermediate imine is reduced in situ by the action of sodium cyanoborohydride or sodium borohydride. The intermediate alkenes (compounds 12U and 12V) were reduced by catalytic hydrogenation in EtOH using palladium on carbon. Compounds which were converted to their corresponding hydrochloride were done so by treatment of the free base with ethereal HCl to afford white solids.

The amines in these syntheses were purchased from Aldrich Chemical Co., Milwaukee, Wis., or from Celgene Corp., Warren, N.J., or were prepared synthetically using standard techniques. All other reagent chemicals were purchased from Aldrich Chemical Co.

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Example 6

Synthesis of Compound 25Y

N-(3-(2-Phenyl)propyl)-1-(1-naphthyl) ethylamine

A mixture of 3-phenyl-1-propylamine (135 mg, 1 mmol), 1'-acetonaphthone (170 mg, 1 mmol), and titanium (IV) isopropoxide (355 mg, 1.3 mmol) was stirred at room temperature for 1 hour. The reaction was treated with 1 Methanolic sodium cyanoborohydride (1 mL) and stirred at room temperature for 16 hours. The reaction was diluted with ether and treated with water (0.1 mL). The reaction was centrifuged and the ether layer removed and concentrated to a milky oil. A small portion of this material (10 mg) was purified by HPLC (Phenomenex, 1.0x25 cm, 5 μM silica) using a gradient of dichloromethane to 10% methanol in dichloromethane containing 0.1% isopropylamine. This afforded the product (free base) as a single component by GC/EI-MS (R_t=10.48 min) m/z (rel. int.) 289 (M⁺, 11), 274 (63), 184 (5), 162 (5), 155 (100), 141 (18), 115 (8), 91 (45), 77(5).

Example 7

Synthesis of Compound 8J

N-(3-phenylpropyl)-1-(3-thiomethylphenyl)ethylamine hydrochloride

3'-Aminoacetophenone (2.7 g, 20 mmol) was dissolved in 4 mL of concentrated HCl, 4 g of ice and 8 mL of water. The solution was cooled to 0° C., and sodium nitrite (1.45 g, 21 mmol) dissolved in 3-5 mL of water was added over 5 minutes while maintaining the temperature below 6° C. Sodium thiomethoxide (1.75 g, 25 mmol) was dissolved in 5 mL of water and cooled to 0° C. To this solution was added the diazonium salt over 10 minutes while maintaining the temperature below 10° C. The reaction was stirred for an additional hour while allowing the temperature to rise to ambient. The reaction mixture was partitioned between ether and water. The ether layer was separated and washed with sodium bicarbonate and sodium chloride, and dried over sodium sulfate. The ether was evaporated to give a 74% yield of 3'-thiomethylacetophenone. The crude material was purified by distillation at reduced pressure.

3-Phenylpropylamine (0.13 g, 1 mmol), 3'-thiomethylacetophenone (0.17 g, 1 mmol), and titanium (IV) isopropoxide (0.36 g, 1.25 mmol) were mixed together and allowed to stand for 4 hours. Ethanol (1 mL) and sodium cyanoborohydride (0.063 g, 1 mmol) were added and the reaction was stirred overnight. The reaction was worked up by the addition of 4 mL of ether and 200 μL of water. The mixture was vortexed and then spun in a centrifuge to separate the solids. The ether layer was separated from the precipitate, and the solvent removed in vacuo. The oil was redissolved in dichloromethane and the compound purified by preparative TLC on silica gel eluted with 3% methanol/dichloromethane to yield the title compound as a pure oil: GC/EI-MS(R_t=7.64 min) m/z (rel. int.) 285 (M⁺, 18), 270 (90), 180(17), 151(100), 136(32), 104(17), 91(54), 77(13).

Example 8

Synthesis of Compound 8U

N-3-(2-methoxyphenyl)-1-propyl-(R)-3-methoxy-α-methylbenzylamine hydrochloride

A mixture of (R)-(+)-3-methoxy-α-methylbenzylamine (3.02 g, 20 mmol), 2-methoxycinnamaldehyde (3.24 g, 20 mmol), and titanium (IV) isopropoxide (8.53 g, 30 mmol, 1.5 Eq.) was stirred 2 hours at room temperature and treated with 1 M (20 mL) ethanolic sodium cyanoborohydride. The

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reaction was stirred overnight (16 hours), diluted with diethylether, and treated with water (1.44 mL, 80 mmol, 4 Eq.). After mixing for 1 hour the reaction mixture was centrifuged and the ether layer removed and concentrated to an oil. This material was dissolved in glacial acetic acid, shaken with palladium hydroxide and hydrogenated under 60 p.s.i. hydrogen for 2 hours at room temperature. The catalyst was removed by filtration and the resulting solution concentrated to a thick oil. This material was dissolved in dichloromethane and neutralized with 1 N NaOH. The dichloromethane solution was separated from the aqueous phase, dried over anhydrous potassium carbonate and concentrated to an oil. This material was dissolved in ether and treated with 1 M HCl in diethylether. The resulting precipitate (white solid) was collected, washed with diethylether, and air dried. GC/EI-MS (R_t=9.69 min) of this material (free base) showed a single component: m/z (rel. int.) 299 (M⁺, 21), 284 (100), 164 (17), 150 (8), 135 (81), 121 (40), 102 (17), 91 (43), 77 (18).

Example 9

Synthesis of Compound 9R

(R)-N-(1-(2-naphthyl)ethyl)-(R)-1-(1-naphthyl) ethylamine hydrochloride

A mixture of (R)-(+)-1-(1-naphthyl)ethylamine (10.0 g, 58 mmol), 2'-acetonaphthone (9.4 g, 56 mmol), titanium (IV) isopropoxide (20.7 g, 73.0 mmol), and EtOH (abs.) (100 mL) was heated to 60° C. for 3 hours. Sodium cyanoborohydride (NaCNBH₃) (3.67 g, 58.4 mmol) was then added. The reaction mixture was stirred at room temperature for 18 hours. Ether (1 L) and H₂O (10 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was recrystallized four times from hot hexane, to provide 1.5 g of pure (98+% diastereomer). The free base was dissolved in hexane, filtered, and then ethereal HCl was added to precipitate the product as a white solid (1.1 g, 6% yield), m.p.: softens 200-240° C. (dec.).

Example 10

Synthesis of Compound 11X

N-(4-Isopropylbenzyl)-(R)-1-(1-naphthyl)ethylamine hydrochloride

A mixture of (R)-(+)-1-(1-naphthyl)ethylamine (1.06 g, 6.2 mmol), 4-isopropylbenzaldehyde (0.92 g, 6.2 mmol), and titanium (IV) isopropoxide (2.2 g, 7.7 mmol) was heated to 100° C. for 5 min then allowed to stir at room temperature for 4 hours. Sodium cyanoborohydride (NaCNBH₃) (0.39 g, 6.2 mmol) was then added followed by EtOH (1 mL). The reaction mixture was stirred at room temperature for 18 hours. Ether (100 mL) and H₂O (1 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was chromatographed on silica gel (50 mmx30 cm column) (elution with 1% MeOH/CHCl₃). The chromatographed material was then dissolved in hexane and ethereal HCl was added to precipitate the product as a white solid (0.67 g, 35% yield), m.p.: 257-259° C.

Example 11

Synthesis of Compound 12U

N-3-(2-methylphenyl)-1-propyl-(R)-3-methoxy-α-methylbenzyl amine hydrochloride

A solution of 2-methylcinnamionitrile (1.43 g, 10 mmol) in dichloromethane (10 mL) was cooled to 0° C. and treated

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dropwise (15 minutes) with 1 M diisobutylaluminum hydride (10 mL, dichloromethane). The reaction was stirred at 0° C. for 15 minutes and treated dropwise (15 minutes) with a 1 M solution of (R)-(+)-3-methoxy- α -methylbenzylamine (1.51 g, 10 mmol) in dichloromethane (10 mL). The reaction was stirred 1 hour at 0° C. and poured into a solution of ethanol (100 mL) containing sodium cyanoborohydride (1 g, 16 mmol). The reaction mixture was stirred 48 hour at room temperature. The reaction was diluted with ether and neutralized with 1 N NaOH. The ether layer was removed, dried over anhydrous potassium carbonate and concentrated to an oil. This material was chromatographed through silica using a gradient of dichloromethane to 5% methanol in dichloromethane to afford the unsaturated intermediate, a single component by GC/EI-MS (R_f =10.06 min) m/z (rel. int.) 281 (M+, 17), 266 (59), 176 (19), 146 (65), 135 (73), 131 (100), 91 (21), 77 (13).

The unsaturated intermediate in ethanol was hydrogenated (1 atm H₂) in the presence of palladium on carbon for 16 hours at room temperature. The product from this reaction was converted to the hydrochloride salt by treatment with 1 M HCl in diethylether. GC/EI-MS (R_f =9.31 min) of this material (free base) showed a single component: m/z (rel. int.) 283 (M+, 21), 268 (100), 164 (12), 148 (8), 135 (85), 121 (12), 105 (49), 91 (23), 77 (21).

Example 12

Synthesis of Compound 12V

N-3-(3-methylphenyl)-1-propyl-(R)-1-(1-naphthyl) ethylamine hydrochloride

The compound was prepared following the procedure described in Example 11, but using 2-methylcinnamitrile. The unsaturated intermediate was a single component by GC/EI-MS (R_f =10.21 min) m/z (rel. int.) 281 (M+, 57), 266 (86), 146 (98), 135 (88), 131 (100), 115 (43), 102 (26), 91 (43), 77 (18). Reduction of this material and hydrochloride formation using the procedure described Example 11 afforded the product. GC/EI-MS (R_f =9.18 min) of this material (free base) showed a single component; m/z (rel. int.) 283 (M+, 19), 268 (100), 164 (11), 148 (8), 135 (76), 121 (16), 105 (45), 91 (23), 77 (21).

Example 13

Synthesis of Compound 12Z

N-3-(2-chlorophenyl)-1-propyl-(R)-1-(1-naphthyl) ethylamine hydrochloride

The compound was prepared following the procedures described in Example 11, but using 2-chlorohydrocinnamitrile and (R)-(+)-1-(1-naphthyl) ethylamine on a 10 mmol scale. Chromatography through silica using a gradient of dichloromethane to 5% methanol in dichloromethane afforded the product as a single component by TLC analysis (5% methanol in dichloromethane). The hydrochloride was prepared by treatment with 1 M HCl in diethylether.

Example 14

Synthesis of Compound 14U

(R)-N-(1-(4-methoxyphenyl)ethyl)-(R)-1-(1-naphthyl) ethylamine hydrochloride

A mixture of (R)-(+)-1-(1-naphthyl)ethylamine (1.1 g, 6.2 mmol), 4'-methoxyacetophenone (0.93 g, 6.2 mmol), titanium (IV) isopropoxide (2.2 g, 7.7 mmol), and EtOH (abs.) (1 mL) was heated to 60° C. for 3 hours. Sodium cyanoboro-

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hydride (NaCNBH₃) (0.39 g, 6.2 mmol) was then added, and the reaction mixture was stirred at room temperature for 18 hours. Ether (200 mL) and H₂O (2 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was chromatographed on silica gel (25 mmx25 cm column) (elution with 1% MeOH/CHCl₃). A portion of this material was HPLC chromatographed [Selectosil, 5 μ M silica gel; 25 cmx10.0 mm (Phenomenex, Torrance, Calif.), 4 mL per minute; UV det. 275 nM; 12% ethyl acetate-88% hexane (elution time 12.0 min)]. The HPLC purified diastereomer was then dissolved in hexanes and ethereal HCl was added to precipitate the product as a white solid (20 mg), m.p.: 209-210° C. (dec.).

Example 15

Synthesis of Compound 17M

N-(3-chloro-4-methoxybenzyl)-(R)-1-(1-naphthyl) ethylamine hydrochloride

A mixture of (R)-(+)-1-(1-naphthyl)ethylamine (6.6 g, 39 mmol), 3'-chloro-4'-methoxybenzaldehyde (6.6 g, 39 mmol), and titanium (IV) isopropoxide (13.8 g, 48.8 mmol), and EtOH (abs.) (30 mL) was heated to 80° C. for 30 minutes then allowed to stir at room temperature for 3 hours. Sodium cyanoborohydride (NaCNBH₃) (2.45 g, 39 mmol) was then added. The reaction mixture was stirred at room temperature for 18 hours. Ether (100 mL) and H₂O (2 mL) were added to the reaction mixture and the resulting precipitate was then removed by centrifugation. The supernatant was evaporated under vacuum and the crude product was chromatographed on silica gel (50 mmx30 cm column) (elution with CH₂Cl₂). The chromatographed material was then dissolved in hexane (500 mL), decolorized with Norit® filtered (0.2 μ M), and then ethereal HCl was added to precipitate the product as a white solid (10.2 g, 56% yield), m.p.: 241-242° C. (dec.).

