Title: NOVEL 2-AMINOPYRIMIDINE DERIVATIVES AND THEIR USE

Abstract: This invention relates to novel compounds having the structural formula I below and to their pharmaceutically acceptable salts, compositions and methods of use. These novel compounds provide a treatment or prophylaxis of cognitive impairment, Alzheimer Disease, neurodegeneration and dementia.
Novel 2-aminopyrimidine derivatives and their use

The present invention relates to novel compounds, their pharmaceutical compositions. In addition, the present invention relates to therapeutic methods for the treatment and/or prevention of Aβ-related pathologies such as Downs syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration.

Background of the invention

Several groups have identified and isolated aspartate proteinases that have β-secretase activity (Hussain et al., 1999; Lin et. al, 2000; Yan et. al, 1999; Sinha et. al., 1999 and Vassar et. al., 1999). β-secretase is also known in the literature as Asp2 (Yan et. al, 1999), Beta site APP Cleaving Enzyme (BACE) (Vassar et. al., 1999) or memapsin-2 (Lin et al., 2000). BACE was identified using a number of experimental approaches such as EST database analysis (Hussain et al. 1999); expression cloning (Vassar et al. 1999); identification of human homologs from public databases of predicted *C. elegans* proteins (Yan et al. 1999) and finally utilizing an inhibitor to purify the protein from human brain (Sinha et al. 1999). Thus, five groups employing three different experimental approaches led to the identification of the same enzyme, making a strong case that BACE is a β-secretase. Mention is also made of the patent literature: WO96/40885, EP871720, U.S. Patents Nos. 5,942,400 and 5,744,346, EP855444, US 6,319,689, WO99/64587, WO99/31236, EP1037977, WO00/17369, WO01/23533, WO0047618, WO00/58479, WO00/69262, WO01/00663, WO01/00665, US 6,313,268.

BACE was found to be a pepsin-like aspartic proteinase, the mature enzyme consisting of the N-terminal catalytic domain, a transmembrane domain, and a small cytoplasmic
domain. BACE has an optimum activity at pH 4.0-5.0 (Vassar et al, 1999)) and is inhibited weakly by standard pepsin inhibitors such as pepstatin. It has been shown that the catalytic domain minus the transmembrane and cytoplasmic domain has activity against substrate peptides (Lin et al, 2000). BACE is a membrane bound type 1 protein that is synthesized as a partially active proenzyme, and is abundantly expressed in brain tissue. It is thought to represent the major β-secretase activity, and is considered to be the rate-limiting step in the production of amyloid-β-protein (Aβ). It is thus of special interest in the pathology of Alzheimer’s disease, and in the development of drugs as a treatment for Alzheimer’s disease.

Aβ or amyloid-β-protein is the major constituent of the brain plaques which are characteristic of Alzheimer’s disease (De Strooper et al, 1999). Aβ is a 39-42 residue peptide formed by the specific cleavage of a class I transmembrane protein called APP, or amyloid precursor protein. Aβ-secretase activity cleaves this protein between residues Met671 and Asp672 (numbering of 770aa isoform of APP) to form the N-terminus of Aβ. A second cleavage of the peptide is associated with γ-secretase to form the C-terminus of the Aβ peptide.

Alzheimer’s disease (AD) is estimated to afflict more than 20 million people worldwide and is believed to be the most common form of dementia. Alzheimer’s disease is a progressive dementia in which massive deposits of aggregated protein breakdown products - amyloid plaques and neurofibrillary tangles accumulate in the brain. The amyloid plaques are thought to be responsible for the mental decline seen in Alzheimer’s patients.

The likelihood of developing Alzheimer’s disease increases with age, and as the aging population of the developed world increases, this disease becomes a greater and greater problem. In addition to this, there is a familial link to Alzheimer’s disease and consequently any individuals possessing the double mutation of APP known as the Swedish mutation (in which the mutated APP forms a considerably improved substrate for BACE) have a much greater chance of developing AD, and also of developing it at an early age (see also US 6,245,964 and US 5,877,399 pertaining to transgenic rodents
comprising APP-Swedish). Consequently, there is also a strong need for developing a compound that can be used in a prophylactic fashion for these individuals.

The gene encoding APP is found on chromosome 21, which is also the chromosome found as an extra copy in Down's syndrome. Down's syndrome patients tend to acquire Alzheimer's disease at an early age, with almost all those over 40 years of age showing Alzheimer's-type pathology (Oyama et al., 1994). This is thought to be due to the extra copy of the APP gene found in these patients, which leads to overexpression of APP and therefore to increased levels of APPβ causing the high prevalence of Alzheimer's disease seen in this population. Thus, inhibitors of BACE could be useful in reducing Alzheimer's-type pathology in Down's syndrome patients.

Drugs that reduce or block BACE activity should therefore reduce Aβ levels and levels of fragments of Aβ in the brain, or elsewhere where Aβ or fragments thereof deposit, and thus slow the formation of amyloid plaques and the progression of AD or other maladies involving deposition of Aβ or fragments thereof (Yankner, 1996; De Strooper and Konig, 1999). BACE is therefore an important candidate for the development of drugs as a treatment and/or prophylaxis of Aβ-related pathologies such as Downs syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson's disease, progressive supranuclear palsy or cortical basal degeneration.

It would therefore be useful to inhibit the deposition of Aβ and portions thereof by inhibiting BACE through inhibitors such as the compounds provided herein.

The therapeutic potential of inhibiting the deposition of Aβ has motivated many groups to isolate and characterize secretase enzymes and to identify their potential inhibitors (see,

The compounds of the present invention show improved properties compared to the potential inhibitors known in the art, e.g. improved hERG selectivity.

Provided herein are novel compounds of structural formula I:

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R^1 \quad R^2 \quad \text{L} \quad \text{Q}
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or a pharmaceutically acceptable salt, tautomer, or in vivo-hydrolysable precursor thereof, wherein:

- R^1 is H, Si(C_{1-10} alkyl)_3, CN, NO_2, OR^a, SR^a, OC(O)R^a, OC(O)OR^b, OC(O)NR^aR^d, C(O)R^a, C(O)OR^b, C(O)NR^aR^d, NR^d, NR^aC(O)R^a, NR^aC(O)OR^b, NR^aS(O)_{2}R^b, S(O)R^a, S(O)NR^aR^d, S(O)_{2}R^a, S(O)_{2}NR^aR^d, C_{1-10} alkyl, C_{1-10} haloalkyl, C_{2-10} alkenyl, C_{2-10} alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C_{1-10} alkyl, C_{1-10} haloalkyl, C_{2-10} alkenyl, C_{2-10} alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2 or 3 R^d;
- R^2 is halo or OR^3;
- R^3 is C_{1-6} alkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C_{1-6} alkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R^d;
$R^4$ is each, independently, halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO$_2$, OR$^a$, SR$^a$, C(O)R$^b$, C(O)NR$^c$R$^d$, C(O)OR$^a$, OC(O)R$^b$, OC(O)NR$^c$R$^d$, NR$^c$R$^d$, NR$^c$C(O)R$^d$, NR$^c$C(O)OR$^a$, NR$^c$S(O)$_2$R$^b$, S(O)R$^b$, S(O)NR$^c$R$^d$, S(O)$_2$R$^b$, or S(O)$_2$NR$^c$R$^d$;

$R^5$ and $R^6$ are each, independently, H, halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO$_2$, OR$^a$, SR$^a$, C(O)R$^b$, C(O)NR$^c$R$^d$, C(O)OR$^a$, OC(O)R$^b$, OC(O)NR$^c$R$^d$, NR$^c$R$^d$, NR$^c$C(O)R$^d$, NR$^c$C(O)OR$^a$, NR$^c$S(O)$_2$R$^b$, S(O)R$^b$, S(O)NR$^c$R$^d$, S(O)$_2$R$^b$, or S(O)$_2$NR$^c$R$^d$;

Q is aryl, cycloalkyl, heteroaryl or heterocycloalkyl, each substituted by 1 Cy$^1$ and optionally substituted by 1, 2, 3, or 4 A$^1$;

L is C$_{2-10}$ alkenylenyl, C$_{2-10}$ alkynylenyl, (CR$^3$R$^6$)$_3$ (CR$^3$R$^6$)$_4$CO(CR$^3$R$^6$)$_6$CO or (CR$^3$R$^6$)$_6$CONR$^a$(CR$^3$R$^6$)$_6$;

Cy$^1$ is aryl, heteroaryl, cycloalkyl, or heterocycloalkyl, each optionally substituted with 1, 2, 3, or 5 A$^2$;

A$^1$ and A$^2$ are each, independently, halo, CN, NO$_2$, OR$^a$, SR$^a$, C(O)R$^b$, C(O)NR$^c$R$^d$, C(O)OR$^a$, OC(O)R$^b$, OC(O)NR$^c$R$^d$, NR$^c$R$^d$, NR$^c$C(O)R$^d$, NR$^c$C(O)OR$^a$, NR$^c$S(O)R$^b$, NR$^c$S(O)$_2$R$^b$, S(O)R$^b$, S(O)NR$^c$R$^d$, S(O)$_2$R$^b$, S(O)$_2$NR$^c$R$^d$, C$_{1-4}$ alkoxy, C$_{1-4}$ haloalkoxy, amino, C$_{1-4}$ alkylamino, C$_{2-8}$ dialkylamino, C$_{1-6}$ alkylic, C$_{2-6}$ alkenyl, C$_{2-6}$ alkynyl, arylalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl or heterocycloalkyl, wherein each of the C$_{1-6}$ alkylic, C$_{2-6}$ alkenyl, C$_{2-6}$ alkynyl, arylalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl or heterocycloalkyl is optionally substituted by 1, 2, 3, 4 or 5 halo, C$_{1-6}$ alkylic, C$_{2-6}$ alkenyl, C$_{2-6}$ alkynyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO$_2$, OR$^a$, SR$^a$, C(O)R$^b$, C(O)NR$^c$R$^d$, C(O)OR$^a$, OC(O)R$^b$, OC(O)NR$^c$R$^d$, NR$^c$R$^d$, NR$^c$C(O)R$^d$, NR$^c$C(O)OR$^a$, NR$^c$S(O)R$^b$, NR$^c$S(O)$_2$R$^b$, S(O)R$^b$, S(O)NR$^c$R$^d$, S(O)$_2$R$^b$, S(O)$_2$NR$^c$R$^d$, or S(O)$_2$NR$^c$R$^d$;

R$^a$ and R$^a$ are each, independently, H, C$_{1-6}$ alkylic, C$_{1-6}$ haloalkyl, C$_{2-6}$ alkenyl, C$_{2-6}$ alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C$_{1-6}$ alkylic, C$_{1-6}$ haloalkyl, C$_{2-6}$ alkenyl, C$_{2-6}$ alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C$_{1-6}$ alkylic, C$_{1-6}$ haloalkyl, aryl, alkylic, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl;
R^b and R^{b'} are each, independently, H, C_{1-6} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-5} alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C_{1-6} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-5} alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C_{1-6} alkyl, C_{1-6} haloalkyl, C_{1-6} haloalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl;

R^c and R^d are each, independently, H, C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-5} alkenyl, C_{2-6} alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-5} alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C_{1-6} alkyl, C_{1-6} haloalkyl, C_{1-6} haloalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl;

or R^c and R^d together with the N atom to which they are attached form a 4-, 5-, 6- or 7-membered heterocycloalkyl group;

R^{c'} and R^{d'} are each, independently, H, C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C_{1-6} alkyl, C_{1-6} haloalkyl, C_{1-6} haloalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl;

or R^{c'} and R^{d'} together with the N atom to which they are attached form a 4-, 5-, 6- or 7-membered heterocycloalkyl group;

R^e is H, C_{1-4} alkyl, C_{1-4} haloalkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, or CO-(C_{1-4} alkyl);

q is 1, 2, 3, 4, 5 or 6;

q1 is 0, 1, 2 or 3; and

q2 is 0, 1, 2 or 3.
In some embodiments, R^1 is H, C\_1-6 alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C\_1-6 alkyl, C\_1-6 haloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R^4.

In some embodiments, R^1 is H, C\_1-6 alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C\_1-6 alkyl, C\_1-6 haloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2 or 3 substituents independently selected from halo, CN, OH, C\_1-6 alkoxy, C\_1-6 haloalkoxy, C\_1-6 haloalkyl, C\_1-6 alkyl, C\_2-6 alkenyl, C\_2-6 alkynyl, arylalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl and heterocycloalkyl.

In some embodiments, R^1 is H, C\_1-6 alkyl or C\_1-6 haloalkyl, wherein the C\_1-6 alkyl is optionally substituted by 1, 2 or 3 substituents independently selected from halo, CN, OH, C\_1-6 alkoxy, C\_1-6 haloalkoxy, C\_1-6 haloalkyl, C\_1-6 alkyl, C\_2-6 alkenyl, C\_2-6 alkynyl, arylalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl and heterocycloalkyl.

In some embodiments, R^1 is H, C\_1-6 alkyl or C\_1-6 haloalkyl.

In some embodiments, R^1 is H.

In some embodiments, R^2 is halo.

In some embodiments, R^2 is chloro.

In some embodiments, R^2 is OR^3.

In some embodiments, R^2 is OR^3; and R^3 is C\_1-6 alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C\_1-6 alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R^4.
In some embodiments, $R^2$ is OR$^3$; and $R^3$ is C$_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C$_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy.

In some embodiments, $R^4$ is each, independently, halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy or heterocycloalkyloxy.

In some embodiments, $L$ is C$_{2-10}$ alkenylenyl, C$_{2-10}$ alkynylenyl or (CR$^5$R$^6$)$_q$.

In some embodiments, $L$ is (CR$^5$R$^6$)$_q$.

In some embodiments, $L$ is (CR$^5$R$^6$)$_q$; and $R^5$ and $R^6$ are each, independently, H, halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl CN, NO$_2$, OH, C$_{1-4}$ alkoxy.

In some embodiments, $Q$ is aryl or heteroaryl, each substituted by 1 Cy$^1$ and optionally substituted by 1, 2, 3, or 4 A$^1$.

In some embodiments, $Q$ is aryl or heteroaryl, each substituted by 1 Cy$^1$ and optionally substituted by 1, 2, 3, or 4 A$^1$; and Cy$^1$ is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A$^2$.

In some embodiments, $Q$ is aryl substituted by 1 Cy$^1$ and optionally substituted by 1, 2, 3, or 4 A$^1$; and Cy$^1$ is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A$^2$.

In some embodiments, $Q$ is phenyl substituted by 1 Cy$^1$ and optionally substituted by 1, 2, 3, or 4 A$^1$; and Cy$^1$ is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A$^2$. 
In some embodiments, Q is phenyl substituted by 1 Cy\(^1\) at a meta-position and optionally substituted by 1, 2, 3, or 4 A\(^1\); and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).