Example 16

Synthesis of Compound 17P

4-Methoxy-3-methylacetophenone [17P Precursor]

A mixture of 4'-hydroxy-3'-methylacetophenone (5.0 g, 33.3 mmol), iodomethane (5.7 g, 40.0 mmol), K₂CO₃ (granular, anhydrous) (23.0 g, 167 mmol), and acetone (250 mL) was refluxed for 3 hours. The reaction mixture was then cooled to room temperature, filtered to remove the inorganic salts, and evaporated under vacuum. The crude product was dissolved in ether (100 mL) and washed with H₂O (2x20 mL). The organic layer was dried (Na₂SO₄) and evaporated to yield 4.5 g, 82.4% yield. The ketone was used in the following reaction without further purification.

(R)-N-(1-(4-Methoxy-3-methylphenyl)ethyl)-(R)-1-(1-naphthyl)ethylamine hydrochloride [Compound 17P]

A mixture of (R)-(+)-1-(1-naphthyl)ethylamine (4.24 g, 24.8 mmol), 4'-methoxy-3'-methylacetophenone (4.06 g, 24.8 mmol), and titanium (IV) isopropoxide (8.8 g, 30.9 mmol), and EtOH (abs.) (1 mL) was heated to 100° C. for 2 hours. Isopropanol (45 mL) was added and the reaction was then cooled to 10° C. in an ice bath. Sodium triacetoxyborohydride (NaHB(O₂CCH₃)₂) (10.5 g, 49.5 mmol) was then added in portions over 15 minutes. The reaction mixture was then heated to 70° C. for 18 hours. The mixture was cooled to room temperature and poured into ether (400 mL).

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The suspension was centrifuged, the supernatant was collected and the pellet was washed with ether (400 mL). The combined organic washings were evaporated under vacuum. The residue was dissolved in ether (400 mL) and washed with 1 N NaOH (4x50 mL) and H₂O (2x50 mL). The organic layer was dried (Na₂SO₄), filtered and evaporated under vacuum. EtOH (abs.) was added to the wet residue which was then dried thoroughly on a rotary evaporator to provide an oil. The mixture was then chromatographed on silica gel (50 mmx30 cm) [elution with (1% MeOH:1% IPA:CHCl₃) to give 4.8 g of an oil].

The desired diastereomer was further purified by HPLC chromatography [SUPELCOSIL™ PLC-Si, 18 μM silica gel; 25 cmx21.2 mm (Supelco, Inc., Bellefonte, Pa.), 7 mL per minute; UV det. 275 nm; 20% EtOAc-80% hexane (elution time 9.5–11.0 min)]. Injections (800 mL aliquots) of the mixture (100 mg/mL solution in eluent) provided 65 mg of the desired isomer. Multiple HPLC injections provided 1.0 g of purified material. The HPLC chromatographed material was dissolved in hexane (50 mL) and the hydrochloride salt was precipitated with ethereal HCl. The salt was collected on fritted glass and washed with hexane to provide 1.0 g of a white solid, mp 204–205° C.

Example 17

Synthesis of Compound 17X

3-Chloro-4-methoxybenzaldehyde

A mixture of 3-chloro-4-hydroxybenzaldehyde (25 g, 160 mmol), iodomethane (27.25 g, 192 mmol), K₂CO₃ (granular, anhydrous) (110.6 g, 800 mmol), and acetone (300 mL) was refluxed for 3 hours. The reaction mixture was then cooled to room temperature. Diethyl ether (500 mL) was added and the mixture was filtered through paper to remove the inorganic solids. The filtrate was evaporated under reduced pressure, dissolved in diethyl ether (800 mL), and washed with 0.1 N NaOH (3x100 mL). The organic layer was dried (Na₂SO₄) and evaporated under vacuum to yield 24 g, 92% yield of crude product. This material was further purified by chromatography on silica gel (50 mmx30 cm) (elution with hexane-EtOAc, 5:1) to give 15.02 g, 56% yield of a white solid; TLC (hexane-EtOAc, 5:1) R_f=0.24; GC R_f=4.75 min; MS (EI) m/z 170(M⁺), 172(M+2).

1-Methyl-(3'-chloro-4'-methoxybenzyl) alcohol

A mixture of 3-chloro-4-methoxybenzaldehyde (13 g, 76.5 mmol), methylmagnesium chloride (52 g, 153 mmol), and THF (300 mL) was refluxed for 3 hours. The reaction mixture was cooled to room temperature. NH₄Cl (satd. soln., 6 mL) was added dropwise followed by diethyl ether (500 mL) and the mixture was filtered through paper to remove the inorganic solids. The filtrate was evaporated under reduced pressure and the resulting solid was dissolved in diethyl ether (300 mL) and washed with water (4x25 mL). The organic layer was dried (Na₂SO₄) and evaporated under vacuum to yield 11.3 g, 80% yield of crude product. This material was further purified by chromatography on silica gel (50 mmx30 cm) (elution with CH₂Cl₂) to yield 11.3 g, 63% yield of an oil; TLC (CH₂Cl₂) R_f=0.25; GC R_f=5.30 min; MS (EI) m/z 186(M⁺), 188(M+2).

3'-Chloro-4'-methoxyacetophenone

A mixture of 1-methyl-(3'-chloro-4'-methoxybenzyl) alcohol (7.6 g, 41 mmol), pyridinium chlorochromate (PCC) (13.16 g, 61.5 mmol), and CH₂Cl₂ (300 mL) was allowed to stir at room temperature for 2 hours. Diethyl ether (1000 mL) was added and the resulting mixture was placed on a chromatography column of silica gel (50 mmx30 cm)

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(elution with diethyl ether) to yield 7.3 g, 97% yield of crude solid product. GC analysis of this material showed it to be 99% pure and it was used in the following reaction without further purification. TLC (diethyl ether) R_f=1.0; GC R_f=5.3 min; MS (EI) m/z 184(M⁺), 184(M+2).

(R,R)-N-(1-Ethyl-4'-methoxy-3'-chlorophenyl)-1-(1-naphthylethyl) amine

A mixture of 3'-chloro-4'-methoxyacetophenone (5.3 g, 29 mmol), (R)-(+)-1-(1-naphthyl)ethylamine (4.98 g, 29 mmol), titanium (IV) isopropoxide (10.2 g, 36 mmol), and isopropanol (20 mL) was heated to 100° C. for 3 hours. Sodium triacetoxyborohydride (NaB(O₂CCH₃)₃; 12.29 g, 58 mmol) was added in portions over 10 minutes. The reaction mixture was heated to reflux for 30 minutes and was then allowed to stir at room temperature for 18 hours. The mixture was then poured into diethyl ether (500 mL); H₂O (2 mL) was added and the suspension was centrifuged to remove the fine precipitate of titanium salts. The supernatant was collected and the pellet was washed with ether (500 mL). The combined organic layers were dried (Na₂SO₄) and evaporated under vacuum to yield 6.81 g, 70% of crude product.

This material was further purified by chromatography on silica gel (50 mmx30 cm) (elution with 3% MeOH-97% CH₂Cl₂) to give 2.01 g of an oil. The diastereomer was further purified by recrystallization. The free base (1.98 g) was converted to its HCl salt with ethereal HCl. This salt was dissolved in hot isopropanol (65 mL) and the solution was filtered through paper. The filtrate was evaporated under vacuum and the resulting solid dissolved in isopropanol (30 mL). After standing at room temperature for 18 hours, the crystalline solid was collected, washed with cold isopropanol (20 mL), and dried to yield 0.87 g, 40% (from free base) of the diastereomerically pure hydrochloride salt: mp 236–237° C. (dec); TLC (MeOH-CH₂Cl₂[99:1]) R_f=0.25; GC R_f=11.06 min; FTIR (KBr pellet, cm⁻¹) 3433, 2950, 2931, 2853, 2803, 2659, 2608, 2497, 1604, 1595, 1504, 1461, 1444, 1268, 1260, 1067, 1021, 802, 781, 733; MS (EI) m/z 339(M⁺), 341(M+2).

Example 18

Additional Synthesis Protocol

Preparation of 22Z and 23A

A stirred solution of sodium hydride (2.173 g, 60% in oil, 54.325 mmol) in dimethylformamide (100 ml) was treated dropwise with triethyl phosphonoacetate (12.47 g, 55.65 mmol) and stirred 30 min at rt. After this time, a solution of m-trifluoromethoxy benzaldehyde (10.0 g, 52.6 mmol) in dimethylformamide (50 ml) was added dropwise and the solution stirred 30 min at rt and 30 min at 100° C. The reaction was quenched by the addition of water and transferred to a separatory funnel using diethyl ether (500 ml). The ether solution was washed with saturated ammonium chloride (4x500 ml), dried over anhydrous magnesium sulfate, filtered and concentrated to afford ethyl m-trifluoromethoxybenzyl alcohol as an oil; m/z (rel. int.) 260 (M⁺, 19), 232 (16), 215 (100), 187 (21), 101 (28).

The ethyl ester in ethanol (100 ml) was reduced under 60 p.s.i. hydrogen using a catalytic amount (10% by weight) palladium hydroxide. After reduction (2 hr, rt) the reaction was filtered and concentrated to afford ethyl m-trifluoromethoxyhydrocinnamate as an oil; m/z (rel. int.) 262 (M⁺, 16), 217 (7), 188 (100), 175 (28), 103 (31), 91 (18), 77 (23).

The saturated ethyl ester was hydrolyzed in a solution of ethanol-10 M sodium hydroxide (1:1) for 16 hr at rt. After

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this time the solution was acidified and the product extracted into diethyl ether. The ether solution was dried over anhydrous magnesium sulfate and concentrated to afford m-trifluoromethoxyhydrocinnamic acid as a solid; m/z (rel. int.) 234 (M⁺, 46), 188 (100), 174 (65), 103 (27), 91 (12), 77 (17).

The acid, was stirred in excess thionyl chloride for 4 hr at rt. The excess thionyl chloride was evaporated at reduced pressure (100° C.) to afford m-trifluoromethoxyhydrocinnamyl chloride as an oil. The product was used without further purification.

A solution of m-trifluoromethoxyhydrocinnamyl chloride (9.8 g, 39 mmol) in tetrahydrofuran was cooled to -78° C. and treated dropwise with a solution (13 ml of 3 M in tetrahydrofuran) of methylmagnesium bromide (39 mmol). The reaction was stirred 4 hr at -78° C., 8 hr at rt, and quenched with dilute HCl. The reaction mixture was extracted with diethyl ether. The ether was dried over anhydrous magnesium sulfate, filtered and concentrated to an oil. Chromatography of this material through silica using a gradient of hexane to acetone afforded 4-(3-trifluoromethoxyphenyl)-2-butanone as an oil; m/z (rel. int.) 232 (M⁺, 68), 217 (7), 189 (59), 175 (31), 103 (28), 43 (100).

A solution of 4-(3-trifluoromethoxyphenyl)-2-butanone (2.32 g, 10 mmol), (R)-1-(3-methoxyphenyl)ethylamine (1.51 g, 10 mmol), and titanium (IV) isopropoxide (3.55 g, 12.5 mmol) were stirred 4 hr at rt. The reaction mixture was then treated with a solution (10 ml of 1 M) of ethanolic sodium cyanoborohydride (10 mmol) and stirred 16 hr at rt. The reaction was diluted with diethyl ether (50 ml) and treated with water (0.72 ml, 40 mmol). After mixing thoroughly the solution was centrifuged and the ether layer decanted and concentrated to a oily solid. The solid was suspended in diethyl ether, filtered through 0.45 μm CR PTFE Acrodisc and concentrated to give a clear oil. Repetitive preparative thin-layer chromatography using 5% methanol in chloroform afforded the two diastereomers, (S,R)-N-[4-(3-trifluoromethoxyphenyl)-2-butyl]-1-(3-methoxyphenyl)ethylamine, 22Z [m/z (rel. int.) 367 (M⁺, 3), 352 (20), 232 (4), 178 (47), 135 (100), 105 (14), 91 (10), 77 (11)] and (R,R)-N-[4-(3-trifluoromethoxyphenyl)-2-butyl]-1-(3-methoxyphenyl)ethylamine, 23A; m/z (rel. int.) 367 (M⁺, 3), 352 (19), 232 (7), 178 (43), 135 (100), 105 (19), 91 (10), 77 (11).

Preparation of 22X and 22Y

In a similar fashion an equal molar amount of 4-(3-trifluoromethoxyphenyl)-2-butanone, (R)-1-(1-naphthyl)ethylamine and 1.25 equivalents titanium(IV) isopropoxide were mixed and the intermediate imine reduced with ethanolic sodium cyanoborohydride. Work-up and repetitive preparative thin-layer chromatography using 5% methanol in chloroform afforded (S,R)-N-[4-(3-trifluoromethoxyphenyl)-2-butyl]-1-(1-naphthyl)ethylamine, 22X; m/z (rel. int.) 387 (M⁺, 3), 372 (15), 198 (15), 176 (12), 155 (100), 128 (8), 115 (6), 109 (4), 103 (5), 77 (8) and (R,R)-N-[4-(3-trifluoromethoxyphenyl)-2-butyl]-1-(1-naphthyl)ethylamine, 22Y; m/z (rel. int.) 387 (M⁺, 2), 372 (12), 198 (16), 176 (11), 155 (100), 128 (8), 115 (6), 109 (4), 103 (5), 77 (8).

Preparation of 4T

In a similar fashion an equal molar amount of 4-(2-chlorophenyl)-2-butanone, prepared from o-chlorobenzaldehyde, (R)-1-(3-methoxyphenyl)ethylamine and 1.25 equivalents titanium(IV) isopropoxide were mixed and the intermediate imine reduced with ethanolic sodium cyanoborohydride. Work-up and repetitive preparative thin-

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layer chromatography using 5% methanol in chloroform afforded (R,R)-N-[4-(2-chlorophenyl)-2-butyl]-1-(3-methoxyphenyl)ethylamine, 4T; m/z (rel. int.) 317 (M⁺, 3), 302 (16), 178 (62), 135 (100), 125 (15), 105 (10), 91 (6), 77 (8).

Preparation of 21Y

In a similar fashion an equal molar amount of 4-(3-trifluoromethylphenyl)-2-butanone, prepared from m-trifluoromethylbenzaldehyde, (R)-1-(3-methoxyphenyl)ethylamine and 1.25 equivalents titanium(IV) isopropoxide were mixed and the intermediate imine reduced with ethanolic sodium cyanoborohydride. Work-up and repetitive preparative thin-layer chromatography using 5% methanol in chloroform afforded (R,R)-N-[4-(3-trifluoromethylphenyl)-2-butyl]-1-(3-methoxyphenyl)ethylamine, 21Y [m/z (rel. int.) 351 (M⁺, 2), 336 (18), 216 (4), 202 (3), 178 (45), 135 (100), 105 (13), 91(9), 77 (8)] and (S,R)-N-[4-(3-trifluoromethylphenyl)-2-butyl]-1-(3-methoxyphenyl)ethylamine, 21X.

Preparation of 25C and 25D.

In a similar fashion an equal molar amount of 4-(3-trifluoromethylphenyl)-2-butanone, (R)-1-(1-naphthyl)ethylamine and 1.25 equivalents titanium(IV) isopropoxide were mixed and the intermediate imine reduced with ethanolic sodium cyanoborohydride. Work-up and repetitive preparative thin-layer chromatography using 5% methanol in chloroform afforded (S,R)-N-[4-(3-trifluoromethylphenyl)-2-butyl]-1-(1-naphthyl)ethylamine, 25C [m/z (rel. int.) 371 (M⁺, 3), 356 (16), 198 (15), 155 (100), 129 (8), 115 (5), 109 (3), 77 (2)] and (R,R)-N-[4-(3-trifluoromethylphenyl)-2-butyl]-1-(1-naphthyl)ethylamine, 25D; m/z (rel. int.) 371 (M⁺, 3), 356 (16), 198 (15), 155 (100), 129 (8), 115 (5), 109 (3), 77 (2).

Preparation of 21D

In a similar fashion an equal molar amount of 4-phenyl-2-butanone (Aldrich Chemical Co.), (R)-1-(3-methoxyphenyl)ethylamine and 1.25 equivalents titanium (IV) isopropoxide were mixed and the intermediate imine reduced with ethanolic sodium cyanoborohydride. Work-up and repetitive preparative thin-layer chromatography using 5% methanol in chloroform afforded (R,R)-N-(4-phenyl-2-butyl)-1-(3-methoxyphenyl)ethylamine, 21D [m/z (rel. int.) 283 (M⁺, 4), 268 (13), 178 (45), 135 (100), 105 (15), 91 (43), 77 (11)] and (S,R)-N-(4-phenyl-2-butyl)-1-(3-methoxyphenyl)ethylamine, 21E.

Preparation of 21F

In a similar fashion an equal molar amount of 4-phenyl-2-butanone (Aldrich Chemical Co.), (R)-1-(1-naphthyl)ethylamine and 1.25 equivalents titanium(IV) isopropoxide were mixed and the intermediate imine reduced with ethanolic sodium cyanoborohydride. Work-up and repetitive preparative thin-layer chromatography using 5% methanol in chloroform afforded (R,R)-N-(4-phenyl-2-butyl)-1-(1-naphthyl)ethylamine, 21F; m/z (rel. int.) 303 (M⁺, 6), 288 (14), 198 (22), 155 (100), 129 (8), 115 (5), 91 (19), 77 (4).

Preparation of 12Z

A stirred solution of 2-chlorohydrocinnamionitrile (Aldrich Chemical Co., 1.66 g, 10 mmol) in dichloromethane (100 ml) was cooled to -78° C. and treated dropwise with diisobutylaluminum hydride (1.42 g, 10 mmol). The reaction was stirred 1 hr at rt, cooled to -78° C. and treated with a solution of 1-(1-naphthyl)ethylamine (1.71 g, 10 mmol) in dichloromethane (25 ml). The reaction was transferred to an ice bath and stirred 2 hr. After this time the reaction was poured directly into a stirred solution of

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ethanolic sodium borohydride (50 ml of 0.2 M, 10 mmol). The mixture was stirred 30 min at rt and the excess sodium borohydride quenched by the addition of 10% HCl. The solution was then made basic by the addition of 10 N NaOH and transferred to a separatory funnel washing with diethyl ether (300 ml). The aqueous phase was removed and the remaining organic layer washed with 1 N NaOH (3x100 ml). The organic layer was dried over anhydrous magnesium sulfate, and concentrated to an oil. Chromatography of this material through silica gel using a gradient of chloroform to 10% methanol-chloroform afforded 2.34 g (72% yield) of (R)-N-[3-(2-chlorophenyl)propyl]-1-(1-naphthyl)ethylamine, 12Z, as a clear oil; m/z (rel. int.) 323 (M⁺, 2), 308 (63), 288 (7), 196 (5), 184 (5), 155 (100), 125 (24), 115 (8), 103 (4), 91 (3), 77 (7).

Preparation of 12B

In a similar fashion, 4-methylcinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-[3-(4-methylphenyl)prop-2-enyl]-1-(3-methoxyphenyl)ethylamine, 12B, as a clear, colorless oil; m/z (rel. int.) 281 (M⁺, 6), 266 (5), 176 (27), 146 (75), 135 (63), 131 (100), 115 (25), 105 (21), 91 (21), 77 (21).

Preparation of 12C

In a similar fashion, 2-methylcinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-[3-(2-methylphenyl)prop-2-enyl]-1-(3-methoxyphenyl)ethylamine, 12C, as a clear, colorless oil; m/z (rel. int.) 281 (M⁺, 4), 266 (15), 176 (18), 146 (62), 135 (58), 131 (100), 115 (23), 105 (19), 91 (38), 77 (17).

Preparation of 12D

In a similar fashion, 2,4,6-trimethylcinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-[3-(2,4,6-trimethylphenyl)prop-2-enyl]-1-(3-methoxyphenyl)ethylamine, 12D, as a clear, colorless oil; m/z (rel. int.) 309 (M⁺, 8), 294 (25), 174 (82), 159 (100), 135 (52), 129 (29), 105 (21), 91 (17), 77 (14).

Preparation of 12E

In a similar fashion, 4-isopropylcinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-[3-(4-isopropylphenyl)prop-2-enyl]-1-(3-methoxyphenyl)ethylamine, 12E, as a clear, colorless oil; m/z (rel. int.) 309 (M⁺, 9), 294 (7), 174 (98), 159 (22), 135 (80), 117 (100), 105 (35), 91 (37), 77 (19).

Preparation of 12F

In a similar fashion, 2,4-dimethylcinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-[3-(2,4-dimethylphenyl)

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prop-2-enyl]-1-(3-methoxyphenyl)ethylamine, 12F, as a clear, colorless oil; m/z (rel. int.) 295 (M⁺, 8), 294 (15), 174 (29), 160 (75), 145 (100), 135 (68), 117 (21), 105 (30), 91 (26), 77 (19).

Preparation of 12G

In a similar fashion, 3-methylcinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-[3-(3-methylphenyl)prop-2-enyl]-1-(3-methoxyphenyl)ethylamine, 12G, as a clear, colorless oil; m/z (rel. int.) 281 (M⁺, 5), 266 (9), 176 (24), 146 (71), 135 (62), 131 (100), 115 (23), 105 (19), 91 (41), 77 (18).

Preparation of 25E

In a similar fashion, cinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-(3-phenylprop-2-enyl)-1-(3-methoxyphenyl)ethylamine, 25E, as a clear colorless oil; m/z (rel. int.) 267 (M⁺, 3), 252 (14), 176 (17), 135 (62), 117 (100), 105 (28), 91 (56), 77 (33).

Preparation of 25G

In a similar fashion, α -methylcinnamionitrile was treated with diisobutyl aluminum hydride and the intermediate aluminum-imine complex treated with (R)-1-(3-methoxyphenyl)ethylamine. The intermediate imine was treated with ethanolic sodium borohydride. Work-up and chromatography yielded (R)-N-(2-methyl-3-phenylprop-2-enyl)-1-(3-methoxyphenyl)ethylamine, 25G, as a clear, colorless oil; m/z (rel. int.) 281 (M⁺, 5), 266 (18), 190 (12), 146 (78), 135 (82), 131 (100), 115 (21), 105 (21), 91 (62), 77 (19).

Preparation of 6X

A stirred solution of sodium hydride (1.8 g, 75 mmol) in dimethylformamide (150 ml) was treated with a solution of diethylcyanomethyl phosphonate (13.3 g, 75 mmol) in dimethylformamide (50 ml). The reaction was stirred 30 min at rt. After this time the reaction was treated with 3-chlorobenzaldehyde (10.54 g, 75 mmol) and stirred 1 hr at rt and 30 min at 60° C. The reaction was then quenched by the addition of water (200 ml). The reaction mixture was transferred to a separatory funnel using diethyl ether (300 ml) and the resulting organic phase washed with water (5x300 ml) and brine. The organic layer was dried over anhydrous potassium carbonate and concentrated to yield 3-chlorocinnamionitrile (11.06 g) as a solid. The solid was dissolved in tetrahydrofuran (50 ml) and treated with excess diborane and stirred 30 min at rt. The reaction was poured over ice/10% HCl. The acidic aqueous phase was washed with diethyl ether (2x200 ml). The aqueous phase was made basic by the addition of 10 N NaOH and extracted with diethyl ether (200 ml). The ether extract was dried over anhydrous potassium carbonate and concentrated to afford 3-(3-chlorophenyl)propylamine as an oil (0.6 g, 3.54 mmol). The 3-(3-chlorophenyl)propylamine (0.60 g, 3.54 mmol), 3'-methoxyacetophenone (0.53 g, 3.54 mmol) and 1.25 molar equivalents titanium(IV) isopropoxide (1.26 g, 4.43 mmol) were mixed 4 hr at rt and the intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). The reaction was stirred 16 hr at rt, diluted with diethyl ether (50 ml) and treated with water (0.32 ml, 17.7 mmol). After mixing thoroughly the solution was

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centrifuged and the ether layer concentrated to a milky solid. This material was suspended in diethyl ether and filtered through a 0.45 μ M CR PTFE Acrodisc. The ether wash was concentrated to an oil. Chromatography of this material (silica, preparative thin-layer chromatography) using 3% methanol-dichloromethane (containing 0.1% isopropylamine) afforded N-[3-(3-dichlorophenyl)propyl]-1-(3-methoxyphenyl)ethylamine, 6X; m/z (rel. int.) 303 (M^+ , 3), 288 (40), 196 (3), 164 (8), 135 (100), 125 (46), 103 (26), 91 (29), 77 (29).