In some embodiments, R\(^1\) is H, C\(_{1-6}\) alkyl or C\(_{1-6}\) haloalkyl; R\(^2\) is chloro or OR\(^3\); R\(^3\) is C\(_{1-6}\) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C\(_{1-6}\) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, C\(_{1-4}\) alkyl, C\(_{1-4}\) haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy; L is (CR\(^5\)R\(^6\))\(_{\nu}\); R\(^5\) and R\(^6\) are each, independently, H, halo, C\(_{1-4}\) alkyl, C\(_{1-4}\) haloalkyl CN, NO\(_2\), OH, C\(_{1-4}\) alkoxy; Q is aryl or heteroaryl, each substituted by 1 Cy\(^1\) and optionally substituted by 1, 2, 3, or 4 A\(^1\); and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).

In some embodiments, q is 2.

In some embodiments, Q is phenyl substituted by 1 Cy\(^1\) and optionally substituted by 1, 2, 3, or 4 A\(^1\); and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).

Also provided herein are novel compounds of structural formula II:

![Structural formula II](image)

Wherein t is 0 or 1, and the other variables are defined as above.

In some embodiments, q is 2 and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).
In some embodiments, $R^1$ is H, $C_{1-6}$ alkyl or $C_{1-6}$ haloalkyl; $R^2$ is chloro or OR$^3$; and $R^3$ is $C_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the $C_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, $C_{1-4}$ alkyl, $C_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryl oxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy.

The present invention further provides compositions comprising a compound of any of the formulas described herein, or a pharmaceutically acceptable salt, tautomer or in vivo-hydrolysable precursor thereof, and at least one pharmaceutically acceptable carrier, diluent or excipient.

The present invention further provides methods of modulating activity of BACE comprising contacting the BACE with a compound of any of the formulas described herein, or a pharmaceutically acceptable salt, tautomer or in vivo-hydrolysable precursor thereof.

The present invention further provides methods of treating or preventing an Aβ-related pathology in a patient, comprising administering to the patient a therapeutically effective amount of a compound of any of the formulas described herein, or a pharmaceutically acceptable salt, tautomer or in vivo-hydrolysable precursor thereof.

The present invention further provides a compound of any of the formulas described herein, or a pharmaceutically acceptable salt, tautomer or in vivo-hydrolysable precursor thereof, described herein for use as a medicament.

The present invention further provides a compound of any of the formulas described herein, or a pharmaceutically acceptable salt, tautomer or in vivo-hydrolysable precursor thereof, described herein for the manufacture of a medicament.
Detailed Description of the Invention

Provided herein are novel compounds of structural formula I:

\[
\begin{array}{c}
\text{R}^1 \\
\text{R}^2 \\
\text{L} \\
\text{Q} \\
\text{NH}_2 \\
1
\end{array}
\]

or a pharmaceutically acceptable salt, tautomer, or in vivo-hydrolysable precursor thereof.

In some embodiments, \( \text{R}^1 \) is H, Si(\text{C}_{1-10} \text{alkyl})_3, CN, NO_2, OR^a, SR^a, OC(O)R^a, OC(O)OR^b, OC(O)NR^dR^d, C(O)R^a, C(O)OR^b, C(O)NR^dR^d, NR^dR^d, NR^dC(O)R^a, NR^dC(O)OR^b, NR^dS(O)NR^dR^d, S(O)R^a, S(O)OR^d, S(O)NR^dR^d, S(O)NR^dR^d, \text{C}_{1-10} \text{alkyl}, \text{C}_{1-10} \text{haloalkyl}, \text{C}_{2-10} \text{alkeny}, \text{C}_{2-10} \text{alkynyl}, \text{aryl}, \text{cycloalkyl}, \text{heteroaryl}, \text{heterocycloalkyl}, \text{arylalkyl}, \text{heteroarylalkyl}, \text{cycloalkylalkyl} \) or heterocycloalkylalkyl, or any subgroup thereof, wherein the \( \text{C}_{1-10} \text{alkyl}, \text{C}_{1-10} \text{haloalkyl}, \text{C}_{2-10} \text{alkeny}, \text{C}_{2-10} \text{alkynyl}, \text{aryl}, \text{cycloalkyl}, \text{heteroaryl}, \text{heterocycloalkyl}, \text{arylalkyl}, \text{heteroarylalkyl}, \text{cycloalkylalkyl} \) or heterocycloalkylalkyl is optionally substituted by 1, 2 or 3 \( \text{R}^d \), or any subgroup thereof. In some embodiments, \( \text{R}^1 \) is H, \( \text{C}_{1-6} \text{alkyl} \), \( \text{arylalkyl} \), heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the \( \text{C}_{1-6} \text{alkyl}, \text{C}_{1-6} \text{haloalkyl}, \text{arylalkyl}, \text{heteroarylalkyl}, \text{cycloalkylalkyl} \) or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 \( \text{R}^d \). In some embodiments, \( \text{R}^1 \) is H, \( \text{C}_{1-6} \text{alkyl} \), \( \text{arylalkyl} \), heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the \( \text{C}_{1-6} \text{alkyl}, \text{C}_{1-6} \text{haloalkyl}, \text{arylalkyl}, \text{heteroarylalkyl}, \text{cycloalkylalkyl} \) or heterocycloalkylalkyl is optionally substituted by 1, 2 or 3 substituents independently selected from halo, CN, OH, \( \text{C}_{1-6} \text{alkoxy}, \text{C}_{1-6} \text{haloalkoxy}, \text{C}_{1-6} \text{haloalkyl}, \text{C}_{1-6} \text{alkyl}, \text{C}_{2-6} \text{alkeny}, \text{C}_{2-6} \text{alkynyl}, \text{arylalkyl}, \text{cycloalkylalkyl}, \text{heteroarylalkyl}, \text{heterocycloalkylalkyl}, \text{aryl}, \text{cycloalkyl}, \text{heteroaryl} \) and heterocycloalkyl. In some embodiments, \( \text{R}^1 \) is H, \( \text{C}_{1-6} \text{alkyl} \) or \( \text{C}_{1-6} \text{haloalkyl} \), wherein the \( \text{C}_{1-6} \text{alkyl} \) is optionally substituted by 1, 2 or 3 substituents independently selected from halo, CN, OH, \( \text{C}_{1-6} \text{alkoxy}, \text{C}_{1-6} \text{haloalkoxy}, \text{C}_{1-6} \text{haloalkyl}, \text{C}_{1-6} \text{alkyl}, \text{C}_{2-6} \text{alkeny}, \text{C}_{2-6} \text{alkynyl}, \text{arylalkyl}, \text{cycloalkylalkyl}, \text{heteroarylalkyl}, \text{cycloalkylalkyl} \) or heterocycloalkyl.
heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl and heterocycloalkyl. In some embodiments, $R^1$ is H, C$_{1-6}$ alkyl or C$_{1-6}$ haloalkyl. In some embodiments, $R^1$ is H. In some embodiments, $R^1$ is H, C$_{1-6}$ alkyl or C$_{1-6}$ haloalkyl.

In some embodiments, $R^2$ is halo or OR$^3$. In some embodiments, $R^2$ is halo. In some embodiments, $R^2$ is chloro. In some embodiments, $R^2$ is OR$^3$. In some embodiments, $R^2$ is chloro or OR$^3$.

In some embodiments, $R^2$ is C$_{1-6}$ alkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, or any subgroup thereof, wherein each of the C$_{1-6}$ alkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R$^4$, or any subgroup thereof. In some embodiments, $R^2$ is C$_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C$_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R$^4$. In some embodiments, $R^2$ is C$_{1-6}$ alkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C$_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy. In some embodiments, $R^2$ is C$_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C$_{1-6}$ alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy.

In some embodiments, $R^4$ is each, independently, halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO$_2$, OR$^a$, SR$^a$, C(O)R$^b$, C(O)NR$^c$R$^d$, C(O)OR$^a$, OC(O)R$^c$, OC(O)NR$^c$R$^d$, NR$^c$R$^d$, NR$^c$C(O)R$^d$, NR$^c$C(O)OR$^a$, NR$^c$S(O)R$^b$, S(O)NR$^c$R$^d$, S(O)OR$^b$, or S(O)$_2$NR$^c$R$^d$, or any subgroup thereof. In some embodiments, $R^4$ is each, independently, halo, C$_{1-4}$ alkyl, C$_{1-4}$ haloalkyl, aryl,
cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy or heterocycloalkyloxy.

In some embodiments, R⁵ and R⁶ are each, independently, H, halo, C1-4 alkyl, C1-4 haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO₂, OR⁸, SR⁸, C(O)R⁹, C(O)NR⁸R¹⁰, C(O)OR⁸, OC(O)R⁹, NR⁸R¹⁰, NR⁸C(O)R⁹, NR⁸C(O)OR⁸, NR⁸S(O)₂R¹⁰, S(O)R⁹, S(O)NR⁸R¹⁰, S(O)₂R¹⁰, or S(O)₂NR⁸R¹⁰, or any subgroup thereof. In some embodiments, R⁵ and R⁶ are each, independently, H, halo, C1-4 alkyl, C1-4 haloalkyl CN, NO₂, OH, C1-4 alkoxy.

In some embodiments, Q is aryl, cycloalkyl, heteroaryl or heterocycloalkyl, or any subgroup thereof, each substituted by 1 Cy¹ and optionally substituted by 1, 2, 3, or 4 A¹, or any subgroup thereof. In some embodiments, Q is aryl or heteroaryl, each substituted by 1 Cy¹ and optionally substituted by 1, 2, 3, or 4 A¹. In some embodiments, Q is aryl substituted by 1 Cy¹ and optionally substituted by 1, 2, 3, or 4 A¹. In some embodiments, Q is phenyl substituted by 1 Cy¹ and optionally substituted by 1, 2, 3, or 4 A¹. In some embodiments, Q is phenyl substituted by 1 Cy¹ at a meta-position and optionally substituted by 1, 2, 3, or 4 A¹.

In some embodiments, L is C₂-₁₀ alkenylenyl, C₂-₁₀ alkynyl, (CR⁵R⁶)₉, (CR⁵R⁶)₄, CO(CR⁵R⁶)₂, or (CR⁵R⁶)₂CONR⁸(CR⁷R⁸)₄, or any subgroup thereof. In some embodiments, L is C₂-₁₀ alkenylenyl, C₂-₁₀ alkynyl or (CR⁵R⁶)₉. In some embodiments, L is (CR⁵R⁶)₄. In some embodiments, L is (CR⁵R⁶)₂.

In some embodiments, Cy¹ is aryl, heteroaryl, cycloalkyl, or heterocycloalkyl, or any subgroup thereof, each optionally substituted with 1, 2, 3, 4 or 5 A², or any subgroup thereof. In some embodiments, Cy¹ is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A².

In some embodiments, A¹ and A² are each, independently, halo, CN, NO₂, OR⁸, SR⁸, C(O)R⁹, C(O)NR⁸R¹⁰, C(O)OR⁸, OC(O)R⁹, OC(O)NR⁸R¹⁰, NR⁸R¹⁰, NR⁸C(O)R⁹, NR⁸C(O)OR⁸, NR⁸S(O)R⁹, NR⁸S(O)₂R¹⁰, S(O)R⁹, S(O)NR⁸R¹⁰, S(O)₂R¹⁰, S(O)₂NR⁸R¹⁰, C₁-₄
alkoxy, C₁₋₄ haloalkoxy, amino, C₁₋₄ alkylamino, C₂₋₈ dialkylamino, C₁₋₆ alkyl, C₂₋₆ alkenyl, C₂₋₆ alkyne, arylalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl or heterocycloalkyl, or any subgroup thereof, wherein each of the C₁₋₆ alkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, arylalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl or heterocycloalkyl is optionally substituted by 1, 2, 3, 4 or 5 halo, C₁₋₆ alkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, C₁₋₄ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO₂, OR⁺, SR⁺, C(O)R⁺, C(O)NR⁺⁺R⁺⁺⁺, C(O)OR⁺⁺⁺, OC(O)R⁺⁺⁺, OC(O)NR⁺⁺⁺R⁺⁺⁺⁺, NR⁺⁺⁺⁺R⁺⁺⁺⁺, NR⁺⁺⁺⁺C(O)R⁺⁺⁺⁺, NR⁺⁺⁺⁺S(O)R⁺⁺⁺⁺, NR⁺⁺⁺⁺S(O)₂R⁺⁺⁺⁺, S(O)R⁺⁺⁺⁺, S(O)NR⁺⁺⁺⁺R⁺⁺⁺⁺, S(O)₂R⁺⁺⁺⁺, or S(O)₂NR⁺⁺⁺⁺R⁺⁺⁺⁺, or any subgroup thereof.

In some embodiments, R⁺ and R⁺⁺ are each, independently, H, C₁₋₆ alkyl, C₁₋₆ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, or any subgroup thereof, wherein the C₁₋₆ alkyl, C₁₋₆ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C₁₋₆ alkyl, C₁₋₆ haloalkyl, aryl, arylalkyl, heteroaryl, heterocycloalkyl, cycloalkyl or heterocycloalkyl, or any subgroup thereof.

In some embodiments, R⁺⁺ and R⁺⁺⁺ are each, independently, H, C₁₋₆ alkyl, C₁₋₆ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, or any subgroup thereof, wherein the C₁₋₆ alkyl, C₁₋₆ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C₁₋₆ alkyl, C₁₋₆ haloalkyl, aryl, arylalkyl, heteroaryl, heterocycloalkyl, cycloalkyl or heterocycloalkyl, or any subgroup thereof.

In some embodiments, R⁺⁺⁺ and R⁺⁺⁺⁺ are each, independently, H, C₁₋₁₀ alkyl, C₁₋₆ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, or any subgroup thereof, wherein the C₁₋₁₀ alkyl, C₁₋₆ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is
optionally substituted with OH, amino, halo, C_{1-6} alkyl, C_{1-6} haloalkyl, C_{1-6} haloalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl, or any subgroup thereof.

In some embodiments, R^c and R^d together with the N atom to which they are attached form a 4-, 5-, 6- or 7-membered heterocycloalkyl group, or any subgroup thereof.

In some embodiments, R^{c'} and R^{d'} are each, independently, H, C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, or any subgroup thereof, wherein the C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C_{1-6} alkyl, C_{1-6} haloalkyl, C_{1-6} haloalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl, or any subgroup thereof.

In some embodiments, R^{c'} and R^{d'} together with the N atom to which they are attached form a 4-, 5-, 6- or 7-membered heterocycloalkyl group, or any subgroup thereof.

In some embodiments, R^c is H, C_{1-4} alkyl, C_{1-4} haloalkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, or CO-(C_{1-4} alkyl), or any subgroup thereof.

In some embodiments, q is 1, 2, 3, 4, 5 or 6, or any subgroup thereof. In some embodiments, q is 2.

In some embodiments, q1 is 0, 1, 2 or 3, or any subgroup thereof.

In some embodiments, q2 is 0, 1, 2 or 3, or any subgroup thereof.

In some embodiments, R^2 is OR^3; and R^3 is C_{1-6} alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C_{1-6} alkyl, arylalkyl,
heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 \( R^4 \).

In some embodiments, \( R^2 \) is OR\(^2 \); and \( R^3 \) is \( C_{1-6} \) alkyl, arylalkyl, heteroaryllalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the \( C_{1-6} \) alkyl, arylalkyl, heteroaryllalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, \( C_{1-4} \) alkyl, \( C_{1-4} \) haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy.

In some embodiments, \( L \) is \((CR^5R^6)_5\); and \( R^5 \) and \( R^6 \) are each, independently, H, halo, \( C_{1-4} \) alkyl, \( C_{1-4} \) haloalkyl CN, NO\(_2\), OH, \( C_{1-4} \) alkoxy.

In some embodiments, \( Q \) is aryl or heteroaryl, each substituted by 1 \( Cy^1 \) and optionally substituted by 1, 2, 3, or 4 \( A^1 \); and \( Cy^1 \) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \( A^2 \).

In some embodiments, \( Q \) is aryl substituted by 1 \( Cy^1 \) and optionally substituted by 1, 2, 3, or 4 \( A^1 \); and \( Cy^1 \) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \( A^2 \).

In some embodiments, \( Q \) is phenyl substituted by 1 \( Cy^1 \) and optionally substituted by 1, 2, 3, or 4 \( A^1 \); and \( Cy^1 \) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \( A^2 \).

In some embodiments, \( Q \) is phenyl substituted by 1 \( Cy^1 \) at a meta-position and optionally substituted by 1, 2, 3, or 4 \( A^1 \); and \( Cy^1 \) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \( A^2 \).

In some embodiments, \( R^1 \) is H, \( C_{1-6} \) alkyl or \( C_{1-6} \) haloalkyl; \( R^2 \) is chloro or OR\(^3 \); \( R^3 \) is \( C_{1-6} \) alkyl, arylalkyl, heteroaryllalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the \( C_{1-6} \) alkyl, arylalkyl, heteroaryllalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, \( C_{1-4} \) alkyl, \( C_{1-4} \) haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy,
cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy; L is \((CR^6R^6)_q\); \(R^5\) and \(R^6\) are each, independently, H, halo, C\(_{1-4}\) alkyl, C\(_{1-4}\) haloalkyl CN, NO\(_2\), OH, C\(_{1-4}\) alkoxy; Q is aryl or heteroaryl, each substituted by 1 Cy\(^1\) and optionally substituted by 1, 2, 3, or 4 \(A^1\); and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \(A^2\).

In some embodiments, Q is phenyl substituted by 1 Cy\(^1\) and optionally substituted by 1, 2, 3, or 4 \(A^1\); and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \(A^2\).

Also provided herein are novel compounds of structural formula II:

![Structural formula II](image)

or a pharmaceutically acceptable salt, tautomer, or in vivo-hydrolysable precursor thereof.

In some embodiments, t is 0 or 1, and the other variables are defined as above.

In some embodiments, q is 2 and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \(A^2\), or any subgroup thereof.

In some embodiments, R\(^1\) is H, C\(_{1-6}\) alkyl or C\(_{1-6}\) haloalkyl; R\(^2\) is chloro or OR\(^3\); and R\(^3\) is C\(_{1-6}\) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, or any subgroup thereof, wherein each of the C\(_{1-6}\) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, C\(_{1-4}\) alkyl, C\(_{1-4}\) haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy, or any subgroup thereof.
Compounds of the invention also include:

4-{(2-(3-Furyl)phenyl)ethyl}-6-(3-methylbutoxy)pyrimidin-2-amine trifluoroacetate;
4-(Cyclohexylmethoxy)-6-[2-(3-(2-furyl)phenyl)ethyl]pyrimidin-2-amine trifluoroacetate;
4-[2-(1,3-Dioxan-2-yl)ethoxy]-6-[2-(3-(2-furyl)phenyl)ethyl]pyrimidin-2-amine trifluoroacetate;
2-[[2-Amino-6-[2-(3-(2-furyl)phenyl)ethyl]pyrimidin-4-yl]oxymethyl]benzonitrile trifluoroacetate;
4-[2-(3-(2-Furyl)phenyl)ethyl]-6-(2-phenoxyethoxy)pyrimidin-2-amine trifluoroacetate;
4-Chloro-6-[2-(3-(2-furyl)phenyl)ethyl]pyrimidin-2-amine;

or a pharmaceutically acceptable salt, alternative salt, tautomer, or in vivo-hydrolysable precursor thereof.

Compounds of the present invention also include pharmaceutically acceptable salts, tautomers and in vivo-hydrolysable precursors of the compounds of any of the formulas described herein. Compounds of the invention further include hydrates and solvates.

Compounds of the invention can be used as medicaments. In some embodiments, the present invention provides compounds of any of the formulas described herein, or pharmaceutically acceptable salts, tautomers or in vivo-hydrolysable precursors thereof, for use as medicaments. In some embodiments, the present invention provides compounds described herein for use as medicaments for treating or preventing an Aβ-related pathology. In some further embodiments, the Aβ-related pathology is Downs syndrome, a β-amyloid angiopathy, cerebral amyloid angiopathy, hereditary cerebral hemorrhage, a disorder associated with cognitive impairment, MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with Alzheimer disease, dementia of mixed vascular origin, dementia of degenerative origin, pre-senile dementia, senile dementia, dementia associated with Parkinson's disease, progressive supranuclear palsy or cortical basal degeneration.

In some embodiments, the present invention provides compounds of any of the formulas described herein, or pharmaceutically acceptable salts, tautomers or in vivo-hydrolysable
precursors thereof, in the manufacture of a medicament for the treatment or prophylaxis of Aβ-related pathologies. In some further embodiments, the Aβ-related pathologies include such as Downs syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration.

In some embodiments, the present invention provides a method of inhibiting activity of BACE comprising contacting the BACE with a compound of the present invention. BACE is thought to represent the major β-secretase activity, and is considered to be the rate-limiting step in the production of amyloid-β-protein (Aβ). Thus, inhibiting BACE through inhibitors such as the compounds provided herein would be useful to inhibit the deposition of Aβ and portions thereof. Because the deposition of Aβ and portions thereof is linked to diseases such as Alzheimer Disease, BACE is an important candidate for the development of drugs as a treatment and/or prophylaxis of Aβ-related pathologies such as Downs syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration.

In some embodiments, the present invention provides a method for the treatment of Aβ-related pathologies such as Downs syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders
associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson's disease, progressive supranuclear palsy or cortical basal degeneration, comprising administering to a mammal (including human) a therapeutically effective amount of a compound of any of the formulas described herein, or a pharmaceutically acceptable salt, tautomer or in vivo-hydrolysable precursor thereof.

In some embodiments, the present invention provides a method for the prophylaxis of Aβ-related pathologies such as Down's syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson's disease, progressive supranuclear palsy or cortical basal degeneration comprising administering to a mammal (including human) a therapeutically effective amount of a compound of any of the formulas described herein or a pharmaceutically acceptable salt, tautomer or in vivo-hydrolysable precursors.

In some embodiments, the present invention provides a method of treating or preventing Aβ-related pathologies such as Down's syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson's disease, progressive supranuclear palsy or cortical basal degeneration by administering to a
mammal (including human) a compound of any of the formulas described herein or a pharmacologically acceptable salt, tautomer or in vivo-hydrolysable precursors and a cognitive and/or memory enhancing agent.

In some embodiments, the present invention provides a method of treating or preventing Aβ-related pathologies such as Downs syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration by administering to a mammal (including human) a compound of any of the formulas described herein or a pharmacologically acceptable salt, tautomer or in vivo-hydrolysable precursors thereof wherein constituent members are provided herein, and a choline esterase inhibitor or anti-inflammatory agent.

In some embodiments, the present invention provides a method of treating or preventing Aβ-related pathologies such as Downs syndrome and β-amyloid angiopathy, such as but not limited to cerebral amyloid angiopathy, hereditary cerebral hemorrhage, disorders associated with cognitive impairment, such as but not limited to MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with diseases such as Alzheimer disease or dementia including dementia of mixed vascular and degenerative origin, pre-senile dementia, senile dementia and dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration, or any other disease, disorder, or condition described herein, by administering to a mammal (including human) a compound of the present invention, and an atypical antipsychotic agent. Atypical antipsychotic agents includes, but not limited to, Olanzapine (marketed as Zyprexa), Aripiprazole (marketed as Abilify), Risperidone (marketed as Risperdal), Quetiapine
(marketed as Seroquel), Clozapine (marketed as Clozaril), Ziprasidone (marketed as Geodon) and Olanzapine/Fluoxetine (marketed as Symbyax).

In some embodiments, the mammal or human being treated with a compound of the present invention, has been diagnosed with a particular disease or disorder, such as those described herein. In these cases, the mammal or human being treated is in need of such treatment. Diagnosis, however, need not be previously performed. The anti-dementia treatment defined herein may be applied as a sole therapy or may involve, in addition to the compound of the invention, conventional chemotherapy. Such chemotherapy may include one or more of the following categories of agents: acetyl cholinesterase inhibitors, anti-inflammatory agents, cognitive and/or memory enhancing agents or atypical antipsychotic agents.

Such conjoint treatment may be achieved by way of the simultaneous, sequential or separate dosing of the individual components of the treatment. Such combination products employ the compounds of this invention.

Cognitive enhancing agents memory enhancing agents and choline esterase inhibitors includes, but not limited to, onepezil (Aricept), galantamine (Reminyl or Razadyne), rivastigmine (Exelon), tacrine (Cognex) and memantine (Namenda, Axura or Ebixa)

Atypical antipsychotic agents includes, but not limited to, olanzapine (marketed as Zyprexa), aripiprazole (marketed as Abilify), risperidone (marketed as Risperdal), quetiapine (marketed as Seroquel), clozapine (marketed as Clozaril), ziprasidone (marketed as Geodon) and olanzapine/fluoxetine (marketed as Symbyax).

The present invention also includes pharmaceutical compositions which contain, as the active ingredient, one or more of the compounds of the invention herein together with at least one pharmaceutically acceptable carrier, diluent or excipient.

When used for pharmaceutical compositions, medicaments, manufacture of a medicament, inhibiting activity of BACE, or treating or preventing Aβ-related pathologies, compounds
of the present invention include the compounds of any of the formulas described herein, and pharmaceutically acceptable salts, tautomers and in vivo-hydrolysable precursors thereof. Compounds of the present invention further include hydrates and solvates.

The definitions set forth in this application are intended to clarify terms used throughout this application. The term "herein" means the entire application.

As used in this application, the term "optionally substituted," as used herein, means that substitution is optional and therefore it is possible for the designated atom or moiety to be unsubstituted. In the event a substitution is desired then such substitution means that any number of hydrogens on the designated atom or moiety is replaced with a selection from the indicated group, provided that the normal valency of the designated atom or moiety is not exceeded, and that the substitution results in a stable compound. For example, if a methyl group (i.e., CH₃) is optionally substituted, then 3 hydrogens on the carbon atom can be replaced. Examples of suitable substituents include, but are not limited to: halogen, CN, NH₂, OH, SO, SO₂, COOH, OC₃₆alkyl, CH₂OH, SO₂H, C₁₆alkyl, OC₁₆alkyl, C(=O)C₁₆alkyl, C(=O)OC₁₆alkyl, C(=O)NH₂, C(=O)NHC₁₆alkyl, C(=O)N(C₁₆alkyl)₂, SO₂C₁₆alkyl, SO₂NHC₁₆alkyl, SO₂N(C₁₆alkyl)₂, NH(C₁₆alkyl), N(C₁₆alkyl)₂, NHC(=O)C₁₆alkyl, NC(=O)(C₁₆alkyl)₂, C₅₆aryl, OC₅₆aryl, C(=O)C₅₆aryl, C(=O)OC₅₆aryl, C(=O)NHC₅₆aryl, C(=O)N(C₅₆aryl)₂, SO₂C₅₆aryl, SO₂NHC₅₆aryl, SO₂N(C₅₆aryl)₂, NH(C₅₆aryl), N(C₅₆aryl)₂, NC(=O)C₅₆aryl, NC(=O)(C₅₆aryl)₂, C₅₆heterocyclyl, OC₅₆heterocyclyl, C(=O)C₅₆heterocyclyl, C(=O)OC₅₆heterocyclyl, C(=O)NHC₅₆heterocyclyl, C(=O)N(C₅₆heterocyclyl)₂, SO₂C₅₆heterocyclyl, SO₂NHC₅₆heterocyclyl, SO₂N(C₅₆heterocyclyl)₂, NH(C₅₆heterocyclyl), N(C₅₆heterocyclyl)₂, NC(=O)C₅₆heterocyclyl, NC(=O)(C₅₆heterocyclyl)₂.

A variety of compounds in the present invention may exist in particular geometric or stereoisomeric forms. The present invention takes into account all such compounds, including cis- and trans isomers, R- and S- enantiomers, diastereomers, (D)-isomers, (L)-isomers, the racemic mixtures thereof, and other mixtures thereof, as being covered within the scope of this invention. Additional asymmetric carbon atoms may be present in a substituent such as an alkyl group. All such isomers, as well as mixtures thereof, are
intended to be included in this invention. The compounds herein described may have asymmetric centers. Compounds of the present invention containing an asymmetrically substituted atom may be isolated in optically active or racemic forms. It is well known in the art how to prepare optically active forms, such as by resolution of racemic forms or by synthesis from optically active starting materials. When required, separation of the racemic material can be achieved by methods known in the art. Many geometric isomers of olefins, C=N double bonds, and the like can also be present in the compounds described herein, and all such stable isomers are contemplated in the present invention. Cis and trans geometric isomers of the compounds of the present invention are described and may be isolated as a mixture of isomers or as separated isomeric forms. All chiral, diastereomeric, racemic forms and all geometric isomeric forms of a structure are intended, unless the specific stereochemistry or isomeric form is specifically indicated.

When a bond to a substituent is shown to cross a bond connecting two atoms in a ring, then such substituent may be bonded to any atom on the ring. When a substituent is listed without indicating the atom via which such substituent is bonded to the rest of the compound of a given formula, then such substituent may be bonded via any atom in such substituent. Combinations of substituents and/or variables are permissible only if such combinations result in stable compounds.

As used herein, “alkyl”, “alkylenyl” or “alkylene” used alone or as a suffix or prefix, is intended to include both branched and straight-chain saturated aliphatic hydrocarbon groups having from 1 to 12 carbon atoms or if a specified number of carbon atoms is provided then that specific number would be intended. For example “C_{1-6}alkyl” denotes alkyl having 1, 2, 3, 4, 5 or 6 carbon atoms. Examples of alkyl include, but are not limited to, methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, sec-butyl, t-butyl, pentyl, and hexyl. As used herein, “C_{1-3}alkyl”, whether a terminal substituent or an alkylene (or alkylenyl) group linking two substituents, is understood to specifically include both branched and straight-chain methyl, ethyl, and propyl.
As used herein, “alkenyl” refers to an alkyl group having one or more double carbon-carbon bonds. Example alkenyl groups include ethenyl, propenyl, cyclohexenyl, and the like. The term “alkenylenyl” refers to a divalent linking alkenyl group.

As used herein, “alkynyl” refers to an alkyl group having one or more triple carbon-carbon bonds. Example alkynyl groups include ethynyl, propynyl, and the like. The term “alkynylenyl” refers to a divalent linking alkynyl group.