Preparation of 6V

An equal molar amount of 3-(4-chlorophenyl)propylamine (prepared in a similar fashion from 4-chlorobenzaldehyde as above) 3'-methoxyacetophenone and 1.25 molar equivalents titanium(IV) isopropoxide were mixed 4 hr at rt and the intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). Work-up and chromatography afforded N-[3-(4-chlorophenyl)propyl]-1-(3-methoxyphenyl)ethylamine, 6V, as an oil; m/z (rel. int.) 303 (M^+ , 8), 288 (91), 196 (4), 164 (10), 135 (100), 125 (61), 103 (21), 91 (21), 77 (18).

Preparation of 20A

In a similar fashion, an equal molar amount of 1-(1-methoxyphenyl)ethylamine, 4-t-butylacetophenone and 1.25 molar equivalents titanium(IV) isopropoxide were mixed 4 hr at rt and the intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). Work-up and chromatography afforded (R)-N-[1-(4-t-butylphenyl)ethyl]-1-(1-naphthyl)ethylamine, 20A, as an oil; m/z (rel. int.) 331 (M^+ , 12), 316 (29), 161 (70), 155 (100), 131 (14), 127 (13), 115(10), 105 (6), 91 (10), 77 (7).

Preparation of 25H and 25I

In a similar fashion, an equal molar amount of (R)-1-(3-methoxyphenyl)ethylamine, trans-4-phenyl-3-butene-2-one and 1.25 molar equivalents titanium(IV) isopropoxide were mixed 4 hr at rt and the intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). Work-up and chromatography afforded (R,R)-N-(2-methyl-4-phenylbut-3-enyl)-1-(3-methoxyphenyl)ethylamine, 25H, as an oil; m/z (rel. int.) 283 (M^+ , 4), 268 (13), 178 (40), 135 (100), 105 (15), 91 (47), 77 (13) and (S,R)-N-(2-methyl-4-phenylbut-3-enyl)-1-(3-methoxyphenyl)ethylamine, 25I, as an oil; m/z (rel. int.) 283 (M^+ , 4), 268 (13), 178 (40), 135 (100), 105 (15), 91 (47), 77 (13).

Preparation of 16L and 16M

In a similar fashion, an equal molar amount of (R)-1-(3-methoxyphenyl)ethylamine, 3-methoxyacetophenone and 1.25 molar equivalents titanium(IV) isopropoxide were mixed 4 hr at rt and the intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). Work-up and chromatography afforded (R,R)-N-[1-(4-methoxyphenyl)ethyl]-1-(3-methoxyphenyl)ethylamine, 16L, as an oil; m/z (rel. int.) 284 (M^+ , 1), 270 (85), 150 (83), 135 (100), 120 (12), 105 (28), 91 (25), 77 (23) and (S,R)-N-[1-(4-methoxyphenyl)ethyl]-1-(3-methoxyphenyl)ethylamine, 16M, as an oil; m/z (rel. int.) 284 (M^+ , 1), 270 (53), 150 (98), 135 (100), 120 (11), 105 (33), 91 (25), 77 (23).

Preparation of 5B/5C

In a similar fashion, 4-chloroacetophenone was used to prepare 3-methyl-3-(4-chlorophenyl)cinnamionitrile. The nitrile was catalytically reduced (palladium hydroxide, acetic acid, 60 p.s.i. hydrogen 2 hr) to generate 3-methyl-3-(4-chlorophenyl)propylamine. An equal molar amount of the amine, 3'-methoxyacetophenone and 1.25 molar equivalents titanium(IV) isopropoxide were mixed 4 hr at rt and the

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intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). Work-up and chromatography afforded N-[3-methyl-3-(4-chlorophenyl)propyl]-1-(3-methoxyphenyl)ethylamine, 5B/5C as an oil; m/z (rel. int.) 317 (M^+ , 12), 302 (74), 210 (2), 182 (4), 164 (12), 135 (100), 121 (25), 103 (40), 91 (19), 77 (28).

Preparation of 4Z/5A

In a similar fashion, 3-chloroacetophenone was used to prepare 3-methyl-3-(3-chlorophenyl)cinnamionitrile. The nitrile was catalytically reduced (palladium hydroxide, acetic acid, 60 p.s.i. hydrogen 2 hr) to generate 3-methyl-3-(3-chlorophenyl)propylamine. An equal molar amount of the amine, 3'-methoxyacetophenone and 1.25 molar equivalents titanium(IV) isopropoxide were mixed 4 hr at rt and the intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). Work-up and chromatography afforded N-[3-methyl-3-(3-chlorophenyl)propyl]-1-(3-methoxyphenyl)ethylamine, 4Z/5A, as an oil; m/z (rel. int.) 283 (M^+ , 17), 268 (71), 164 (13), 135 (100), 121 (21), 105 (27), 91 (26), 77 (14).

Preparation of 4Y

In a similar fashion, 2-chloroacetophenone was used to prepare 3-methyl-3-(2-chlorophenyl)cinnamionitrile. The nitrile was catalytically reduced (palladium hydroxide, acetic acid, 60 p.s.i. hydrogen 2 hr) to generate 3-methyl-3-(2-chlorophenyl)propylamine. An equal molar amount of the amine, 3'-methoxyacetophenone and 1.25 molar equivalents titanium(IV) isopropoxide were mixed 4 hr at rt and the intermediate imine treated with an ethanolic sodium cyanoborohydride (5 ml of 1 M, 5 mmol). Work-up and chromatography afforded N-[3-methyl-3-(2-chlorophenyl)propyl]-1-(3-methoxyphenyl)ethylamine, 4Y, as an oil; m/z (rel. int.) 283 (M^+ , 17), 268 (71), 164 (13), 135 (100), 121 (21), 105 (27), 91 (26), 77 (14).

Preparation of 6T

A solution of NPS R-568 (30.3 g 100 mmol) in dichloromethane at -78° C. was treated dropwise with borontrichloride (50 g, 200 mmol). The reaction 40 was stirred 1 hr at rt and poured over ice. The hydrobromide was extracted from the aqueous phase with chloroform. The chloroform solubles were then washed (4x100 ml) with 50% HCl. The chloroform wash was dried over anhydrous magnesium sulfate and concentrated to afford (R)-N-[3-(2-chlorophenyl)propyl]-1-(3-hydroxyphenyl)ethylamine hydrochloride as a solid. A solution of sodium hydride (0.48 g, 20 mmol) in dimethylformamide was treated with (R)-N-[3-(2-chlorophenyl)propyl]-1-(3-hydroxyphenyl)ethylamine hydrochloride (3.25 g, 10 mmol) and the reaction stirred 1 hr at rt. The reaction was treated with iodoethane (1.71 g, 11 mmol) and stirred 16 hr at rt. Work-up and chromatography through silica using 3% methanol in chloroform afforded (R)-N-[3-(2-chlorophenyl)propyl]-1-(3-ethoxyphenyl)ethylamine, 6T, as an oil; m/z (rel. int.) 316 (M^+ , 1), 302 (100), 282 (11), 196 (5), 178 (7), 149 (74), 121 (34), 103 (25), 91 (28), 77 (29).

Preparation of 6R

NPS R-467 was used in a similar fashion to prepare (R)-N-(3-phenylpropyl)-1-(3-ethoxyphenyl)ethylamine, 6R, as an oil; m/z (rel. int.) 283 (M^+ , 10), 268 (74), 178 (11), 162 (8), 149 (100), 121 (30), 103 (16), 91 (86), 77 (29).

Preparation of 3U

An equal molar mixture of 3,3-diphenylpropylamine (2.11 g, 10 mmol), 1'-acetonaphthone (1.70 g, 10 mmol) and 1.25 equivalents of titanium(IV) isopropoxide (3.55 g, 12.5 mmol) were stirred 4 hr at rt. The reaction mixture was then

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5 treated with a 1 M solution of ethanolic sodium cyanoborohydride (12.5 ml, 12.5 mmol) and stirred 16 hr at rt. The reaction was diluted with diethyl ether (50 ml) and treated with water (0.72 ml, 40 mmol). After mixing thoroughly the mixture was centrifuged and the ether layer decanted and concentrated to a milky oil. The oil was suspended in diethyl ether and filtered through a 0.45 μ M CR PTFE Acrodisc. The diethyl ether filtrate was concentrated to afford N-(3,3-diphenylpropyl)-(1-naphthyl)ethylamine, 3U, as a clear, colorless oil; m/z (rel. int.) 365 (M^+ , 17), 350 (19), 181 (23), 155 (100), 141 (25), 115 (11), 91 (13), 77 (6).

Preparation of 6F

15 In a similar fashion equal molar amounts 1-(3-methoxyphenyl)ethylamine (1.51 g, 10 mmol), 2'-acetonaphthone (1.70 g, 10 mmol) and 1.25 equivalents of titanium(IV) isopropoxide (3.55 g, 12.5 mmol) were treated as above. Work-up yielded N-[1-(2-naphthyl)ethyl]-1-(3-methoxyphenyl)ethylamine, 6F, as a clear, colorless oil; m/z (rel. int.) 305 (M^+ , 1), 290 (35), 170 (49), 155 (100), 135 (55), 115 (8), 105 (10), 91 (9), 77 (10).

Preparation of 4G

25 In a similar fashion equal molar amounts of (R)-1-phenylethylamine, 1'-acetonaphthone and 1.25 equivalents of titanium(IV) isopropoxide were mixed and the resulting intermediate imine was reduced with ethanolic sodium cyanoborohydride. Work-up and chromatography yielded N-[1-(1-naphthyl)ethyl]-1-phenylethylamine, 4G, as a clear, colorless oil; m/z (rel. int.) 275 (M^+ , 16), 260 (79), 155 (100), 127 (27), 105 (70), 77 (32).

Preparation of 4H

30 In a similar fashion equal molar amounts of (R)-1-phenylethylamine, 2'-acetonaphthone and 1.25 equivalents of titanium(IV) isopropoxide were mixed and the resulting intermediate imine was reduced with ethanolic sodium cyanoborohydride. Work-up and chromatography yielded N-[1-(2-naphthyl)ethyl]-1-phenylethylamine, 4H, as a clear, colorless oil; m/z (rel. int.) 275 (M^+ , 1), 260 (61), 155 (100), 120 (36), 105 (55), 77 (15).

Preparation of 6E

35 In a similar fashion equal molar amounts of 1-(3-methoxyphenyl)ethylamine, 1'-acetonaphthone and 1.25 equivalents of titanium(IV) isopropoxide were mixed and the resulting intermediate imine was reduced with ethanolic sodium cyanoborohydride. Work-up and chromatography yielded N-1-(1-naphthyl)ethyl-1-(3-methoxyphenyl)ethylamine, 6E, as a clear, colorless oil; m/z (rel. int.) 305 (M^+ , 10), 290 (30), 170 (43), 155 (100), 135 (69), 115 (9), 105 (15), 91 (14), 77 (18).

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Example 19

Pharmaceutical Formulation

Preparation of a pharmaceutical formulation suitable for administering a calcimimetic into a human patient is shown in Table 3.

TABLE 3

Ingredient	mg/capsule	g/representative batch of 5,000 capsules
NPS R-568	56.0	280.0
Pregelatinized Starch NF	134.0	670.0
Microcrystalline Cellulose NF	34.0	170.0
Colloidal Silicon Dioxide	1.0	5.0
Total	225 mg	1125 g

25 Other examples of NPS (R)-568 hydrochloride formulations and dosage forms include those suitable for sustained or extended release, using standard techniques.

30 Proper dosing can also be carried out using standard techniques. For example, in one set of experiments, 10-400 mg oral doses of NPS (R)-568 hydrochloride showed pharmacological activity in human subjects. Significant levels of the O-glucuronide conjugate of 17Q, a principal metabolite of NPS (R)-568, was observed in human plasma following oral administration of NPS (R)-568 hydrochloride. Thus, the glucuronide conjugate of 17Q may be exerting some beneficial effect.

35 Using standard techniques other suitable dosage ranges for NPS (R)-568 can be determined.

40 Suitable dosage ranges, formulations, and dosage forms for other compounds described herein can also be determined by one skilled in art based on the teachings provided in the application.

45 Other embodiments are within the following claims. Thus, while several embodiments have been shown and described, various modifications may be made, without departing from the spirit and scope of the present invention.

SEQUENCE LISTING

(1) GENERAL INFORMATION:

(iii) NUMBER OF SEQUENCES: 2

(2) INFORMATION FOR SEQ ID NO: 1:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 5006 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

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(ii) MOLECULE TYPE: cDNA to mRNA

(ix) FEATURE:
 (A) NAME/KEY: CDS
 (B) LOCATION: 436..3699
 (D) OTHER INFORMATION:

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 1:

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GCTGCTGTGG CCGGACCCGA AGGCGGGCGC CGGGAGCGCA GCGAGCCAGA CCGCCTCTC      60
CAAGACCCGTG ACCTTGGCAT AGGGAGCGGG GCTGCGCGCA GTCCGTGAGAT CAGACCAGAG      120
CTCATCTCTCG TGGAGACCCA CGGCCGAGGG GCCGGAGCTG CCTCTGTGCG AGGGAGCCCT      180
GGCCGCGGGC CAGAAGGCAT CACAGGAGGC CTCTGCATGA TGTGGCTTCC AAAGACTCAA      240
GGACCACCCA CATTACAAGT CTGGATTGAG GAAGGCAGAA ATGGAGATTG AACACCACG      300
TCTTCTATTA TTTTATTAAT CAATCTGTAG ACATGTGTCC CCACTGCAGG GAGTGAAGT      360
CTCCAAGGGA GAAACTTCTG GGAGCCCTCCA AACTCCTAGC TGTCTCATCC CTTGCCCTGG      420
AGAGACGGCA GAACC ATG GCA TTT TAT AGC TGC TGC TGG GTC CTC TTG GCA      471
Met Ala Phe Tyr Ser Cys Cys Trp Val Leu Leu Ala
      1              5              10

CTC ACC TGG CAC ACC TCT GCC TAC GGG CCA GAC CAG CGA GCC CAA AAG      519
Leu Thr Trp His Thr Ser Ala Tyr Gly Pro Asp Gln Arg Ala Gln Lys
      15              20              25

AAG GGG GAC ATT ATC CTT GGG GGG CTC TTT CCT ATT CAT TTT GGA GTA      567
Lys Gly Asp Ile Ile Leu Gly Gly Leu Phe Pro Ile His Phe Gly Val
      30              35              40

GCA GCT AAA GAT CAA GAT CTC AAA TCA AGG CCG GAG TCT GTG GAA TGT      615
Ala Ala Lys Asp Gln Asp Leu Lys Ser Arg Pro Glu Ser Val Glu Cys
      45              50              55              60

ATC AGG TAT AAT TTC CGT GGG TTT CGC TGG TTA CAG GCT ATG ATA TTT      663
Ile Arg Tyr Asn Phe Arg Gly Phe Arg Trp Leu Gln Ala Met Ile Phe
      65              70              75

GCC ATA GAG GAG ATA AAC AGC AGC CCA GCC CTT CTT CCC AAC TTG ACG      711
Ala Ile Glu Glu Ile Asn Ser Ser Pro Ala Leu Leu Pro Asn Leu Thr
      80              85              90

CTG GGA TAC AGG ATA TTT GAC ACT TGC AAC ACC GTT TCT AAG GCC TTG      759
Leu Gly Tyr Arg Ile Phe Asp Thr Cys Asn Thr Val Ser Lys Ala Leu
      95              100              105

GAA GCC ACC CTG AGT TTT GTT GCT CAA AAC AAA ATT GAT TCT TTG AAC      807
Glu Ala Thr Leu Ser Phe Val Ala Gln Asn Lys Ile Asp Ser Leu Asn
      110              115              120

CTT GAT GAG TTC TGC AAC TGC TCA GAG CAC ATT CCC TCT ACG ATT GCT      855
Leu Asp Glu Phe Cys Asn Cys Ser Glu His Ile Pro Ser Thr Ile Ala
      125              130              135              140

GTG GTG GGA GCA ACT GGC TCA GGC GTC TCC ACG GCA GTG GCA AAT CTG      903
Val Val Gly Ala Thr Gly Ser Gly Val Ser Thr Ala Val Ala Asn Leu
      145              150              155

CTG GGG CTC TTC TAC ATT CCC CAG GTC AGT TAT GCC TCC TCC AGC AGA      951
Leu Gly Leu Phe Tyr Ile Pro Gln Val Ser Tyr Ala Ser Ser Ser Arg
      160              165              170

CTC CTC AGC AAC AAG AAT CAA TTC AAG TCT TTC CTC CGA ACC ATC CCC      999
Leu Leu Ser Asn Lys Asn Gln Phe Lys Ser Phe Leu Arg Thr Ile Pro
      175              180              185

AAT GAT GAG CAC CAG GCC ACT GCC ATG GCA GAC ATC ATC GAG TAT TTC      1047
Asn Asp Glu His Gln Ala Thr Ala Met Ala Asp Ile Ile Glu Tyr Phe
      190              195              200

CGC TGG AAC TGG GTG GGC ACA ATT GCA GCT GAT GAC GAC TAT GGG CGG      1095
Arg Trp Asn Trp Val Gly Thr Ile Ala Ala Asp Asp Asp Tyr Gly Arg
      205              210              215              220
    
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CAG CAT GTG GTA GAG GTG ATT CAA AAT TCC ACG GCC AAA GTC ATC GTG Gln His Val Val Glu Val Ile Gln Asn Ser Thr Ala Lys Val Ile Val 255 260 265	1239
GTT TTC TCC AGT GGC CCA GAT CTT GAG CCC CTC ATC AAG GAG ATT GTC Val Phe Ser Ser Gly Pro Asp Leu Glu Pro Leu Ile Lys Glu Ile Val 270 275 280	1287
CGG CGC AAT ATC ACG GGC AAG ATC TGG CTG GCC AGC GAG GCC TGG GCC Arg Arg Asn Ile Thr Gly Lys Ile Trp Leu Ala Ser Glu Ala Trp Ala 285 290 295 300	1335
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ACC ATT GGA TTC GCT CTG AAG GCT GGG CAG ATC CCA GGC TTC CGG GAA Thr Ile Gly Phe Ala Leu Lys Ala Gly Gln Ile Pro Gly Phe Arg Glu 320 325 330	1431
TTC CTG AAG AAG GTC CAT CCC AGG AAG TCT GTC CAC AAT GGT TTT GCC Phe Leu Lys Lys Val His Pro Arg Lys Ser Val His Asn Gly Phe Ala 335 340 345	1479
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GGG GAT GAG AAC ATC AGC AGT GTC GAG ACC CCT TAC ATA GAT TAC ACG Gly Asp Glu Asn Ile Ser Ser Val Glu Thr Pro Tyr Ile Asp Tyr Thr 400 405 410	1671
CAT TTA CGG ATA TCC TAC AAT GTG TAC TTA GCA GTC TAC TCC ATT GCC His Leu Arg Ile Ser Tyr Asn Val Tyr Leu Ala Val Tyr Ser Ile Ala 415 420 425	1719
CAC GCC TTG CAA GAT ATA TAT ACC TGC TTA CCT GGG AGA GGG CTC TTC His Ala Leu Gln Asp Ile Tyr Thr Cys Leu Pro Gly Arg Gly Leu Phe 430 435 440	1767
ACC AAT GGC TCC TGT GCA GAC ATC AAG AAA GTT GAG GCG TGG CAG GTC Thr Asn Gly Ser Cys Ala Asp Ile Lys Lys Val Glu Ala Trp Gln Val 445 450 455 460	1815
CTG AAG CAC CTA CGG CAT CTA AAC TTT ACA AAC AAT ATG GGG GAG CAG Leu Lys His Leu Arg His Leu Asn Phe Thr Asn Asn Met Gly Glu Gln 465 470 475	1863
GTG ACC TTT GAT GAG TGT GGT GAC CTG GTG GGG AAC TAT TCC ATC ATC Val Thr Phe Asp Glu Cys Gly Asp Leu Val Gly Asn Tyr Ser Ile Ile 480 485 490	1911
AAC TGG CAC CTC TCC CCA GAG GAT GGC TCC ATC GTG TTT AAG GAA GTC Asn Trp His Leu Ser Pro Glu Asp Gly Ser Ile Val Phe Lys Glu Val 495 500 505	1959
GGG TAT TAC AAC GTC TAT GCC AAG AAG GGA GAA AGA CTC TTC ATC AAC Gly Tyr Tyr Asn Val Tyr Ala Lys Lys Gly Glu Arg Leu Phe Ile Asn 510 515 520	2007
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Phe Glu Cys Val Glu Cys Pro Asp Gly Glu Tyr Ser Asp Glu Thr Asp	
575 580 585	
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Ala Ser Ala Cys Asn Lys Cys Pro Asp Asp Phe Trp Ser Asn Glu Asn	
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CAC ACC TCC TGC ATT GCC AAG GAG ATC GAG TTT CTG TCG TGG ACG GAG	2295
His Thr Ser Cys Ile Ala Lys Glu Ile Glu Phe Leu Ser Trp Thr Glu	
605 610 615 620	
CCC TTT GGG ATC GCA CTC ACC CTC TTT GCC GTG CTG GGC ATT TTC CTG	2343
Pro Phe Gly Ile Ala Leu Thr Leu Phe Ala Val Leu Gly Ile Phe Leu	
625 630 635	
ACA GCC TTT GTG CTG GGT GTG TTT ATC AAG TTC CGC AAC ACA CCC ATT	2391
Thr Ala Phe Val Leu Gly Val Phe Ile Lys Phe Arg Asn Thr Pro Ile	
640 645 650	
GTC AAG GCC ACC AAC CGA GAG CTC TCC TAC CTC CTC CTC TTC TCC CTG	2439
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655 660 665	
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670 675 680	
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Trp Thr Cys Arg Leu Arg Gln Pro Ala Phe Gly Ile Ser Phe Val Leu	
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Glu Ala Lys Ile Pro Thr Ser Phe His Arg Lys Trp Trp Gly Leu Asn	
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CTG CAG TTC CTG CTG GTT TTC CTC TGC ACC TTC ATG CAG ATT GTC ATC	2679
Leu Gln Phe Leu Leu Val Phe Leu Cys Thr Phe Met Gln Ile Val Ile	
735 740 745	
TGT GTG ATC TGG CTC TAC ACC GCG CCC CCC TCA AGC TAC CGC AAC CAG	2727
Cys Val Ile Trp Leu Tyr Thr Ala Pro Pro Ser Ser Tyr Arg Asn Gln	
750 755 760	
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Glu Leu Glu Asp Glu Ile Ile Phe Ile Thr Cys His Glu Gly Ser Leu	
765 770 775 780	
ATG GCC CTG GGC TTC CTG ATC GGC TAC ACC TGC CTG CTC GCT GCC ATC	2823
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TGC TTC TTC TTT GCC TTC AAG TCC CGG AAG CTG CCG GAG AAC TTC AAT	2871
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Glu Ala Lys Phe Ile Thr Phe Ser Met Leu Ile Phe Phe Ile Val Trp	
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830 835 840	
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845	850	855	860	
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GTG GCT GCC CGG GCC ACG CTG CGC CGC AGC AAC GTC TCC CGC AAG CGG Val Ala Ala Arg Ala Thr Leu Arg Arg Ser Asn Val Ser Arg Lys Arg 895 900 905				3159
TCC AGC AGC CTT GGA GGC TCC ACG GGA TCC ACC CCC TCC TCC TCC ATC Ser Ser Ser Leu Gly Gly Ser Thr Gly Ser Thr Pro Ser Ser Ser Ile 910 915 920				3207
AGC AGC AAG AGC AAC AGC GAA GAC CCA TTC CCA CGG CCC GAG AGG CAG Ser Ser Lys Ser Asn Ser Glu Asp Pro Phe Pro Arg Pro Glu Arg Gln 925 930 935 940				3255
AAG CAG CAG CAG CCG CTG GCC CTA ACC CAG CAA GAG CAG CAG CAG CAG Lys Gln Gln Gln Pro Leu Ala Leu Thr Gln Gln Gln Gln Gln Gln 945 950 955				3303
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TTT GAT GAG CCT CAG AAG AAC GCC ATG GCC CAC AGG AAT TCT ACG CAC Phe Asp Glu Pro Gln Lys Asn Ala Met Ala His Arg Asn Ser Thr His 990 995 1000				3447
CAG AAC TCC CTG GAG GCC CAG AAA AGC AGC GAT ACG CTG ACC CGA CAC Gln Asn Ser Leu Glu Ala Gln Lys Ser Ser Asp Thr Leu Thr Arg His 1005 1010 1015 1020				3495
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ATAAGGAGAA TGTATCTCCT CCTATTTATG AAAACCATAT GATATTTTGT CTCCTACCTG				4219
CTGCTGCTAT TATGTAACAT CCAGAAGTT TGCACCCCTC CTATACCATA TGTCTGGTTC				4279