As used herein, “aromatic” refers to hydrocarbyl groups having one or more polyunsaturated carbon rings having aromatic characters, (e.g., 4n + 2 delocalized electrons) and comprising up to about 14 carbon atoms.

As used herein, the term “aryl” refers to an aromatic ring structure made up of from 5 to 14 carbon atoms. Ring structures containing 5, 6, 7 and 8 carbon atoms would be single-ring aromatic groups, for example, phenyl. Ring structures containing 8, 9, 10, 11, 12, 13, or 14 would be a polycyclic moiety in which at least one carbon is common to any two adjoining rings therein (for example, the rings are “fused rings”), for example naphthyl. The aromatic ring can be substituted at one or more ring positions with such substituents as described above. The term “aryl” also includes polycyclic ring systems having two or more cyclic rings in which two or more carbons are common to two adjoining rings (the rings are “fused rings”) wherein at least one of the rings is aromatic, for example, the other cyclic rings can be cycloalkyls, cycloalkenyls or cycloalkynyls. The terms ortho, meta and para apply to 1,2-, 1,3- and 1,4-disubstituted benzenes, respectively. For example, the names 1,2-dimethylbenzene and ortho-dimethylbenzene are synonymous.

As used herein, “cycloalkyl” refers to non-aromatic cyclic hydrocarbons including cyclized alkyl, alkenyl, and alkynyl groups, having the specified number of carbon atoms. Cycloalkyl groups can include mono- or polycyclic (e.g., having 2, 3 or 4 fused or bridged rings) groups. Example cycloalkyl groups include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclopentenyl, cyclohexenyl, cyclohexadienyl, cycloheptatrienyl, norbornyl, norpinyl, norcarnyl, adamantyl, and the like. Also included in the definition of cycloalkyl are moieties that have one or more aromatic rings fused (i.e., having a bond in
common with) to the cycloalkyl ring, for example, benzo derivatives of cyclopentane (i.e., indanyl), cyclopentene, cyclohexane, and the like. The term “cycloalkyl” further includes saturated ring groups, having the specified number of carbon atoms. These may include fused or bridged polycyclic systems. Preferred cycloalkyls have from 3 to 10 carbon atoms in their ring structure, and more preferably have 3, 4, 5, and 6 carbons in the ring structure.

For example, “C₃₋₆ cycloalkyl” denotes such groups as cyclopropyl, cyclobutyl, cyclopentyl, or cyclohexyl.

As used herein, “cycloalkenyl” refers to ring-containing hydrocarbyl groups having at least one carbon-carbon double bond in the ring, and having from 3 to 12 carbons atoms.

As used herein, “halo” or “halogen” refers to fluoro, chloro, bromo, and iodo.

“Counterion” is used to represent a small, negatively or positively charged species such as chloride (Cl⁻), bromide (Br⁻), hydroxide (OH⁻), acetate (CH₃COO⁻), sulfate (SO₄²⁻), tosylate (CH₃-phenyl-SO₃⁻), benzensulfonate (phenyl-SO₃⁻), sodium ion (Na⁺), potassium (K⁺), ammonium (NH₄⁺), and the like.

As used herein, the term “heterocyclyl” or “heterocyclic” or “heterocycle” refers to a ring-containing monovalent and divalent structures having one or more heteroatoms, independently selected from N, O and S, as part of the ring structure and comprising from 3 to 20 atoms in the rings, more preferably 3- to 7-membered rings. The number of ring-forming atoms in heterocyclyl are given in ranges herein. For example, C₅₋₁₀ heterocyclyl refers to a ring structure comprising from 5 to 10 ring-forming atoms wherein at least one of the ring-forming atoms is N, O or S. Heterocyclic groups may be saturated or partially saturated or unsaturated, containing one or more double bonds, and heterocyclic groups may contain more than one ring as in the case of polycyclic systems.

The heterocyclic rings described herein may be substituted on carbon or on a heteroatom atom if the resulting compound is stable. If specifically noted, nitrogen in the heterocyclyl may optionally be quaternized. It is understood that when the total number of S and O atoms in the heterocyclyl exceeds 1, then these heteroatoms are not adjacent to one another.
Examples of heterocycls include, but are not limited to, 1H-indazole, 2-pyrrolidinyl, 2H, 6H-1, 5,2-dithiazinyl, 2H-pyrrolyl, 3H-indolyl, 4-piperidinyl, 4aH-carbazole, 4H-quinolizinyl, 6H-1, 2,5-thiadiazinyl, acridinyl, azabicyclo, azetidine, azepane, aziridinyl, azocinyl, benzimidazolyl, benzodioxolyl, benzofuranyl, benzothiofuranyl, benzothiophenyl, benzoxazolyl, benzothiazolyl, benzotriazolyl, benzotetrazolyl, benzisoxazolyl, benzisothiazolyl, benzimidazolonyl, carbazolyl, 4aH-carbazolyl, b-carbolinyl, chromanyl, chromenyl, cinnolinyl, diazepan, decahydroquinolinyll, 2H,6H-1,5,2-dithiazinyl, dioxolane, furyl, 2,3-dihydrofurany, 2,5-dihydrofuranyl, dihydrofuro[2,3-b]tetrahydrofurany, furanyl, furazanyl, homopiperidinyl, imidazolidine, imidazolidinyl, imidazolyl, imidazolyl, 1H-indazolyl, indolentyl, indolinyll, indolizinyl, indolyl, isobenzofuranyll, isochromanyll, isoindazolyl, isoindolinyll, isoindolyl, isoquinolinyl, isoaxazolyl, morpholinyl, naphthyridinyl, octahydroisoquinolinyll, oxadiazolyl, 1,2,3-oxadiazollyll, 1,2,4-oxadiazolyl, 1,2,5-oxadiazollyll, 1,3,4-oxadiazolyl, oxazolinyll, oxazolyl, oxiranyll, oxazolidinylperimidinyl, phenanthridinyl, phenanthrolinyl, phenarsazinyl, phenazinyl, phenothiazinyl, phenoxathiinyl, phenoxazinyl, phthalazinyl, piperazinyl, piperidinyl, pteridinyl, piperidonyll, 4-piperidinyl, purinyl, pyranly, pyrrolinyl, pyrrolidine, pyrazinyl, pyrazolindinyl, pyrazolinyl, pyrazolyl, pyridazinyl, pyridoazolol, pyridoimidazole, pyridothiazole, pyridinyl, N-oxide-pyridinyl, pyridyl, pyrimidinyl, pyrrolidinyl, pyrrolidinyl dine, pyrrolinyll, pyrrolyl, pyridine, quinazolinyll, quinolinyl, 4H-quinolizinyl, quinoxalinyl, quinuclidinyl, carbolinyll, tetrahydrofuranyll, tetramethylpiperidinyl, tetrahydroquinolinyll, tetrahydroisoquinolinyll, thiophane, thiotetrahydroquinolinyll, 6H-1,2,5-thiadiazinyl, 1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,2,5-thiadiazolyl, 1,3,4-thiadiazolyl, thianthrenyl, thiazolyl, thienyl, thienothiazolyl, thienoazolyl, thienimidazolyl, thiopheneyll, thiiraneg, triazinyl, 1,2,3-triazyll, 1,2,4-triazyll, 1,2,5-triazyll, 1,3,4-triazyll, xanthenyll.

As used herein, “heteroaryl” refers to an aromatic heterocycle having at least one heteroatom ring member such as sulfur, oxygen, or nitrogen. Heteroaryl groups include monocyclic and polycyclic (e.g., having 2, 3 or 4 fused rings) systems. Examples of heteroaryl groups include without limitation, pyridinyl (i.e., pyridinyl), pyrimidinyl, pyrazinyl, pyridazinyl, triazinyl, furyl (i.e. furanyll), quinolyl, isoquinolyl, thienyll,
imidazolyl, thiazolyl, indolyl, pyrryl, oxazolyl, benzofuryl, benzothienyl, benzothiazolyl, isoxazolyl, pyrazolyl, triazolyl, tetrazolyl, indazolyl, 1,2,4-thiadiazolyl, isothiazolyl, benzothienyl, purinyl, carbazolyl, benzimidazolyl, indoliny1, and the like. In some embodiments, the heteroaryl group has from 1 to about 20 carbon atoms, and in further embodiments from about 3 to about 20 carbon atoms. In some embodiments, the heteroaryl group contains 3 to about 14, 4 to about 14, 3 to about 7, or 5 to 6 ring-forming atoms. In some embodiments, the heteroaryl group has 1 to about 4, 1 to about 3, or 1 to 2 heteroatoms. In some embodiments, the heteroaryl group has 1 heteroatom.

As used herein, "alkoxy" or "alkyloxy" represents an alkyl group as defined above with the indicated number of carbon atoms attached through an oxygen bridge. Examples of alkoxy include, but are not limited to, methoxy, ethoxy, n-propoxy, isopropoxy, n-butoxy, isobutoxy, t-butoxy, n-pentoxy, isopentoxy, cyclopropylmethoxy, allyloxy and propargyloxy. Similarly, "alkylthio" or "thioalkoxy" represent an alkyl group as defined above with the indicated number of carbon atoms attached through a sulphur bridge.

As used herein, the term "carbonyl" is art recognized and includes such moieties as can be represented by the general formula:

\[
\begin{align*}
\text{O} & \quad \text{X} \quad \text{R} \\
\text{O} & \quad \text{X} \quad \text{R}'
\end{align*}
\]

wherein X is a bond or represents an oxygen or sulfur, and R represents a hydrogen, an alkyl, an alkenyl, \(-\text{(CH}_2\text{)}_m\text{-}}\) or a pharmaceutically acceptable salt, R' represents a hydrogen, an alkyl, an alkenyl or \(-\text{(CH}_2\text{)}_m\text{-}}\), where m is an integer less than or equal to ten, and R'' is alkyl, cycloalkyl, alkenyl, aryl, or heteroaryl. Where X is an oxygen and R and R' is not hydrogen, the formula represents an "ester". Where X is an oxygen, and R is as defined above, the moiety is referred to herein as a carboxyl group, and particularly when R' is a hydrogen, the formula represents a "carboxylic acid." Where X is oxygen, and R' is a hydrogen, the formula represents a "formate." In general, where the oxygen atom of the above formula is replaced by sulfur, the formula represents a "thiolcarbonyl" group. Where X is a sulfur and R and R' is not hydrogen, the formula represents a "thioester." Where X is sulfur and R is hydrogen, the formula represents a
“thiol carboxylic acid.” Where X is sulfur and R’ is hydrogen, the formula represents a “thiolfomate.” On the other hand, where X is a bond, and R is not a hydrogen, the above formula represents a “ketone” group. Where X is a bond, and R is hydrogen, the above formula is represents an “aldehyde” group.

As used herein, the term “sulfonyl” refers to a moiety that can be represented by the general formula:

\[
\begin{array}{c}
\text{O} \\
\text{S} \text{R} \\
\text{O}
\end{array}
\]

wherein R is represented by but not limited to hydrogen, alkyl, cycloalkyl, alkenyl, aryl, heteroaryl, aralkyl, or heteroaralkyl.

As used herein, some substituents are described in a combination of two or more groups. For example, the expression of “C(=O)C_{3,9}$cycloalkylR^d$” is meant to refer to a structure:

\[
\begin{array}{c}
\text{O} \\
\text{R}^d
\end{array}
\]

wherein p is 1, 2, 3, 4, 5, 6 or 7 (i.e., C_{3,9}$cycloalkyl$); the C_{3,9}$cycloalkyl$ is substituted by R^d; and the point of attachment of the “C(=O)C_{3,9}$cycloalkylR^d$” is through the carbon atom of the carbonyl group, which is on the left of the expression.

For example, the expressions “arylalkyl” and “arylalkyloxy” are meant to refer to a type of structure as exemplified by the two depicted variants, respectively:
As used herein, the phrase “protecting group” means temporary substituents which protect a potentially reactive functional group from undesired chemical transformations. Examples of such protecting groups include esters of carboxylic acids, silyl ethers of alcohols, and acetals and ketals of aldehydes and ketones respectively. The field of protecting group chemistry has been reviewed (Greene, T.W.; Wuts, P.G.M. *Protective Groups in Organic Synthesis*, 3rd ed.; Wiley: New York, 1999).

As used herein, “pharmaceutically acceptable” is employed herein to refer to those compounds, materials, compositions, and/or dosage forms which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problem or complication, commensurate with a reasonable benefit/risk ratio.

As used herein, “pharmaceutically acceptable salts” refer to derivatives of the disclosed compounds wherein the parent compound is modified by making acid or base salts thereof (i.e., also include counterions). Examples of pharmaceutically acceptable salts include, but are not limited to, mineral or organic acid salts of basic residues such as amines; alkali or organic salts of acidic residues such as carboxylic acids; and the like. The pharmaceutically acceptable salts include the conventional non-toxic salts or the quaternary ammonium salts of the parent compound formed, for example, from non-toxic inorganic or organic acids. For example, such conventional non-toxic salts include those derived from inorganic acids such as hydrochloric, phosphoric, and the like; and the salts prepared from organic acids such as lactic, maleic, citric, benzoic, methanesulfonic, and the like.
The pharmaceutically acceptable salts of the present invention can be synthesized from the parent compound that contains a basic or acidic moiety by conventional chemical methods. Generally, such salts can be prepared by reacting the free acid or base forms of these compounds with a stoichiometric amount of the appropriate base or acid in water or in an organic solvent, or in a mixture of the two; nonaqueous media like ether, ethyl acetate, ethanol, isopropanol, or acetonitrile can be used.

As used herein, "in vivo hydrolysable precursors" means an in vivo hydrolysable (or cleavable) ester of a compound of any of the formulas described herein that contains a carboxy or a hydroxy group. For example amino acid esters, C1-6 alkoxyxymethyl esters like methoxyxymethyl; C1-6alkanoyloxymethyl esters like pivaloyloxymethyl; C3-9cycloalkoxyxcarbonyloxy C1-6alkyl esters like 1-cyclohexylcarbonyloxyethyl, acetoxymethoxy, or phosphoramidic cyclic esters.

As used herein, "tautomer" means other structural isomers that exist in equilibrium resulting from the migration of a hydrogen atom. For example, keto-enol tautomerism where the resulting compound has the properties of both a ketone and an unstaturated alchol.

As used herein "stable compound" and "stable structure" are meant to indicate a compound that is sufficiently robust to survive isolation to a useful degree of purity from a reaction mixture, and formulation into an efficacious therapeutic agent.

The present invention further includes isotopically-labeled compounds of the invention.

An "isotopically" or "radio-labeled" compound is a compound of the invention where one or more atoms are replaced or substituted by an atom having an atomic mass or mass number different from the atomic mass or mass number typically found in nature (i.e., naturally occurring). Suitable radionuclides that may be incorporated in compounds of the present invention include but are not limited to ²H (also written as D for deuterium), ³H (also written as T for tritium), ¹¹C, ¹³C, ¹⁴C, ¹³N, ¹⁵N, ¹⁵O, ¹⁷O, ¹⁸O, ¹⁸F, ³⁵S, ³⁶Cl, ³²Br, ⁷⁵Br, ⁷³Br, ⁷¹Br, ¹²³I, ¹²⁴I, ¹²⁵I and ¹³¹I. The radionuclide that is incorporated in the instant radio-labeled compounds will depend on the specific application of that radio-labeled
compound. For example, for in vitro receptor labeling and competition assays, compounds that incorporate $^3$H, $^{14}$C, $^{82}$Br, $^{125}$I, $^{131}$I, $^{35}$S or will generally be most useful. For radio-imaging applications $^{11}$C, $^{18}$F, $^{125}$I, $^{123}$I, $^{124}$I, $^{131}$I, $^{75}$Br, $^{76}$Br or $^{77}$Br will generally be most useful.