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TGTCCAGGAC ATGATACTGA TGCCATGTTT AGATTCCAGG ATCACAAGAA TCACCTCAA 4339
 TTGTTAGGAA GGGACTGCAT AAACCAATGA GCTGTATCTG TAATTAATAT TCCTATATGT 4399
 AGCTTTATCC TTAGGAAAAT GCTTCTGTG TAATAGTCCA TGGACAATAT AAACGAAA 4459
 ATGTCAGTCT GGTTTATATA AGCCAGTATT ATTGAGCTCT ATTTCCCCAC CCCACTATCC 4519
 TCACTCCCAT AAGCTAAGCC TTATGTGAGC CCCTTCAGGG ACTCAAGGGT CCAGAAGTCC 4579
 CTCCCATCTC TACCCCAAG AATTCCTGAA GCCAGATCCA CCCTATCCCT GTACAGAGTA 4639
 AGTTCTCAAT TATTGGCCTG CTAATAGCTG CTAGGGTAGG AAGCGTGGT TCCAAGAAAG 4699
 ATCCACCCCT AAATGTGCGA GCTATGTTCC CTCCAGCAGT GGTATTAATA CTGCCGGTCA 4759
 CCCAGGCTCT GGAGCCAGAG AGACAGACCG GGGTTCAAGC CATGGCTTCG TCATTTGCAA 4819
 GCTGAGTGAC TGTAGGCAGG GAACCTTAC CTCTCTAAGC CACAGCTTCT TCATCTTAA 4879
 AATAAGGATA ATAATCATT CTCCCTCA GAGCTCTTAT GTGGATTAAA CGAGATAATG 4939
 TATATAAAGT ACTTTAGCCT GGTACCTAGC ACACAATAAG CATTCAATAA ATATTAGTTA 4999
 ATATTAT 5006

(2) INFORMATION FOR SEQ ID NO: 2:

- (i) SEQUENCE CHARACTERISTICS:
 - (A) LENGTH: 3809 base pairs
 - (B) TYPE: nucleic acid
 - (C) STRANDEDNESS: single
 - (D) TOPOLOGY: linear
- (ii) MOLECULE TYPE: cDNA to mRNA
- (ix) FEATURE:
 - (A) NAME/KEY: CDS
 - (B) LOCATION: 373...3606
 - (D) OTHER INFORMATION:
- (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 2:

CAACAGGCAC CTGGCTGCAG CCAGGAAGGA CCGCACGCC TTTCCGCGCAG GAGAGTGGAA 60
 GGAGGGGACT GTTGGCCAGC ACCGAGGTCT TCGGCGCACAG GCAACGCTTG ACCTGAGTCT 120
 TGCAGAAATGA AAGGCATCAC AGGAGGCCTC TGCATGATGT GGCITCCAAA GACTCAAGGA 180
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 TCTATTATT TATTAATCAA TCTGTAGACA TGTGTCCCA CTGCAGGGAG TGAAGTCTC 300
 CAAGGGAGAA ACTTCTGGGA GCCTCCAAC TCCTAGCTGT CTCATCCCTT GCCCTGGAGA 360
 GACGGCAGAA CC ATG GCA TTT TAT AGC TGC TGC TGG GTC CTC TTG GCA 408
 Met Ala Phe Tyr Ser Cys Cys Trp Val Leu Leu Ala
 1 5 10
 CTC ACC TGG CAC ACC TCT GCC TAC GGG CCA GAC CAG CGA GCC CAA AAG 456
 Leu Thr Trp His Thr Ser Ala Tyr Gly Pro Asp Gln Arg Ala Gln Lys
 15 20 25
 AAG GGG GAC ATT ATC CTT GGG GGG CTC TTT CCT ATT CAT TTT GGA GTA 504
 Lys Gly Asp Ile Ile Leu Gly Gly Leu Phe Pro Ile His Phe Gly Val
 30 35 40
 GCA GCT AAA GAT CAA GAT CTC AAA TCA AGG CCG GAG TCT GTG GAA TGT 552
 Ala Ala Lys Asp Gln Asp Leu Lys Ser Arg Pro Glu Ser Val Glu Cys
 45 50 55 60
 ATC AGG TAT AAT TTC CGT GGG TTT CGC TGG TTA CAG GCT ATG ATA TTT 600
 Ile Arg Tyr Asn Phe Arg Gly Phe Arg Trp Leu Gln Ala Met Ile Phe
 65 70 75
 CCC ATA CAG GAG ATA AAC AGC AGC CCA GCC CTT CTT CCC AAC TTG ACG 648
 Ala Ile Glu Glu Ile Asn Ser Ser Pro Ala Leu Leu Pro Asn Leu Thr

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	80	85	90	
CTG GGA TAC AGG ATA TTT GAC ACT TGC AAC ACC GTT TCT AAG GCC TTG				696
Leu Gly Tyr Arg Ile Phe Asp Thr Cys Asn Thr Val Ser Lys Ala Leu	95	100	105	
GAA GCC ACC CTG AGT TTT GTT GCT CAA AAC AAA ATT GAT TCT TTG AAC				744
Glu Ala Thr Leu Ser Phe Val Ala Gln Asn Lys Ile Asp Ser Leu Asn	110	115	120	
CTT GAT GAG TTC TGC AAC TGC TCA GAG CAC ATT CCC TCT ACG ATT GCT				792
Leu Asp Glu Phe Cys Asn Cys Ser Glu His Ile Pro Ser Thr Ile Ala	125	130	135	140
GTG GTG GGA GCA ACT GGC TCA GGC GTC TCC ACG GCA GTG GCA AAT CTG				840
Val Val Gly Ala Thr Gly Ser Glu Val Ser Thr Ala Val Ala Asn Leu	145	150	155	
CTG GGG CTC TTC TAC ATT CCC CAG GTC AGT TAT GCC TCC TCC AGC AGA				888
Leu Gly Leu Phe Tyr Ile Pro Gln Val Ser Tyr Ala Ser Ser Ser Arg	160	165	170	
CTC CTC AGC AAC AAG AAT CAA TTC AAG TCT TTC CTC CGA ACC ATC CCC				936
Leu Leu Ser Asn Lys Asn Gln Phe Lys Ser Phe Leu Arg Thr Ile Pro	175	180	185	
AAT GAT GAG CAC CAG GCC ACT GCC ATG GCA GAC ATC ATC GAG TAT TTC				984
Asn Asp Glu His Gln Ala Thr Ala Met Ala Asp Ile Ile Glu Tyr Phe	190	195	200	
CGC TGG AAC TGG GTG GGC ACA ATT GCA GCT GAT GAC GAC TAT GGG CGG				1032
Arg Trp Asn Trp Val Gly Thr Ile Ala Ala Asp Asp Asp Tyr Gly Arg	205	210	215	220
CCG GGG ATT GAG AAA TTC CGA GAG GAA GCT GAG GAA AGG GAT ATC TGC				1080
Pro Gly Ile Glu Lys Phe Arg Glu Glu Ala Glu Glu Arg Asp Ile Cys	225	230	235	
ATC CAC TTC AGT GAA CTC ATC TCC CAG TAC TCT GAT GAG GAA GAG ATC				1128
Ile Asp Phe Ser Glu Leu Ile Ser Gln Tyr Ser Asp Glu Glu Glu Ile	240	245	250	
CAG CAT GTG GTA GAG GTG ATT CAA AAT TCC ACG GCC AAA GTC ATC GTG				1176
Gln His Val Val Glu Val Ile Gln Asn Ser Thr Ala Lys Val Ile Val	255	260	265	
GTT TTC TCC AGT GGC CCA GAT CTT GAG CCC CTC ATC AAG GAG ATT GTC				1224
Val Phe Ser Ser Gly Pro Asp Leu Glu Pro Leu Ile Lys Glu Ile Val	270	275	280	
CGG CGC AAT ATC ACG GGC AAG ATC TGG CTG GCC AGC GAG GCC TGG GCC				1272
Arg Arg Asn Ile Thr Gly Lys Ile Trp Leu Ala Ser Glu Ala Trp Ala	285	290	295	300
AGC TCC TCC CTG ATC GCC ATG CCT CAG TAC TTC CAC GTG GTT GGC GGC				1320
Ser Ser Ser Leu Ile Ala Met Pro Gln Tyr Phe His Val Val Gly Gly	305	310	315	
ACC ATT GGA TTC GCT CTG AAG GCT GGG CAG ATC CCA GCG TTC CCG GAA				1368
Thr Ile Gly Phe Ala Leu Lys Ala Gly Gln Ile Pro Gly Phe Arg Glu	320	325	330	
TTC CTG AAG AAG GTC CAT CCC AGG AAG TCT GTC CAC AAT GGT TTT GCC				1416
Phe Leu Lys Lys Val His Pro Arg Lys Ser Val His Asn Gly Phe Ala	335	340	345	
AAG GAG TTT TGG GAA GAA ACA TTT AAC TGC CAC CTC CAA GAA GGT GCA				1464
Lys Glu Phe Trp Glu Glu Thr Phe Asn Cys His Leu Gln Glu Gly Ala	350	355	360	
AAA GGA CCT TTA CCT GTG GAC ACC TTT CTG AGA GGT CAC GAA GAA AGT				1512
Lys Gly Pro Leu Pro Val Asp Thr Phe Leu Arg Gly His Glu Glu Ser	365	370	375	380
GGC GAC AGG TTT AGC AAC AGC TCG ACA GCC TTC CGA CCC CTC TGT ACA				1560
Gly Asp Arg Phe Ser Asn Ser Ser Thr Ala Phe Arg Pro Leu Cys Thr	385	390	395	
GGG GAT GAG AAC ATC AGC AGT GTC GAG ACC CCT TAC ATA GAT TAC ACG				1608