It is understood that a “radio-labeled compound” is a compound that has incorporated at least one radionuclide. In some embodiments the radionuclide is selected from the group consisting of $^3$H, $^{14}$C, $^{125}$I, $^{35}$S and $^{82}$Br.

The antidementia treatment defined herein may be applied as a sole therapy or may involve, in addition to the compound of the invention, conventional chemotherapy.

Such conjoint treatment may be achieved by way of the simultaneous, sequential or separate dosing of the individual components of the treatment. Such combination products employ the compounds of this invention.

Compounds of the present invention may be administered orally, parenteral, buccal, vaginal, rectal, inhalation, insufflation, sublingually, intramuscularly, subcutaneously, topically, intranasally, intraperitoneally, intrathoracically, intravenously, epidurally, intrathecally, intracerebroventricularly and by injection into the joints.

The dosage will depend on the route of administration, the severity of the disease, age and weight of the patient and other factors normally considered by the attending physician, when determining the individual regimen and dosage level as the most appropriate for a particular patient.

An effective amount of a compound of the present invention for use in therapy of dementia is an amount sufficient to symptomatically relieve in a warm-blooded animal, particularly a human the symptoms of dementia, to slow the progression of dementia, or to reduce in patients with symptoms of dementia the risk of getting worse.
For preparing pharmaceutical compositions from the compounds of this invention, inert, pharmaceutically acceptable carriers can be either solid or liquid. Solid form preparations include powders, tablets, dispersible granules, capsules, cachets, and suppositories.

A solid carrier can be one or more substances, which may also act as diluents, flavoring agents, solubilizers, lubricants, suspending agents, binders, or tablet disintegrating agents; it can also be an encapsulating material.

In powders, the carrier is a finely divided solid, which is in a mixture with the finely divided active component. In tablets, the active component is mixed with the carrier having the necessary binding properties in suitable proportions and compacted in the shape and size desired.

For preparing suppository compositions, a low-melting wax such as a mixture of fatty acid glycerides and cocoa butter is first melted and the active ingredient is dispersed therein by, for example, stirring. The molten homogeneous mixture is then poured into convenient sized molds and allowed to cool and solidify.

Suitable carriers include magnesium carbonate, magnesium stearate, talc, lactose, sugar, pectin, dextrin, starch, tragacanth, methyl cellulose, sodium carboxymethyl cellulose, a low-melting wax, cocoa butter, and the like.

Some of the compounds of the present invention are capable of forming salts with various inorganic and organic acids and bases and such salts are also within the scope of this invention. For example, such conventional non-toxic salts include those derived from inorganic acids such as hydrochloric, phosphoric, and the like; and the salts prepared from organic acids such as lactic, maleic, citric, benzoic, methanesulfonic, trifluoroacetate and the like.

In some embodiments, the present invention provides a compound of any of the formulas described herein or a pharmaceutically acceptable salt thereof for the therapeutic treatment (including prophylactic treatment) of mammals including humans, it is normally
formulated in accordance with standard pharmaceutical practice as a pharmaceutical composition.

In addition to the compounds of the present invention, the pharmaceutical composition of this invention may also contain, or be co-administered (simultaneously or sequentially) with, one or more pharmacological agents of value in treating one or more disease conditions referred to herein.

The term composition is intended to include the formulation of the active component or a pharmaceutically acceptable salt with a pharmaceutically acceptable carrier. For example this invention may be formulated by means known in the art into the form of, for example, tablets, capsules, aqueous or oily solutions, suspensions, emulsions, creams, ointments, gels, nasal sprays, suppositories, finely divided powders or aerosols or nebulisers for inhalation, and for parenteral use (including intravenous, intramuscular or infusion) sterile aqueous or oily solutions or suspensions or sterile emulsions.

Liquid form compositions include solutions, suspensions, and emulsions. Sterile water or water-propylene glycol solutions of the active compounds may be mentioned as an example of liquid preparations suitable for parenteral administration. Liquid compositions can also be formulated in solution in aqueous polyethylene glycol solution. Aqueous solutions for oral administration can be prepared by dissolving the active component in water and adding suitable colorants, flavoring agents, stabilizers, and thickening agents as desired. Aqueous suspensions for oral use can be made by dispersing the finely divided active component in water together with a viscous material such as natural synthetic gums, resins, methyl cellulose, sodium carboxymethyl cellulose, and other suspending agents known to the pharmaceutical formulation art.

The pharmaceutical compositions can be in unit dosage form. In such form, the composition is divided into unit doses containing appropriate quantities of the active component. The unit dosage form can be a packaged preparation, the package containing discrete quantities of the preparations, for example, packeted tablets, capsules, and
powders in vials or ampoules. The unit dosage form can also be a capsule, cachet, or tablet itself, or it can be the appropriate number of any of these packaged forms.

Compositions may be formulated for any suitable route and means of administration. Pharmaceutically acceptable carriers or diluents include those used in formulations suitable for oral, rectal, nasal, topical (including buccal and sublingual), vaginal or parenteral (including subcutaneous, intramuscular, intravenous, intradermal, intrathecal and epidural) administration. The formulations may conveniently be presented in unit dosage form and may be prepared by any of the methods well known in the art of pharmacy.

For solid compositions, conventional non-toxic solid carriers include, for example, pharmaceutical grades of mannitol, lactose, cellulose, cellulose derivatives, starch, magnesium stearate, sodium saccharin, talcum, glucose, sucrose, magnesium carbonate, and the like may be used. Liquid pharmaceutically administrable compositions can, for example, be prepared by dissolving, dispersing, etc, an active compound as defined above and optional pharmaceutical adjuvants in a carrier, such as, for example, water, saline aqueous dextrose, glycerol, ethanol, and the like, to thereby form a solution or suspension. If desired, the pharmaceutical composition to be administered may also contain minor amounts of non-toxic auxiliary substances such as wetting or emulsifying agents, pH buffering agents and the like, for example, sodium acetate, sorbitan monolaurate, triethanolamine sodium acetate, sorbitan monolaurate, triethanolamine oleate, etc. Actual methods of preparing such dosage forms are known, or will be apparent, to those skilled in this art; for example, see Remington’s Pharmaceutical Sciences, Mack Publishing Company, Easton, Pennsylvania, 15th Edition, 1975.

The compounds of the invention may be derivatised in various ways. As used herein “derivatives” of the compounds includes salts (e.g. pharmaceutically acceptable salts), any complexes (e.g. inclusion complexes or clathrates with compounds such as cyclodextrins, or coordination complexes with metal ions such as Mn$^{2+}$ and Zn$^{2+}$), esters such as in vivo hydrolysable esters, free acids or bases, polymorphic forms of the compounds, solvates (e.g. hydrates), prodrugs or lipids, coupling partners and protecting groups. By “prodrugs”
is meant for example any compound that is converted *in vivo* into a biologically active compound.

Salts of the compounds of the invention are preferably physiologically well tolerated and non toxic. Many examples of salts are known to those skilled in the art. All such salts are within the scope of this invention, and references to compounds include the salt forms of the compounds.

Compounds having acidic groups, such as carboxylate, phosphates or sulfates, can form salts with alkaline or alkaline earth metals such as Na, K, Mg and Ca, and with organic amines such as triethylamine and Tris (2-hydroxyethyl)amine. Salts can be formed between compounds with basic groups, e.g. amines, with inorganic acids such as hydrochloric acid, phosphoric acid or sulfuric acid, or organic acids such as acetic acid, citric acid, benzoic acid, fumaric acid, or tartaric acid. Compounds having both acidic and basic groups can form internal salts.

Acid addition salts may be formed with a wide variety of acids, both inorganic and organic. Examples of acid addition salts include salts formed with hydrochloric, hydriodic, phosphoric, nitric, sulphuric, citric, lactic, succinic, maleic, malic, isethionic, fumaric, benzenesulphonic, toluenesulphonic, methanesulphonic, ethanesulphonic, naphthalenesulphonic, valeric, acetic, propionic, butanoic, malonic, glucuronic and lactobionic acids.

If the compound is anionic, or has a functional group which may be anionic (e.g., COOH may be COO), then a salt may be formed with a suitable cation. Examples of suitable inorganic cations include, but are not limited to, alkali metal ions such as Na and K, alkaline earth cations such as Ca and Mg, and other cations such as Al. Examples of suitable organic cations include, but are not limited to, ammonium ion (i.e., NH₄⁺) and substituted ammonium ions (e.g., NH₃R⁺, NH₃R₂⁺, NH₄⁺, NR₄⁺). Examples of some suitable substituted ammonium ions are those derived from: ethylamine, diethylamine, dicyclohexylamine, triethylamine, butylamine, ethylenediamine, ethanolamine, diethanolamine, piperazine, benzylamine, phenylbenzylamine, choline, meglumine, and
tromethamine, as well as amino acids, such as lysine and arginine. An example of a common quaternary ammonium ion is \( \text{N(CH}_3\text{)}_4^+ \).

Where the compounds contain an amine function, these may form quaternary ammonium salts, for example by reaction with an alkylating agent according to methods well known to the skilled person. Such quaternary ammonium compounds are within the scope of the invention.

Compounds containing an amine function may also form N-oxides. A reference herein to a compound that contains an amine function also includes the N-oxide.

Where a compound contains several amine functions, one or more than one nitrogen atom may be oxidised to form an N-oxide. Particular examples of N-oxides are the N-oxides of a tertiary amine or a nitrogen atom of a nitrogen-containing heterocycle.

N-Oxides can be formed by treatment of the corresponding amine with an oxidizing agent such as hydrogen peroxide or a per-acid (e.g. a peroxycarboxylic acid), see for example *Advanced Organic Chemistry*, by Jerry March, 4th Edition, Wiley Interscience, pages. More particularly, N-oxides can be made by the procedure of L. W. Deady (*Syn. Comm.* 1977, 7, 509-514) in which the amine compound is reacted with \( m \)-chloroperoxybenzoic acid (MCPBA), for example, in an inert solvent such as dichloromethane.

Esters can be formed between hydroxyl or carboxylic acid groups present in the compound and an appropriate carboxylic acid or alcohol reaction partner, using techniques well known in the art. Examples of esters are compounds containing the group \( \text{C} (=\text{O})\text{OR} \), wherein \( R \) is an ester substituent, for example, a \( \text{C}_{1-7} \) alkyl group, a \( \text{C}_{3-20} \) heterocyclyl group, or a \( \text{C}_{5-20} \) aryl group, preferably a \( \text{C}_{1-7} \) alkyl group. Particular examples of ester groups include, but are not limited to, \( \text{C} (=\text{O})\text{OCH}_3 \), \( \text{C} (=\text{O})\text{OCH}_2\text{CH}_3 \), \( \text{C} (=\text{O})\text{OC}(\text{CH}_3)_2 \), and \( \text{C} (=\text{O})\text{OPh} \). Examples of acyloxy (reverse ester) groups are represented by \( \text{OC} (=\text{O})\text{R} \), wherein \( R \) is an acyloxy substituent, for example, a \( \text{C}_{1-7} \) alkyl group, a \( \text{C}_{3-20} \) heterocyclyl group, or a \( \text{C}_{5-20} \) aryl group, preferably a \( \text{C}_{1-7} \) alkyl group. Particular examples
of acyloxy groups include, but are not limited to, OC(=O)CH₃ (acetoxy), OC(=O)CH₂CH₃, OC(=O)C(CH₃)₃, OC(=O)Ph, and OC(=O)CH₂Ph.

Derivatives which are prodrugs of the compounds are convertible in vivo or in vitro into one of the parent compounds. Typically, at least one of the biological activities of compound will be reduced in the prodrug form of the compound, and can be activated by conversion of the prodrug to release the compound or a metabolite of it. Some prodrugs are esters of the active compound (e.g., a physiologically acceptable metabolically labile ester). During metabolism, the ester group (-C(=O)OR) is cleaved to yield the active drug. Such esters may be formed by esterification, for example, of any of the carboxylic acid groups (-C(=O)OH) in the parent compound, with, where appropriate, prior protection of any other reactive groups present in the parent compound, followed by deprotection if required.

Examples of such metabolically labile esters include those of the formula -C(=O)OR wherein R is: C₁₋₇alkyl (e.g., Me, Et, -nPr, -iPr, -nBu, -sBu, -iBu, tBu); C₁₋₇aminoalkyl (e.g., aminoethyl; 2-(N,N-diethylamino)ethyl; 2(4morpholino)ethyl); and acyloxy-C₁₋₇alkyl (e.g., acyloxyethyl; acyloxyethyl; pivaloyloxyethyl; acetoxyethyl; 1-aceetoxyethyl; 1-(1-methoxy-1-methyl)ethyl-carbonyloxyethyl; 1-(benzoyloxy)ethyl; isoproxy-carbonyloxyethyl; 1-isoproxy-carbonyloxyethyl; cyclohexyl-carbonyloxyethyl; 1-cyclohexyl-carbonyloxyethyl; cyclohexylxy-carbonyloxyethyl; 1-cyclohexylxy-carbonyloxyethyl; (4-tetrahydropranyloxy) carbonyloxyethyl; 1-(4-tetrahydropranyloxy)carbonyloxyethyl; (4-tetrahydropranyl)carbonyloxyethyl; and 1(4tetrahydropranyl)carbonyloxyethyl).

Also, some prodrugs are activated enzymatically to yield the active compound, or a compound which, upon further chemical reaction, yields the active compound (for example, as in ADEPT, GDEPT, LIDEPT, etc.). For example, the prodrug may be a sugar derivative or other glycoside conjugate, or may be an amino acid ester derivative.
Other derivatives include coupling partners of the compounds in which the compounds is linked to a coupling partner, e.g. by being chemically coupled to the compound or physically associated with it. Examples of coupling partners include a label or reporter molecule, a supporting substrate, a carrier or transport molecule, an effector, a drug, an antibody or an inhibitor. Coupling partners can be covalently linked to compounds of the invention via an appropriate functional group on the compound such as a hydroxyl group, a carboxyl group or an amino group. Other derivatives include formulating the compounds with liposomes.

Where the compounds contain chiral centres, all individual optical forms such as enantiomers, epimers and diastereoisomers, as well as racemic mixtures of the compounds are within the scope of the invention.

Compounds may exist in a number of different geometric isomeric, and tautomeric forms and references to compounds include all such forms. For the avoidance of doubt, where a compound can exist in one of several geometric isomeric or tautomeric forms and only one is specifically described or shown, all others are nevertheless embraced by the scope of this invention.