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Gly	Asp	Glu	Asn	Ile	Ser	Ser	Val	Glu	Thr	Pro	Tyr	Ile	Asp	Tyr	Thr		
			400					405					410				
CAT	TTA	CGG	ATA	TCC	TAC	AAT	GTG	TAC	TTA	GCA	GTC	TAC	TCC	ATT	GCC	1656	
His	Leu	Arg	Ile	Ser	Tyr	Asn	Val	Tyr	Leu	Ala	Val	Tyr	Ser	Ile	Ala		
		415					420					425					
CAC	GCC	TTG	CAA	GAT	ATA	TAT	ACC	TGC	TTA	CCT	GGG	AGA	GGG	CTC	TTC	1704	
His	Ala	Leu	Gln	Asp	Ile	Tyr	Thr	Cys	Leu	Pro	Gly	Arg	Gly	Leu	Phe		
		430				435					440						
ACC	AAT	GGC	TCC	TGT	GCA	GAC	ATC	AAG	AAA	GTT	GAG	GCG	TGG	CAG	GTC	1752	
Thr	Asn	Gly	Ser	Cys	Ala	Asp	Ile	Lys	Lys	Val	Glu	Ala	Trp	Gln	Val		
		445			450					455				460			
CTG	AAG	CAC	CTA	CGG	CAT	CTA	AAC	TTT	ACA	AAC	AAT	ATG	GGG	GAG	CAG	1800	
Leu	Lys	His	Leu	Arg	His	Leu	Asn	Phe	Thr	Asn	Asn	Met	Gly	Glu	Gln		
			465					470					475				
GTG	ACC	TTT	GAT	GAG	TGT	GGT	GAC	CTG	GTG	GGG	AAC	TAT	TCC	ATC	ATC	1848	
Val	Thr	Phe	Asp	Glu	Cys	Gly	Asp	Leu	Val	Gly	Asn	Tyr	Ser	Ile	Ile		
			480				485						490				
AAC	TGG	CAC	CTC	TCC	CCA	GAG	GAT	GGC	TCC	ATC	GTG	TTT	AAG	GAA	GTC	1896	
Asn	Trp	His	Leu	Ser	Pro	Glu	Asp	Gly	Ser	Ile	Val	Phe	Lys	Glu	Val		
		495				500						505					
GGG	TAT	TAC	AAC	GTC	TAT	GCC	AAG	AAG	GGA	GAA	AGA	CTC	TTC	ATC	AAC	1944	
Gly	Tyr	Tyr	Asn	Val	Tyr	Ala	Lys	Lys	Gly	Glu	Arg	Leu	Phe	Ile	Asn		
		510				515					520						
GAG	GAG	AAA	ATC	CTG	TGG	AGT	GGG	TTC	TCC	AGG	GAG	GTG	CCC	TTC	TCC	1992	
Glu	Glu	Lys	Ile	Leu	Trp	Ser	Gly	Phe	Ser	Arg	Glu	Val	Pro	Phe	Ser		
					530					535					540		
AAC	TGC	AGC	CGA	GAC	TGC	CTG	GCA	GGG	ACC	AGG	AAA	GGG	ATC	ATT	GAG	2040	
Asn	Cys	Ser	Arg	Asp	Cys	Leu	Ala	Gly	Thr	Arg	Lys	Gly	Ile	Ile	Glu		
			545					550					555				
GGG	GAG	CCC	ACC	TGC	TGC	TTT	GAG	TGT	GTG	GAG	TGT	CCT	GAT	GGG	GAG	2088	
Gly	Glu	Pro	Thr	Cys	Cys	Phe	Glu	Cys	Val	Glu	Cys	Pro	Asp	Gly	Glu		
			560				565						570				
TAT	AGT	GAT	GAG	ACA	GAT	GCC	AGT	GCC	TGT	AAC	AAG	TGC	CCA	GAT	GAC	2136	
Tyr	Ser	Asp	Glu	Thr	Asp	Ala	Ser	Ala	Cys	Asn	Lys	Cys	Pro	Asp	Asp		
		575				580						585					
TTC	TGG	TCC	AAT	GAG	AAC	CAC	ACC	TCC	TGC	ATT	GCC	AAG	GAG	ATC	GAG	2184	
Phe	Trp	Ser	Asn	Glu	Asn	His	Thr	Ser	Cys	Ile	Ala	Lys	Glu	Ile	Glu		
		590				595					600						
TTT	CTG	TCG	TGG	ACG	GAG	CCC	TTT	GGG	ATC	GCA	CTC	ACC	CTC	TTT	GCC	2232	
Phe	Leu	Ser	Trp	Thr	Glu	Pro	Phe	Gly	Ile	Ala	Leu	Thr	Leu	Phe	Ala		
		605			610					615				620			
GTG	CTG	GGC	ATT	TTC	CTG	ACA	GCC	TTT	GTG	CTG	GGT	GTG	TTT	ATC	AAG	2280	
Val	Leu	Gly	Ile	Phe	Leu	Thr	Ala	Phe	Val	Leu	Gly	Val	Phe	Ile	Lys		
				625					630				635				
TTC	CGC	AAC	ACA	CCC	ATT	GTC	AAG	GCC	ACC	AAC	CGA	GAG	CTC	TCC	TAC	2328	
Phe	Arg	Asn	Thr	Pro	Ile	Val	Lys	Ala	Thr	Asn	Arg	Glu	Leu	Ser	Tyr		
			640					645					650				
CTC	CTC	CTC	TTC	TCC	CTG	CTC	TGC	TGC	TTC	TCC	AGC	TCC	CTG	TTC	TTC	2376	
Leu	Leu	Leu	Phe	Ser	Leu	Leu	Cys	Cys	Phe	Ser	Ser	Ser	Leu	Phe	Phe		
			655				660						665				
ATC	GGG	GAG	CCC	CAG	GAC	TGG	ACG	TGC	CGC	CTG	CGC	CAG	CCG	GCC	TTT	2424	
Ile	Gly	Glu	Pro	Gln	Asp	Trp	Thr	Cys	Arg	Leu	Arg	Gln	Pro	Ala	Phe		
		670				675					680						
GCC	ATC	AGC	TTC	GTG	CTC	TGC	ATC	TCA	TGC	ATC	CTG	GTG	AAA	ACC	AAC	2472	
Gly	Ile	Ser	Phe	Val	Leu	Cys	Ile	Ser	Cys	Ile	Leu	Val	Lys	Thr	Asn		
					690					695				700			
CGT	GTC	CTC	CTG	GTG	TTT	GAG	GCC	AAG	ATC	CCC	ACC	AGC	TTC	CAC	CGC	2520	
Arg	Val	Leu	Leu	Val	Phe	Glu	Ala	Lys	Ile	Pro	Thr	Ser	Phe	His	Arg		
					705					710				715			

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AAG TGG TGG GGG CTC AAC CTG CAG TTC CTG CTG GTT TTC CTC TGC ACC	2568
Lys Trp Trp Gly Leu Asn Leu Gln Phe Leu Leu Val Phe Leu Cys Thr	
720 725 730	
TTC ATG CAG ATT GTC ATC TGT GTG ATC TGG CTC TAC ACC GCG CCC CCC	2616
Phe Met Gln Ile Val Ile Cys Val Ile Trp Leu Tyr Thr Ala Pro Pro	
735 740 745	
TCA AGC TAC CGC AAC CAG GAG CTG GAG GAT GAG ATC ATC TTC ATC ACG	2664
Ser Ser Tyr Arg Asn Gln Glu Leu Glu Asp Glu Ile Ile Phe Ile Thr	
750 755 760	
TGC CAC GAG GGC TCC CTC ATG GCC CTG GGC TTC CTG ATC GGC TAC ACC	2712
Cys His Glu Gly Ser Leu Met Ala Leu Gly Phe Leu Ile Gly Tyr Thr	
765 770 775 780	
TGC CTG CTG GCT GCC ATC TGC TTC TTC TTT GCC TTC AAG TCC CGG AAG	2760
Cys Leu Leu Ala Ala Ile Cys Phe Phe Phe Ala Phe Lys Ser Arg Lys	
785 790 795	
CTG CCG GAG AAC TTC AAT GAA GCC AAG TTC ATC ACC TTC AGC ATG CTC	2808
Leu Pro Glu Asn Phe Asn Glu Ala Lys Phe Ile Thr Phe Ser Met Leu	
800 805 810	
ATC TTC TTC ATC GTC TGG ATC TCC TTC ATT CCA GCC TAT GCC AGC ACC	2856
Ile Phe Phe Ile Val Trp Ile Ser Phe Ile Pro Ala Tyr Ala Ser Thr	
815 820 825	
TAT GGC AAG TTT GTC TCT GCC GTA GAG GTG ATT GCC ATC CTG GCA GCC	2904
Tyr Gly Lys Phe Val Ser Ala Val Glu Val Ile Ala Ile Leu Ala Ala	
830 835 840	
AGC TTT GGC TTG CTG GCG TGC ATC TTC TTC AAC AAG ATC TAC ATC ATT	2952
Ser Phe Gly Leu Leu Ala Cys Ile Phe Phe Asn Lys Ile Tyr Ile Ile	
845 850 855 860	
CTC TTC AAG CCA TCC CGC AAC ACC ATC GAG GAG GTG CGT TGC AGC ACC	3000
Leu Phe Lys Pro Ser Arg Asn Thr Ile Glu Glu Val Arg Cys Ser Thr	
865 870 875	
GCA GCT CAC GCT TTC AAG GTG GCT GCC CGG GCC ACG CTG CGC CGC AGC	3048
Ala Ala His Ala Phe Lys Val Ala Ala Arg Ala Thr Leu Arg Arg Ser	
880 885 890	
AAC GTC TCC CGC AAG CGG TCC AGC AGC CTT GGA GGC TCC ACG GGA TCC	3096
Asn Val Ser Arg Lys Arg Ser Ser Ser Leu Gly Gly Ser Thr Gly Ser	
895 900 905	
ACC CCC TCC TCC TCC ATC AGC AGC AAG AGC AAC AGC GAA GAC CCA TTC	3144
Thr Pro Ser Ser Ser Ile Ser Ser Lys Ser Asn Ser Glu Asp Pro Phe	
910 915 920	
CCA CAG CCC GAG AGG CAG AAG CAG CAG CAG CCG CTG GCC CTA ACC CAG	3192
Pro Gln Pro Glu Arg Gln Lys Gln Gln Gln Pro Leu Ala Leu Thr Gln	
925 930 935 940	
CAA GAG CAG CAG CAG CAG CCC CTG ACC CTC CCA CAG CAG CAA CGA TCT	3240
Gln Glu Gln Gln Gln Gln Pro Leu Thr Leu Pro Gln Gln Gln Arg Ser	
945 950 955	
CAG CAG CAG CCC AGA TGC AAG CAG AAG GTC ATC TTT GGC AGC GGC ACG	3288
Gln Gln Gln Pro Arg Cys Lys Gln Lys Val Ile Phe Gly Ser Gly Thr	
960 965 970	
GTC ACC TTC TCA CTG AGC TTT GAT GAG CCT CAG AAG AAC GCC ATG GCC	3336
Val Thr Phe Ser Leu Ser Phe Asp Glu Pro Gln Lys Asn Ala Met Ala	
975 980 985	
CAC GGG AAT TCT ACG CAC CAG AAC TCC CTG GAG GCC CAG AAA AGC AGC	3384
His Gly Asn Ser Thr His Gln Asn Ser Leu Glu Ala Gln Lys Ser Ser	
990 995 1000	
GAT ACG CTG ACC CGA CAC CAG CCA TTA CTC CCG CTG CAG TGC GGG GAA	3432
Asp Thr Leu Thr Arg His Gln Pro Leu Leu Pro Leu Gln Cys Gly Glu	
1005 1010 1015 1020	
ACG GAC TTA GAT CTG ACC GTC CAG GAA ACA GGT CTG CAA GGA CCT GTG	3480
Thr Asp Leu Asp Leu Thr Val Gln Glu Thr Gly Leu Gln Gly Pro Val	
1025 1030 1035	

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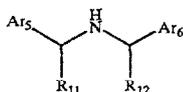
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GGT GGA GAC CAG CGG CCA GAG GTG GAG GAC CCT GAA GAG TFG TCC CCA Gly Gly Asp Gln Arg Pro Glu Val Glu Asp Pro Glu Glu Leu Ser Pro 1040 1045 1050	3528
GCA CTT GTA GTG TCC AGT TCA CAG AGC TTT GTC ATC AGT GGT GGA GGC Ala Leu Val Val Ser Ser Ser Gln Ser Phe Val Ile Ser Gly Gly Gly 1055 1060 1065	3576
AGC ACT GTT ACA GAA AAC GTA GTG AAT TCA TAAAATGGAA GGAGAAGACT Ser Thr Val Thr Glu Asn Val Val Asn Ser 1070 1075	3626
GGGCTAGGGA GAATGCAGAG AGGTTTCTTG GGGTCCCAGG GATGAGGAAT CGCCCCAGAC	3686
TCCTTTCTCTC TGAGGAAGAA GGGATAATAG ACACATCAA TGCCCCGAAT TTAGTCACAC	3746
CATCTTAAAT GACAGTGAAT TGACCCATGT TCCCTTAAA AAAAAAAAAA AAAAAGCGGC	3806
CGC	3809

What is claimed is:

1. A compound having the formula:



wherein Ar₅ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy, benzyl, benzyloxy, α,α-dimethylbenzyl, NO₂, CHO, CH₃CH(OH), acetyl, ethylene dioxy, and —CH=CH-phenyl;

Ar₆ is phenyl substituted with 1 to 5 substituents each independently selected from the group consisting of, acetyl, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, carbomethoxy, OCH₂C(O)C₂H₅ and OCH₂C(O)OC₂H₅ and acetoxy, provided that at least one substituent is OCH₂C(O)OC₂H₅;

R₁₁ is hydrogen or methyl; and

R₁₂ is hydrogen or methyl;

provided that at least one of R₁₁ and R₁₂ is methyl; or a pharmaceutically acceptable salt or complex thereof.