The quantity of the compound to be administered will vary for the patient being treated and will vary from about 100 ng/kg of body weight to 100 mg/kg of body weight per day and preferably will be from 10 pg/kg to 10 mg/kg per day. For instance, dosages can be readily ascertained by those skilled in the art from this disclosure and the knowledge in the art. Thus, the skilled artisan can readily determine the amount of compound and optional additives, vehicles, and/or carrier in compositions and to be administered in methods of the invention.

Compounds of the present invention have been shown to inhibit beta secretase (including BACE) activity in vitro. Inhibitors of beta secretase have been shown to be useful in blocking formation or aggregation of Aβ peptide and therefore have a beneficial effects in treatment of Alzheimer's Disease and other neurodegenerative diseases associated with elevated levels and/or deposition of Aβ peptide. Therefore it is believed that the
compounds of the present invention may be used for the treatment of Alzheimer disease and disease associated with dementia. Hence compounds of the present invention and their salts are expected to be active against age-related diseases such as Alzheimer, as well as other Aβ related pathologies such as Down’s syndrome and b-amyloid angiopathy. It is expected that the compounds of the present invention would most likely be used in combination with a broad range of cognition deficit enhancement agents but could also be used as a single agent.

Generally, the compounds of the present invention have been identified in one or both assays described below as having an IC₅₀ value of 100 micromolar or less.

**IGEN Assay**

Enzyme is diluted 1:30 in 40 mM MES pH 5.0. Stock substrate is diluted to 12 μM in 40 mM MES pH 5.0. PALMEB solution is added to the substrate solution (1:100 dilution). DMSO stock solutions of compounds or DMSO alone are diluted to the desired concentration in 40mM MES pH 5.0. The assay is done in a 96 well PCR plate from Nunc. Compound in DMSO (3 μL) is added to the plate then enzyme is added (27 μL) and pre-incubated with compound for 5 minutes. Then the reaction is started with substrate (30 μL). The final dilution of enzyme is 1:60; the final concentration of substrate is 6 μM (Kₐ is 150 μΜ). After a 20 minute reaction at room temperature, the reaction is stopped by removing 10 μL of the reaction mix and diluting it 1:25 in 0.20M Tris pH 8.0. The compounds are added to the plate by hand then all the rest of the liquid handling is done on the CyBi-well instrument.

All antibodies and the streptavidin coated beads are diluted into PBS containing 0.5% BSA and 0.5% Tween20. The product is quantified by adding 50 μL of a 1:5000 dilution of the neoepitope antibody to 50 μL of the 1:25 dilution of the reaction mix. Then, 100 μL of PBS (0.5% BSA, 0.5% Tween20) containing 0.2 mg/ml IGEN beads and a 1:5000 dilution of ruthynlated goat anti-rabbit (Ru-Gar) antibody is added. The final dilution of neoepitope antibody is 1:20,000, the final dilution of Ru-GAR is 1:10,000 and the final concentration of beads is 0.1 mg/ml. The mixture is read on the IGEN instrument with the CindyAB40 program after a 2-hour incubation at room temperature. Addition of DMSO
alone is used to define the 100% activity. 20 μM control inhibitor is used to define 0% of control activity and 100 nM inhibitor defines 50% control of control activity in single-poke assays. Control inhibitor is also used in dose response assays with an IC50 of 100 nM.

Fluorescent Assay

Enzyme is diluted 1:30 in 40mM MES pH 5.0. Stock substrate is diluted to 30 μM in 40 mM MES pH 5.0. PALMEB solution is added to the substrate solution (1:100 dilution). Enzyme and substrate stock solutions are kept on ice until the placed in the stock plates. The Platemate-plus instrument is used to do all liquid handling. Enzyme (9 μL) is added to the plate then 1 μL of compound in DMSO is added and pre-incubated for 5 minutes.

When a dose response curve is being tested for a compound, the dilutions are done in neat DMSO and the DMSO stocks are added as described above. Substrate (10 μL) is added and the reaction proceeds in the dark for 1 hour at room temperature. The assay is done in a Corning 384 well round bottom, low volume, non-binding surface (Corning #3676). The final dilution of enzyme is 1:60; the final concentration of substrate is 15 μM (Km of 25 μM). The fluorescence of the product is measured on a Victor II plate reader with an excitation wavelength of 360nm and an emission wavelength of 485 nm using the protocol labeled Edans peptide. The DMSO control defines the 100% activity level and 0% activity is defined by using 50 μM of the control inhibitor, which completely blocks enzyme function. The control inhibitor is also used in dose response assays and has an IC50 of 95 nM.

Beta-Secretase Whole Cell Assay

Generation of HEK-Fc33-1:

The cDNA encoding full length BACE was fused in frame with a three amino acid linker (Ala-Val-Thr) to the Fc portion of the human IgG1 starting at amino acid 104. The BACE-Fc construct was then cloned into a GFP/pGEN-IRE5-neoK vector (a proprietary vector of AstraZeneca) for protein expression in mammalian cells. The expression vector was stably transfected into HEK-293 cells using a calcium phosphate method. Colonies were selected with 250 μg/mL of G-418. Limited dilution cloning was performed to generate homogeneous cell lines. Clones were characterized by levels of APP expression
and Aβ secreted in the conditioned media using an ELISA assay developed in-house. Aβ secretion of BACE/Fc clone Fc33-1 was moderate.

Cell Culture:
HEK293 cells stably expressing human BACE (HEK-Fc33) were grown at 37°C in DMEM containing 10% heat-inhibited FBS, 0.5 mg/mL antibiotic-antimycotic solution, and 0.05 mg/mL of the selection antibiotic G-418.

Aβ40 Release Assay:
Cells were harvested when between 80 to 90% confluent. 100 µL of cells at a cell density of 1.5 million/mL were added to a white 96-well cell culture plate with clear flat bottom (Costar 3610), or a clear, flat bottom 96-well cell culture plate (Costar 3595), containing 100 µL of inhibitor in cell culture medium with DMSO at a final concentration of 1%. After the plate was incubated at 37°C for 24 h, 100 µL cell medium was transferred to a round bottom 96-well plate (Costar 3365) to quantify Aβ40 levels. The cell culture plates were saved for ATP assay as described in ATP assay below. To each well of the round bottom plate, 50 µL of detection solution containing 0.2 µg/mL of the RαAβ40 antibody and 0.25 µg/mL of a biotinylated 4G8 antibody (prepared in DPBS with 0.5%BSA and 0.5% Tween-20) was added and incubated at 4°C for at least 7 h. Then a 50 µL solution (prepared in the same buffer as above) containing 0.062 µg/mL of a ruthenylated goat anti-rabbit antibody and 0.125 mg/mL of streptavidin coated Dynabeads was added per well. The plate was shaken at 22°C on a plate shaker for 1 h, and then the plates were then measured for ECL counts in an IGEN M8 Analyzer. Aβ standard curves were obtained with 2-fold serial dilution of an Aβ stock solution of known concentration in the same cell culture medium used in cell-based assays.

ATP Assay:
As indicated above, after transferring 100 µL medium from cell culture plates for Aβ40 detection, the plates, which still contained cells, were saved for cytotoxicity assays by using the assay kit (ViaLight™ Plus) from Cambrex BioScience that measures total cellular ATP. Briefly, to each well of the plates, 50 µL cell lysis reagent was added. The plates were incubated at room temperature for 10 min. Two min following addition of 100
μL reconstituted ViaLight™ Plus reagent for ATP measurement, the luminescence of each well was measured in an LJL plate reader or Wallac Topcount.

**BACE Biacore Protocol**

**Sensor Chip Preparation:**

BACE was assayed on a Biacore3000 instrument by attaching either a peptidic transition state isostere (TSI) or a scrambled version of the peptidic TSI to the surface of a Biacore CM5 sensor chip. The surface of a CM5 sensor chip has 4 distinct channels that can be used to couple the peptides. The scrambled peptide KFES-statine-ETIAEVENV was coupled to channel 1 and the TSI inhibitor KTEEISEVN-statine-VAEF was couple to channel 2 of the same chip. The two peptides were dissolved at 0.2 mg/ml in 20 mM Na Acetate pH 4.5, and then the solutions were centrifuged at 14K rpm to remove any particulates. Carboxyl groups on the dextran layer were activated by injecting a one to one mixture of 0.5M N-ethyl-N' (3-dimethylaminopropyl)-carbodiimide (EDC) and 0.5M N-hydroxysuccinimide (NHS) at 5 μL/minute for 7 minutes. Then the stock solution of the control peptide was injected in channel 1 for 7 minutes at 5 μL/min., and then the remaining activated carboxyl groups were blocked by injecting 1M ethanolamine for 7 minutes at 5 μL/minute.

**Assay Protocol:**

The BACE Biacore assay was done by diluting BACE to 0.5 μM in Na Acetate buffer at pH 4.5 (running buffer minus DMSO). The diluted BACE was mixed with DMSO or compound diluted in DMSO at a final concentration of 5% DMSO. The BACE/inhibitor mixture was incubated for 1 hour at 4°C then injected over channel 1 and 2 of the CM5 Biacore chip at a rate of 20 μL/minute. As BACE bound to the chip the signal was measured in response units (RU). BACE binding to the TSI inhibitor on channel 2 gave a certain signal. The presence of a BACE inhibitor reduced the signal by binding to BACE and inhibiting the interaction with the peptidic TSI on the chip. Any binding to channel 1 was non-specific and was subtracted from the channel 2 responses. The DMSO control was defined as 100% and the effect of the compound was reported as percent inhibition of the DMSO control.
hERG Assay

Cell culture

The hERG-expressing Chinese hamster ovary K1 (CHO) cells described by (Persson, Carlsson, Duker, & Jacobson, 2005) were grown to semi-confluence at 37 °C in a humidified environment (5% CO₂) in F-12 Ham medium containing L-glutamine, 10% foetal calf serum (FCS) and 0.6 mg/ml hygromycin (all Sigma-Aldrich). Prior to use, the monolayer was washed using a pre-warmed (37°C) 3 ml aliquot of Versene 1:5,000 (Invitrogen). After aspiration of this solution the flask was incubated at 37 °C in an incubator with a further 2 ml of Versene 1:5,000 for a period of 6 minutes. Cells were then detached from the bottom of the flask by gentle tapping and 10 ml of Dulbecco's Phosphate-Buffered Saline containing calcium (0.9 mM) and magnesium (0.5 mM) (PBS; Invitrogen) was then added to the flask and aspirated into a 15 ml centrifuge tube prior to centrifugation (50 g, for 4 mins). The resulting supernatant was discarded and the pellet gently re-suspended in 3 ml of PBS. A 0.5 ml aliquot of cell suspension was removed and the number of viable cells (based on trypan blue exclusion) was determined in an automated reader (Cedex; Innovatis) so that the cell re-suspension volume could be adjusted with PBS to give the desired final cell concentration. It is the cell concentration at this point in the assay that is quoted when referring to this parameter. CHO-Kv1.5 cells, which were used to adjust the voltage offset on IonWorks™ HT, were maintained and prepared for use in the same way.

Electrophysiology

The principles and operation of this device have been described by (Schroeder, Neagle, Trezise, & Worley, 2003). Briefly, the technology is based on a 384-well plate (PatchPlate™) in which a recording is attempted in each well by using suction to position and hold a cell on a small hole separating two isolated fluid chambers. Once sealing has taken place, the solution on the underside of the PatchPlate™ is changed to one containing amphotericin B. This permeabilises the patch of cell membrane covering the hole in each well and, in effect, allows a perforated, whole-cell patch clamp recording to be made.
A β-test IonWorks™ HT from Essen Instrument was used. There is no capability to warm solutions in this device hence it was operated at room temperature (~21°C), as follows. The reservoir in the "Buffer" position was loaded with 4 ml of PBS and that in the "Cells" position with the CHO-hERG cell suspension described above. A 96-well plate (V-bottom, Greiner Bio-one) containing the compounds to be tested (at 3-fold above their final test concentration) was placed in the “Plate 1” position and a PatchPlate™ was clamped into the PatchPlate™ station. Each compound plate was laid-out in 12 columns to enable ten, 8-point concentration-effect curves to be constructed; the remaining two columns on the plate were taken up with vehicle (final concentration 0.33% DMSO), to define the assay baseline, and a supra-maximal blocking concentration of cisapride (final concentration 10 μM) to define the 100% inhibition level. The fluidics-head (F-Head) of IonWorks™ HT then added 3.5 μl of PBS to each well of the PatchPlate™ and its underside was perfused with "internal" solution that had the following composition (in mM): K-Gluconate 100, KCl 40, MgCl₂ 3.2, EGTA 3 and HEPES 5 (all Sigma-Aldrich; pH 7.25-7.30 using 10 M KOH). After priming and de-bubbling, the electronics-head (E-head) then moved round the PatchPlate™ performing a hole test (i.e. applying a voltage pulse to determine whether the hole in each well was open). The F-head then dispensed 3.5 μl of the cell suspension described above into each well of the PatchPlate™ and the cells were given 200 seconds to reach and seal to the hole in each well. Following this, the E-head moved round the PatchPlate™ to determine the seal resistance obtained in each well. Next, the solution on the underside of the PatchPlate™ was changed to “access” solution that had the following composition (in mM): KCl 140, EGTA 1, MgCl₂ 1 and HEPES 20 (pH 7.25-7.30 using 10 M KOH) plus 100 μg/ml of amphotericin B (Sigma-Aldrich). After allowing 9 minutes for patch perforation to take place, the E-head moved round the PatchPlate™ 48 wells at a time to obtain pre-compound hERG current measurements. The F-head then added 3.5 μl of solution from each well of the compound plate to 4 wells on the PatchPlate™ (the final DMSO concentration was 0.33% in every well). This was achieved by moving from the most dilute to the most concentrated well of the compound plate to minimise the impact of any compound carry-over. After approximately 3.5 mins incubation, the E-head then moved around all 384-wells of the PatchPlate™ to obtain post-compound hERG current measurements. In this way, non-cumulative concentration-effect curves could be produced
where, providing the acceptance criteria were achieved in a sufficient percentage of wells (see below), the effect of each concentration of test compound was based on recording from between 1 and 4 cells.

The pre- and post-compound hERG current was evoked by a single voltage pulse consisting of a 20 s period holding at -70 mV, a 160 ms step to -60 mV (to obtain an estimate of leak), a 100 ms step back to -70 mV, a 1 s step to + 40 mV, a 2 s step to -30 mV and finally a 500 ms step to -70 mV. In between the pre- and post-compound voltage pulses there was no clamping of the membrane potential. Currents were leak-subtracted based on the estimate of current evoked during the +10 mV step at the start of the voltage pulse protocol. Any voltage offsets in IonWorks™ HT were adjusted in one of two ways. When determining compound potency, a depolarising voltage ramp was applied to CHO-Kv1.5 cells and the voltage noted at which there was an inflection point in the current trace (i.e. the point at which channel activation was seen with a ramp protocol). The voltage at which this occurred had previously been determined using the same voltage command in conventional electrophysiology and found to be -15 mV (data not shown); thus an offset potential could be entered into the IonWorks™ HT software using this value as a reference point. When determining the basic electrophysiological properties of hERG, any offset was adjusted by determining the hERG tail current reversal potential in IonWorks™ HT, comparing it with that found in conventional electrophysiology (-82 mV; see Fig. 1c) and then making the necessary offset adjustment in the IonWorks™ HT software. The current signal was sampled at 2.5 kHz.

Pre- and post-scan hERG current magnitude was measured automatically from the leak subtracted traces by the IonWorks™ HT software by taking a 40 ms average of the current during the initial holding period at -70 mV (baseline current) and subtracting this from the peak of the tail current response. The acceptance criteria for the currents evoked in each well were: pre-scan seal resistance > 60 MΩ, pre-scan hERG tail current amplitude > 150 pA; post-scan seal resistance > 60 MΩ. The degree of inhibition of the hERG current was assessed by dividing the post-scan hERG current by the respective pre-scan hERG current for each well.
Methods of Preparation

The compounds of the present invention can be prepared in a number of ways well known to one skilled in the art of organic synthesis. The compounds of the present invention can be synthesized using the methods described below, together with synthetic methods known in the art of synthetic organic chemistry, or variations thereon as appreciated by those skilled in the art. Such methods include, but are not limited to, those described below. All references cited herein are hereby incorporated in their entirety by reference.

The novel compounds of this invention may be prepared using the reactions and techniques described herein. The reactions are performed in solvents appropriate to the reagents and materials employed and are suitable for the transformations being effected. Also, in the description of the synthetic methods described below, it is to be understood that all proposed reaction conditions, including choice of solvent, reaction atmosphere, reaction temperature, duration of the experiment and workup procedures, are chosen to be the conditions standard for that reaction, which should be readily recognized by one skilled in the art. It is understood by one skilled in the art of organic synthesis that the functionality present on various portions of the molecule must be compatible with the reagents and reactions proposed. Such restrictions to the substituents, which are not compatible with the reaction conditions, will be readily apparent to one skilled in the art and alternate methods must then be used.

The starting materials for the examples contained herein are either commercially available or are readily prepared by standard methods from known materials. For example the following reactions are illustrations but not limitations of the preparation of some of the starting materials and examples used herein.

General procedures for making the compounds of the invention is as follows:

The invention will now be illustrated by the following nonlimiting examples, in which, unless stated otherwise:

Abbreviations: APCI: atmospheric pressure chemical ionization; DCM: dichloromethane; DMF: N,N-dimethyl formamide; HPLC: high pressure liquid chromatography; NMR:
nuclear magnetic resonance; TFA: trifluoroacetic acid; THF: tetrahydrofuran. General experimental details: Where indicated that compounds were purified by reverse phase HPLC, a preparative chromatography system was used employing a C18 column with an appropriate solvent gradient composed of water and acetonitrile, each containing 0.1% TFA. For mass spectral data, results are reported in units of m/z for the parent ion (M+1) unless otherwise indicated. In cases where isotopic splitting (for example, with compounds containing bromine) results in multiple peaks, only the major peak in the cluster is indicated. NMR data are reported for key resonances, were recorded in the indicated deuterated solvent, and chemical shifts are reported in parts per million relative to tetramethyl silane.

The invention will now be illustrated by the following nonlimiting examples.

Scheme 1
Example 1

4-(2-[3-(2-Furyl)phenyl]ethyl)-6-(3-methylbutoxy)pyrimidin-2-amine trifluoroacetate

\[ \text{O} \quad \text{N} \quad \text{NH}_2 \]

*Ethyl 3-(3-bromophenyl)propanoate (Scheme 1, A)*

\[ \text{O} \quad \text{C} \quad \text{Br} \]

To a solution of 3-(3-bromophenyl)-propionic acid (25.0 g, 109 mmol) in DCM (300.0 mL) was added oxalyl chloride (11.9 mL, 136 mmol) and 2 drops of DMF. After stirring for 2 h the solution was concentrated under reduced pressure, dissolved in DCM (80 mL), and cooled to -10 °C. To this solution, ethanol (80 mL) was added dropwise and stirred at room temperature for 4 h. The solution was concentrated under reduced pressure and dried under vacuum to afford the product in quantitative yield. \(^1\)H NMR (300 MHz, DMSO) δ 7.45 (s, 1H), 7.38 (mult 1H), 7.24 (d, \( J = 20.8 \) Hz, 2H), 4.04 (q, \( J = 7.1 \) Hz, 2H), 2.84 (t, \( J = 7.5 \) Hz, 2H), 2.62 (t, \( J = 7.5 \) Hz, 2H), 1.15 (t, \( J = 7.1 \) Hz, 3H); m/z 258.

*Ethyl 3-[3-(2-furyl)phenyl]propanoate (Scheme 1, B)*

\[ \text{O} \quad \text{C} \quad \text{O} \]

To a solution of ethyl 3-(3-bromophenyl)propanoate (13.0 g, 50.5 mmol) in dioxane (338 mL) was added 2-(tributylstannyl)furan (9.5 mL, 30.3 mmol, 0.6 eq.), and dichloro-bis-(triphenylphosphine) palladium (2.48 g, 3.53 mmol, 0.07 eq.). The mixture was heated at 100°C for 20 min. then portions of 2-(tributylstannyl)furan (9.5 mL, 30.3 mmol, 0.6 eq.)
were added at 20 min. intervals until the starting material was consumed. The solution was concentrated under reduced pressure, adsorbed onto silica gel and purified by flash chromatography (hexanes, hexanes:DCM; 9.5/0.5, hexanes:DCM; 4/1, hexanes:DCM; 1/1) to afford the desired product (11.16 g, 45.68 mmol, 90%) as a yellow/brown solid. \(^1\)H NMR (300.132 MHz, DMSO) \(\delta\) 7.73 (s, 1H), 7.54 (t, \(J = 8.3\) Hz, 2H), 7.33 (mult 1H), 7.14 (d, \(J = 12.0\) Hz, 1H), 6.91 (s, 1H), 6.58 (d, \(J = 5.1\) Hz, 1H), 4.05 (q, \(J = 7.1\) Hz, 2H), 2.89 (t, \(J = 7.4\) Hz, 2H), 2.65 (t, \(J = 7.4\) Hz, 2H), 1.15 (t, \(J = 8.0\) Hz, 3H); m/z 245.

3-[3-(2-Furyl)phenyl]propanoic acid (Scheme 1, C)

To a solution of ethyl 3-[3-(2-furyl)phenyl]propanoate (23.23 g, 95.09 mmol) in THF (438 mL) and water (218 mL) was added a solution of LiOH (4.38 g, 104 mmol) in water (40 mL) by dropwise addition. After stirring overnight, the mixture was concentrated under reduced pressure to remove THF. The resulting solution was washed with diethyl ether and the aqueous phase was acidified by addition of HCl and washed with DCM. The DCM solution was dried (Na\(_2\)SO\(_4\)), concentrated under reduced pressure, and dried under vacuum to afford the desired product (18.32 g, 84.72 mmol, 90%) as a yellow solid. \(^1\)H NMR (300MHz, DMSO) \(\delta\) 12.09 (s, 1H), 7.73 (s, 1H), 7.54 (t, \(J = 9.1\) Hz, 2H), 7.33 (t, \(J = 7.7\) Hz, 1H), 7.16 (d, \(J = 7.5\) Hz, 1H), 6.92 (d, \(J = 3.2\) Hz, 1H), 6.58 (s, 1H), 2.87 (t, \(J = 7.4\) Hz, 2H), 2.57 (t, \(J = 7.6\) Hz, 2H); m/z 217 (MH\(^+\))

Ethyl 5-[3-(2-furyl)phenyl]-3-oxopentanoate (Scheme 1, D)

To a stirred suspension of MgCl\(_2\) (20.17 g, 211.8 mmol) in anhydrous acetonitrile (1.0 L) at ambient temperature was added potassium malonate (30.3 g, 178.0 mmol) and
triethylamine (37.8 mL, 271.11 mmol). Stirring was continued for 3 h before the addition of a solution of 3-[3-(2-furyl)phenyl]propanoic acid (18.32 g, 84.71 mmol), acetonitrile (272.0 mL), 1,1'-carbonyldiimidazole (15.1 g, 93.19 mmol) which was allowed to stir for 2 h prior to addition. After stirring for 18 h at room temperature, the reaction was heated in a 90°C oil bath for 3 h. Once cooled to room temperature, a white solid was filtered and washed three times with acetonitrile. The combined filtrates were concentrated under reduced pressure then placed into a separatory funnel along with DCM, H₂O, 10% Citric Acid. The organics were collected, dried (Na₂SO₄), concentrated under reduced pressure and dried under vacuum to give desired product (11.69 g, 40.83 mmol, 48%). ¹H NMR (300. MHz, DMSO) δ 7.73 (s, 1H), 7.52 (t, J = 7.1 Hz, 2H), 7.32 (t, J = 7.6 Hz, 1H), 7.13 (d, J = 7.5 Hz, 1H), 6.91 (d, J = 3.3 Hz, 1H), 6.58 (mult, 1H), 4.08 (q, J = 7.1 Hz, 2H), 3.61 (s, 2H), 2.87 (mult, 4H), 1.17 (t, J = 7.1 Hz, 3H); m/z 287.

2-Amino-6-[3-(2-furyl)phenyl]ethyl]pyrimidin-4(3H)-one (Scheme 1, E)

To a solution of ethyl 5-[3-(2-furyl)phenyl]-3-oxopentanoate (11.70 g, 40.83 mmol) in ethanol (100 mL) was added guanidine carbonate (3.86 g, 21.44 mmol) and the reaction was heated under reflux for 20 h. Concentration under reduced pressure gave a red/orange gum which was purified in the following manner: diethylether (30.0 mL) and H₂O (20.0 mL) were added with the crude mixture triturated for 5 min. This was followed by the addition of diethylether (20.0 mL) three times at 5 min. intervals with constant trituration. The result was formation of a light brown solid which was filtered, dried under reduced pressure to give desired product (8.86 g, 31.4 mmol, 77%). ¹H NMR (300. MHz, DMSO) δ 7.73 (s, 1H), 7.52 (t, J = 7.8 Hz, 2H), 7.32 (t, J = 7.6 Hz, 1H), 7.13 (d, J = 7.5 Hz, 1H), 6.91 (d, J = 3.3 Hz, 1H), 6.56 (mult, 4H), 5.40 (s, 1H), 2.90 (t, J = 7.9 Hz, 2H), 2.58 (t, J = 7.9 Hz, 2H); m/z 282.
**N’-(4-{2-[3-(2-furyl)phenyl]ethyl}-6-oxo-1,6-dihydropyrimidin-2-yl)-N,N-dimethyllimidoformamide (Scheme 1, F)**

To a stirred solution of (5.0 g, 17.8 mmol) 2-amino-6-{2-[3-(2-furyl)phenyl]ethyl}pyrimidin-4(3H)-one (5.0 g, 17.8 mmol) in DMF (54 mL) under nitrogen was added DMF dimethyl acetal (3.5 mL, 26.7 mmol). The reaction was allowed to stir overnight, then H₂O (0.5 mL) was added and solution concentrated under reduced pressure. The resulting material was then dissolved in CH₃CN and again concentrated under reduced pressure to afford desired product as a gum (quantitative yield). ¹H NMR (300 MHz, d₃-MeOD) δ 8.58 (s, 1H), 7.52 (mult, 3H), 7.28 (t, J = 7.7 Hz, 1H), 7.11 (d, J = 7.6 Hz, 1H), 6.72 (d, J = 2.8 Hz, 1H), 6.49 (mult, 1H), 5.78 (s, 1H), 3.17 (s, 3H), 3.11 (s, 3H), 3.00 (mult, 2H), 2.78 (mult, 2H); m/z 337.

**4-{2-[3-(2-Furyl)phenyl]ethyl}-6-(3-methylbutoxy)pyrimidin-2-amine trifluoroacetate (Scheme 1, H)**

A mixture of N’-(4-{2-[3-(2-furyl)phenyl]ethyl}-6-oxo-1,6-dihydropyrimidin-2-yl)-N,N-dimethyllimidoformamide (40 mg, 0.12 mmol), potassium carbonate (25 mg, 0.18 mmol) and 1-bromo-3-methylbutane (22 µL, 0.18 mmol) was stirred at 55°C for 4 h. Additional potassium carbonate (75 mg, 0.53 mmol) and 1-bromo-3-methylbutane (75 µL, 0.61 mmol) were added and stirred at 55 °C for 17 h to give N’-[4-{2-[3-(2-furyl)phenyl]ethyl}-6-(3-methylbutoxy)pyrimidin-2-yl]-N,N-dimethyllimidoformamide(Scheme 1, G) which was
used directly. To the aforementioned mixture was added ammonium hydroxide (400 µL) and acetonitrile (200 µL) and heated in a sealed tube at 90°C for 3.5 h. The mixture was concentrated and purified by preparative reverse phase HPLC using a solvent gradient of water and acetonitrile (each containing 0.1% TFA) to afford the product as the trifluoroacetate salt (8 mg). $^1$H NMR (300 MHz, DMSO) $\delta$ 7.74 (s, 1H), 7.58 - 7.53 (m, 2H), 7.35 (t, $J$ = 7.7 Hz, 1H), 7.16 (d, $J$ = 7.6 Hz, 1H), 6.91 (d, $J$ = 3.1 Hz, 1H), 6.60 - 6.59 (m, 2H), 6.26 (s, 1H), 4.35 (t, $J$ = 6.6 Hz, 2H), 2.97 - 2.91 (m, 4H), 1.74 - 1.56 (m, 3H), 0.91 (d, $J$ = 6.4 Hz, 6H); m/z 352.2.

Example 2

4-(Cyclohexylmethoxy)-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-2-amine trifluoroacetate

This material was prepared in the manner described for Example 1 except (bromomethyl)cyclohexane was used in place of 1-bromo-3-methylbutane $^1$H NMR (300 MHz, DMSO) $\delta$ 8.04 (s, 2H), 7.74 (s, 1H), 7.59 - 7.53 (m, 1H), 7.35 (t, $J$ = 7.6 Hz, 1H), 7.17 (d, $J$ = 7.5 Hz, 1H), 6.90 (d, $J$ = 3.5 Hz, 1H), 6.60 - 6.58 (m, 1H), 6.29 (s, 1H), 4.15 (d, $J$ = 6.2 Hz, 1H), 2.98 - 2.90 (m, 4H), 1.70 (s, 7H), 1.26 - 1.12 (m, 2H), 1.05 - 0.97 (m, 2H); m/z 378.2.

Example 3

4-[2-(1,3-Dioxan-2-yl)ethoxy]-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-2-amine trifluoroacetate
This material was prepared in the manner described for Example 1 except 2-(2-
bromoethyl)-1,3-dioxane was used in place of 1-bromo-3-methylbutane. $^1$H NMR
(300MHz, DMSO) $\delta$ 7.74 (s, 1H), 7.59 - 7.54 (m, 2H), 7.35 (t, $J = 7.7$ Hz, 1H), 7.16 (d, $J = 7.6$ Hz, 1H), 6.91 (d, $J = 3.2$ Hz, 1H), 6.60 - 6.59 (m, 1H), 6.27 (s, 1H), 4.67 (t, $J = 5.1$
Hz, 1H), 4.36 (t, $J = 6.8$ Hz, 2H), 4.01 (d, $J = 5.0$ Hz, 1H), 3.97 (d, $J = 4.9$ Hz, 1H), 3.69 (t,
$J = 12.1$ Hz, 2H), 2.98 - 2.89 (m, 4H), 1.97 - 1.82 (m, 2H), 1.34 (d, $J = 13.4$ Hz, 1H); m/e 396.2.