2. The compound of claim 1, wherein Ar₆ is a substituted phenyl comprising a OCH₂C(O)OC₂H₅ substituent in a meta position.

3. A compound selected from the group consisting of:

21S ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-propoxyphenyl)ethylamine);

21T ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isopropoxyphenyl)ethylamine);

21U ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isobutoxyphenyl)ethylamine);

21Y ((R,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine);

22J ((R)-N-(3-(3-(trifluoromethyl)phenyl)propyl)-1-(1-naphthyl)ethylamine);

23A ((R)-N-(4-(3-(trifluoromethoxy)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine);

23E ((R)-N-(3-(3-(trifluoromethoxy)phenyl)methyl)-1-(1-naphthyl)ethylamine;

24B (N-((3-methyl-4-methoxyphenyl)methyl)-1-(2-(trifluoromethyl)phenyl)ethylamine);

24J ((R)-N-(3-(3-(trifluoromethoxy)phenyl)propyl)-1-(1-naphthyl)ethylamine;

24M ((R)-N-(3-(3,5-difluorophenyl)propyl)-1-(3-methoxyphenyl)ethylamine;

24V (N-((3-methyl-4-methoxyphenyl)methyl)-1-(3-(ethylacetoxy)phenyl)ethylamine);

24X ((R)-N-(3-bromo-4-methoxyphenyl)methyl)-1-(1-naphthyl)ethylamine);

24Y ((R)-N-(3-chloro-4-ethoxyphenyl)methyl)-1-(1-naphthyl)ethylamine;

25C ((S,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine);

25D ((R,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine); and

25E ((R)-N-(3-phenylprop-2-en-1-yl)-1-(3-methoxyphenyl)ethylamine; or a pharmaceutically acceptable salt or complex thereof.

4. The compound of claim 3, wherein said compound is 21Y ((R,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.

5. The compound of claim 3, wherein said compound is 22J ((R)-N-(3-(3-(trifluoromethyl)phenyl)propyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.

6. The compound of claim 3, wherein said compound is 24V (N-((3-methyl-4-methoxyphenyl)methyl)-1-(3-(ethylacetoxy)phenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.

7. The compound of claim 3, wherein said compound is 25D ((R,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.

8. A method of inhibiting bone resorption in a patient comprising the step of administering to said patient a therapeutically effective amount of a compound selected from the group consisting of:

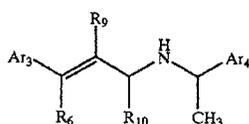
21S ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-propoxyphenyl)ethylamine);

21T ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isopropoxyphenyl)ethylamine);

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- 21U ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isobutoxyphenyl)ethylamine);
 21Y ((R,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine);
 22J ((R)-N-(3-(3-(trifluoromethyl)phenyl)propyl)-1-(1-naphthyl)ethylamine);
 23A ((R)-N-(4-(3-(trifluoromethoxy)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine);
 23E ((R)-N-((3-(trifluoromethoxy)phenyl)methyl)-1-(1-naphthyl)ethylamine);
 24B (N-((3-methyl-4-methoxyphenyl)methyl)-1-(2-(trifluoromethyl)phenyl)ethylamine);
 24J ((R)-N-(3-(3-(trifluoromethoxy)phenyl)propyl)-1-(1-naphthyl)ethylamine);
 24M ((R)-N-(3-(3,5-difluorophenyl)propyl)-1-(3-methoxyphenyl)ethylamine);
 24V (N-((3-methyl-4-methoxyphenyl)methyl)-1-(3-ethylacetoxyphenyl)ethylamine);
 24X ((R)-N-((3-bromo-4-methoxyphenyl)methyl)-1-(1-naphthyl)ethylamine);
 24Y ((R)-N-((3-chloro-4-ethoxyphenyl)methyl)-1-(1-naphthyl)ethylamine);
 25C ((S,R)-N-(4-(3-trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine);
 25D ((R,R)-N-(4-(3-trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine); and
 25E ((R)-N-(3-phenylprop-2-en-1-yl)-1-(3-methoxyphenyl)ethylamine; or a pharmaceutically acceptable salt or complex thereof.
 9. A compound having the formula:



- wherein Ar₃ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of, lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy, benzyl, benzyloxy, dimethylbenzyl, NO₂, CHO, CH₃CH(OH), N(CH₃)₂, acetyl, and ethylene dioxy;
 Ar₄ is either naphthyl or phenyl optionally substituted with 0 to 5 substituents each independently selected from the group consisting of lower alkyl, halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, and acetoxy;
 provided that if Ar₄ is 3-methoxyphenyl, then Ar₃ is a substituted phenyl that is not 2-methoxy, 3-methyl, 2-methyl, 4-methyl, 2,4-dimethyl, 2,4,6-trimethyl, or 4-isopropyl; and if Ar₄ is unsubstituted phenyl, then Ar₃ is a substituted phenyl that is not 2-nitrophenyl, 4-nitrophenyl, or 4-dimethylaminophenyl;
 R₈ is either hydrogen or phenyl;
 R₉ is either hydrogen or methyl; and
 R₁₀ is either hydrogen, methyl, or phenyl;
 or a pharmaceutically acceptable salt or complex thereof.
 10. The compound of claim 3, wherein said compound is
 21S ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-

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- propoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 11. The compound of claim 3, wherein said compound is
 21T ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isopropoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 12. The compound of claim 3, wherein said compound is
 21U ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isobutoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 13. The compound of claim 3, wherein said compound is
 23A ((R)-N-(4-(3-(trifluoromethoxy)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 14. The compound of claim 3, wherein said compound is
 24B (N-((3-methyl-4-methoxyphenyl)methyl)-1-(2-(trifluoromethyl)phenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 15. The compound of claim 3, wherein said compound is
 23E ((R)-N-((3-(trifluoromethoxy)phenyl)methyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 16. The compound of claim 3, wherein said compound is
 24J ((R)-N-(3-(3-(trifluoromethoxy)phenyl)propyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 17. The compound of claim 3, wherein said compound is
 24M ((R)-N-(3-(3,5-difluorophenyl)propyl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 18. The compound of claim 3, wherein said compound is
 24X ((R)-N-((3-bromo-4-methoxyphenyl)methyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 19. The compound of claim 3, wherein said compound is
 24Y ((R)-N-((3-chloro-4-ethoxyphenyl)methyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 20. The compound of claim 3, wherein said compound is
 25E ((R)-N-(3-phenylprop-2-en-1-yl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
 21. A method of decreasing parathyroid hormone level in a patient to achieve a beneficial effect comprising the step of administering to said patient an effective amount of a compound selected from the group consisting of:
 21S ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-propoxyphenyl)ethylamine);
 21T ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isopropoxyphenyl)ethylamine);
 21U ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isobutoxyphenyl)ethylamine);
 21Y ((R,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine);
 22J ((R)-N-(3-(3-(trifluoromethyl)phenyl)propyl)-1-(1-naphthyl)ethylamine);
 23A ((R)-N-(4-(3-(trifluoromethoxy)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine);
 23E ((R)-N-((3-(trifluoromethoxy)phenyl)methyl)-1-(1-naphthyl)ethylamine);
 24B (N-((3-methyl-4-methoxyphenyl)methyl)-1-(2-(trifluoromethyl)phenyl)ethylamine);
 24J ((R)-N-(3-(3-(trifluoromethoxy)phenyl)propyl)-1-(1-naphthyl)ethylamine);
 24M ((R)-N-(3-(3,5-difluorophenyl)propyl)-1-(3-methoxyphenyl)ethylamine);

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- 24V (N-((3-methyl-4-methoxyphenyl)methyl)-1-(3-ethylacetoxyphenyl)ethylamine);
- 24X ((R)-N-((3-bromo-4-methoxyphenyl)methyl)-1-(1-naphthyl)ethylamine);
- 24Y ((R)-N-((3-chloro-4-ethoxyphenyl)methyl)-1-(1-naphthyl)ethylamine;
- 25C ((S,R)-N-(4-(3-trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine); and
- 25D ((R,R)-N-(4-(3-trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine);
- 25E ((R)-N-(3-phenylprop-2-en-1-yl)-1-(3-methoxyphenyl)ethylamine or a pharmaceutically acceptable salt or complex thereof.
22. The method of claim 21, wherein said compound is 21S (R)-N-(3-(2-chlorophenyl)propyl)-1-(3-propoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
23. The method of claim 21, wherein said compound is 21T ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isobutoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
24. The method of claim 21, wherein said compound is 21U ((R)-N-(3-(2-chlorophenyl)propyl)-1-(3-isobutoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
25. The method of claim 21, wherein said compound is 21Y ((R,R)-N-(4-(3-(trifluoromethyl)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
26. The method of claim 21, wherein said compound is 22J ((R)-N-(3-(3-(trifluoromethyl)phenyl)propyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
27. The method of claim 21, wherein said compound is 23A ((R)-N-(4-(3-(trifluoromethoxy)phenyl)-2-butyl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
28. The method of claim 21, wherein said compound is 23E ((R)-N-((3-(trifluoromethoxy)phenyl)methyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
29. The method of claim 21, wherein said compound is 24B (N-((3-methyl-4-methoxyphenyl)methyl)-1-(2-(trifluoromethyl)phenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
30. A method of treating a patient having a disease selected from the group consisting of hyperparathyroidism, Paget's disease, a hypercalcemic disorder, osteoporosis, hypertension, and renal osteodystrophy, comprising the step of administering to said patient an effective amount of the compound of any of claims 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18 or 19 or 20.
31. The method of claim 30, wherein said disease is hyperparathyroidism.
32. The method of claim 30, wherein said disease is Paget's disease.

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33. The method of claim 30, wherein said disease is osteoporosis.
34. The method of claim 30, wherein said disease is hypertension.
35. The method of claim 30, wherein said disease is renal osteodystrophy.
36. The method of claim 21, wherein said compound is 24J ((R)-N-(3-(3-(trifluoromethoxy)phenyl)propyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
37. The method of claim 21, wherein said compound is 24M ((R)-N-(3-(3,5-difluorophenyl)propyl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
38. The method of claim 21, wherein said compound is 24V (N-((3-methyl-4-methoxyphenyl)methyl)-1-(3-ethylacetoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
39. The method of claim 21, wherein said compound is 24X ((R)-N-((3-bromo-4-methoxyphenyl)methyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
40. The method of claim 21, wherein said compound is 24Y ((R)-N-((3-chloro-4-ethoxyphenyl)methyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
41. The method of claim 21, wherein said compound is 25C ((S,R)-N-(4-(3-trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
42. The method of claim 21, wherein said compound is 25D ((R,R)-N-(4-(3-trifluoromethyl)phenyl)-2-butyl)-1-(1-naphthyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
43. The method of claim 21, wherein said compound is 25E ((R)-N-(3-phenylprop-2-en-1-yl)-1-(3-methoxyphenyl)ethylamine) or a pharmaceutically acceptable salt or complex thereof.
44. A pharmaceutical composition comprising a therapeutically effective amount of the compound of any of claims 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, or 20 and a pharmaceutically acceptable carrier.
45. A method of treating a patient having a disease or disorder characterized by abnormal bone and mineral homeostasis comprising the step of administering to said patient a therapeutically effective amount of the compound of any of claims 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20.
46. The compound of claim 9, wherein Ar₃ is either naphthyl optionally substituted with 0-5 substituents or phenyl optionally substituted with 1 to 5 substituents each independently selected from the group consisting of halogen, lower alkoxy, lower thioalkyl, methylene dioxy, lower haloalkyl, lower haloalkoxy, OH, CH₂OH, CONH₂, CN, acetoxy, benzyl, benzyloxy, dimethylbenzyl, NO₂, CHO, CH₃CH(OH), N(CH₃)₂, acetyl, and ethylene dioxy.

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