**Example 4**

2-[[2-Amino-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-4-yl]oxy methyl]benzonitrile
trifluoroacetate

This material was prepared in the manner described for Example 1 except 2-
(bromomethyl)benzonitrile was used in place of 1-bromo-3-methylbutane. $^1$H NMR (300
MHz, DMSO) $\delta$ 7.92 (d, $J = 7.4$ Hz, 1H), 7.74 (s, 3H), 7.59 - 7.53 (m, 3H), 7.34 (t, $J = 7.5$
Hz, 1H), 7.16 (d, $J = 7.0$ Hz, 1H), 6.90 (s, 1H), 6.59 (s, 1H), 6.35 (s, 1H), 5.54 (s, 2H),
2.96 - 2.92 (m, 4H); m/e 397.1.

**Example 5**

4-[[2-[3-(2-Furyl)phenyl]ethyl]-6-(2-phenoxyethoxy)pyrimidin-2-amine
trifluoroacetate
This material was prepared in the manner described for Example 1 except (2-
bromoethoxy)benzene was used in place of 1-bromo-3-methylbutane. \(^1\)H NMR (400 MHz, DMSO) \(\delta\) 8.12 - 7.80 (m, 2H), 7.72 (d, \(J = 1.7\) Hz, 1H), 7.58 (s, 1H), 7.53 (d, \(J = 7.7\) Hz, 1H), 7.33 (t, \(J = 7.7\) Hz, 2H), 7.29 (t, \(J = 8.0\) Hz, 2H), 7.15 (d, \(J = 7.7\) Hz, 1H), 6.95 (t, \(J = 3.2\) Hz, 1H), 6.94 (d, \(J = 5.8\) Hz, 1H), 6.90 (d, \(J = 3.4\) Hz, 1H), 6.58 (d, \(J = 3.4\) Hz, 1H), 6.34 (s, 1H), 4.64 (t, \(J = 4.2\) Hz, 2H), 4.30 (t, \(J = 4.4\) Hz, 2H), 2.96 (t, \(J = 4.5\) Hz, 2H), 2.90 (t, \(J = 4.5\) Hz, 2H); m/z (APCI) 402 M+1.

**Example 6**

4-Chloro-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-2-amine

![Chemical Structure](image)

2-Amino-6-{2-[3-(2-furyl)phenyl]ethyl}pyrimidin-4(3H)-one (Scheme 1, E; 1.4 g) was heated, with stirring, in phosphorous oxychloride (7 mL) at 105°C for 6 hours under nitrogen atmosphere. It was then cooled, concentrated under reduced pressure, poured into a stirring mixture of ice water and chloroform, and basified using aqueous sodium hydroxide. The layers were then separated and the organic dried over Na\(_2\)SO\(_4\), filtered, and concentrated under reduced pressure to give the desired product (160 mg) as a glasslike solid. \(^1\)HNMR (300 MHz, DMSO) \(\delta\) 7.73 (d, \(J = 1.3\) Hz, 1H), 7.57 (s, 1H), 7.52 (d, \(J = 7.9\) Hz, 1H), 7.33 (t, \(J = 7.7\) Hz, 1H), 7.14 (d, \(J = 7.7\) Hz, 1H), 7.03 (s, 2H), 6.91 (d, \(J = 3.3\) Hz, 1H), 6.62 (s, 1H), 6.60 - 6.58 (m, 1H), 3.00 - 2.94 (m, 2H), 2.85-2.80 (m, 2H); m/z 300.0 (MH\(^+\)).

Various modifications of the invention, in addition to those described herein, will be apparent to those skilled in the art from the foregoing description. Such modifications are also intended to fall within the scope of the appended claims. Each reference (including, but not limited to, journal articles, U.S. and non-U.S. patents, patent application publications, international patent application publications, and the like) cited in the present application is incorporated herein by reference in its entirety.
Claims

1. A compound of formula I:

or a pharmaceutically acceptable salt, tautomer, or in vivo-hydrolysable precursor thereof, wherein:

R<sup>1</sup> is H, Si(C<sub>1-10</sub> alkyl)<sub>_3</sub>, CN, NO<sub>2</sub>, OR<sup>a</sup>, SR<sup>a</sup>, OC(O)R<sup>a</sup>, OC(O)OR<sup>b</sup>, OC(O)NR<sup>c</sup>R<sup>d</sup>, C(O)R<sup>a</sup>, C(O)OR<sup>b</sup>, C(O)NR<sup>c</sup>R<sup>d</sup>, NR<sup>c</sup>R<sup>d</sup>, NR<sup>c</sup>C(O)R<sup>a</sup>, NR<sup>c</sup>C(O)OR<sup>b</sup>, NR<sup>c</sup>S(O)_{2}R<sup>b</sup>, S(O)R<sup>a</sup>, S(O)NR<sup>c</sup>R<sup>d</sup>, S(O)_{2}R<sup>a</sup>, S(O)_{2}NR<sup>c</sup>R<sup>d</sup>, C<sub>1-10</sub> alkyl, C<sub>1-10</sub> haloalkyl, C<sub>2-10</sub> alkenyl, C<sub>2-10</sub> alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, aryalkyl, heteroaryalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C<sub>1-10</sub> alkyl, C<sub>1-10</sub> haloalkyl, C<sub>2-10</sub> alkenyl, C<sub>2-10</sub> alkynyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, aryalkyl, heteroaryalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2 or 3 R<sup>4</sup>;

R<sup>2</sup> is halo or OR<sup>3</sup>;

R<sup>3</sup> is C<sub>1-6</sub> alkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aryalkyl, heteroaryalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C<sub>1-6</sub> alkyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aryalkyl, heteroaryalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R<sup>4</sup>;

R<sup>4</sup> is each, independently, halo, C<sub>1-4</sub> alkyl, C<sub>1-4</sub> haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO<sub>2</sub>, OR<sup>a</sup>, SR<sup>a</sup>, C(O)R<sup>b</sup>, C(O)NR<sup>c</sup>R<sup>d</sup>, C(O)OR<sup>b</sup>, OC(O)R<sup>b</sup>, OC(O)NR<sup>c</sup>R<sup>d</sup>, NR<sup>c</sup>R<sup>d</sup>, NR<sup>c</sup>C(O)R<sup>d</sup>, NR<sup>c</sup>C(O)OR<sup>b</sup>, NR<sup>c</sup>S(O)_{2}R<sup>b</sup>, S(O)R<sup>b</sup>, S(O)NR<sup>c</sup>R<sup>d</sup>, S(O)_{2}R<sup>b</sup>, or S(O)_{2}NR<sup>c</sup>R<sup>d</sup>;
R⁵ and R⁶ are each, independently, H, halo, C₁₋₄ alkyl, C₁₋₄ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO₂, OR⁶, NR⁶, C(O)R⁶, C(O)NR⁵R⁶, C(O)OR⁶, OC(O)R⁶, OC(O)NR⁵R⁶, NR⁵R⁶, NR⁵C(O)R⁶, NR⁵C(O)OR⁶, NR⁵C(O)OR⁶, S(O)R⁶, S(O)NR⁵R⁶, S(O)₂R⁶, or S(O)₂NR⁵R⁶;

Q is aryl, cycloalkyl, heteroaryl or heterocycloalkyl, each substituted by 1 C⁴ and optionally substituted by 1, 2, 3, or 4 A⁴;

L is C₂₋₁₀ alkenylenyl, C₂₋₁₀ alkynylenyl, (CR⁵R⁶)ₜ, (CR⁵R⁶)ₜCO(CR⁵R⁶)ₜ₀ or (CR⁵R⁶)ₜ₁CONR⁵(CR⁵R⁶)ₜ₂;

C⁴ is aryl, heteroaryl, cycloalkyl, or heterocycloalkyl, each optionally substituted with 1, 2, 3, 4 or 5 A²;

A¹ and A² are each, independently, halo, CN, NO₂, OR⁴, SR⁴, C(O)R⁴, C(O)NR⁴R⁴, C(O)OR⁴, OC(O)R⁴, OC(O)NR⁴R⁴, NR⁴R⁴, NR⁴C(O)R⁴, NR⁴C(O)OR⁴, NR⁴S(O)R⁴, NR⁴S(O)₂R⁴, S(O)R⁴, S(O)NR⁴R⁴, S(O)₂R⁴, S(O)₂NR⁴R⁴, C₁₋₄ alkoxy, C₁₋₄ haloalkoxy, amino, C₁₋₄ alkylamino, C₂₋₈ dialkylamino, C₁₋₄ alkyln, C₂₋₆ alkenyl, C₂₋₆ alkyln, arylalkyl, cycloalkylalkyl, heteroaryalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl or heterocycloalkyl, wherein each of the C₁₋₄ alkyl, C₂₋₆ alkenyl, C₂₋₆ alkyln, arylalkyl, cycloalkylalkyl, heteroaryalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl or heterocycloalkyl is optionally substituted by 1, 2, 3, 4 or 5 halo, C₁₋₄ alkyl, C₂₋₆ alkenyl, C₂₋₆ alkyln, C₁₋₄ haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, NO₂, OR⁴, SR⁴, C(O)R⁴, C(O)NR⁴R⁴, C(O)OR⁴, OC(O)R⁴, OC(O)NR⁴R⁴, NR⁴R⁴, NR⁴C(O)R⁴, NR⁴C(O)OR⁴, NR⁴S(O)R⁴, NR⁴S(O)₂R⁴, S(O)R⁴, S(O)NR⁴R⁴, S(O)₂R⁴, S(O)₂NR⁴R⁴, R⁴ and R⁴ are each, independently, H, C₁₋₄ alkyl, C₁₋₄ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkyln, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroaryalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C₁₋₆ alkyl, C₁₋₆ haloalkyl, C₂₋₆ alkenyl, C₂₋₆ alkyln, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, arylalkyl, heteroaryalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C₁₋₆ alkyl, C₁₋₆ haloalkyl, aryl, arylalkyl, heteroaryl, heterocycloalkyl, cycloalkyl or heterocycloalkyl;
haloalkyl, C_{1-6} haloalkyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl;

R^e and R^d are each, independently, H, C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkylnyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkylnyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted with OH, amino, halo, C_{1-6} alkyl, C_{1-6} haloalkyl, C_{2-6} haloalkyl, aryalkyl, aryl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl;

or R^e and R^d together with the N atom to which they are attached form a 4-, 5-, 6- or 7-membered heterocycloalkyl group;

R^e and R^d are each, independently, H, C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkylnyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C_{1-10} alkyl, C_{1-6} haloalkyl, C_{2-6} alkenyl, C_{2-6} alkylnyl, aryl, heteroaryl, cycloalkyl, heterocycloalkyl, aryalkyl, heteroarylalkyl, cycloalkyl or heterocycloalkyl;

or R^e and R^d together with the N atom to which they are attached form a 4-, 5-, 6- or 7-membered heterocycloalkyl group;

R^e is H, C_{1-4} alkyl, C_{1-4} haloalkyl, C_{2-4} alkenyl, C_{2-4} alkylnyl, or CO-(C_{1-4} alkyl);

q is 1, 2, 3, 4, 5 or 6;

q1 is 0, 1, 2 or 3; and

q2 is 0, 1, 2 or 3.

2. A compound of claim 1 wherein R^1 is H, C_{1-6} alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein the C_{1-6} alkyl, C_{1-6} haloalkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R^4.

3. A compound of claim 1 wherein R^1 is H, C_{1-6} alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C_{1-6} alkyl, C_{1-6} haloalkyl,
arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2 or 3 substituents independently selected from halo, CN, OH, C<sub>1-6</sub> alkoxy, C<sub>1-6</sub> haloalkoxy, C<sub>1-6</sub> haloalkyl, C<sub>1-6</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>2-6</sub> alkynyl, aryalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl and heterocycloalkyl.

4. A compound of claim 1 wherein R<sup>1</sup> is H, C<sub>1-6</sub> alkyl or C<sub>1-6</sub> haloalkyl, wherein the C<sub>1-6</sub> alkyl is optionally substituted by 1, 2 or 3 substituents independently selected from halo, CN, OH, C<sub>1-6</sub> alkoxy, C<sub>1-6</sub> haloalkoxy, C<sub>1-6</sub> haloalkyl, C<sub>1-6</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>2-6</sub> alkynyl, aryalkyl, cycloalkylalkyl, heteroarylalkyl, heterocycloalkylalkyl, aryl, cycloalkyl, heteroaryl and heterocycloalkyl.

5. A compound of claim 1 wherein R<sup>1</sup> is H, C<sub>1-6</sub> alkyl or C<sub>1-6</sub> haloalkyl.

6. A compound of claim 1 wherein R<sup>1</sup> is H.

7. A compound of claim 1 wherein R<sup>2</sup> is halo.

8. A compound of claim 1 wherein R<sup>2</sup> is chloro.

9. A compound of claim 1 wherein R<sup>2</sup> is OR<sup>3</sup>.

10. A compound of claim 1 wherein:
R<sup>2</sup> is OR<sup>3</sup>; and
R<sup>3</sup> is C<sub>1-6</sub> alkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl,
wherein each of the C<sub>1-6</sub> alkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 R<sup>4</sup>.

11. A compound of claim 1 wherein:
R<sup>2</sup> is OR<sup>3</sup>; and
R<sup>3</sup> is C<sub>1-6</sub> alkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl,
wherein each of the C<sub>1-6</sub> alkyl, aryalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently
selected from halo, C\textsubscript{1-4} alkyl, C\textsubscript{1-4} haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy.

12. A compound of claim 1 wherein R\textsuperscript{4} is each, independently, halo, C\textsubscript{1-4} alkyl, C\textsubscript{1-4} haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy or heterocycloalkyloxy.

13. A compound of claim 1 wherein L is C\textsubscript{2-10} alkenylenyl, C\textsubscript{2-10} alkynylene or (CR\textsuperscript{5}R\textsuperscript{6})\textsubscript{4}.

14. A compound of claim 1 wherein L is (CR\textsuperscript{5}R\textsuperscript{6})\textsubscript{2}.

15. A compound of claim 1 wherein L is (CR\textsuperscript{5}R\textsuperscript{6})\textsubscript{2}.

16. A compound of claim 1 wherein:
L is (CR\textsuperscript{5}R\textsuperscript{6})\textsubscript{2}; and
R\textsuperscript{5} and R\textsuperscript{6} are each, independently, H, halo, C\textsubscript{1-4} alkyl, C\textsubscript{1-4} haloalkyl CN, NO\textsubscript{2}, OH, C\textsubscript{1-4} alkoxy.

17. A compound of claim 1 wherein Q is aryl or heteroaryl, each substituted by 1 Cy\textsuperscript{1} and optionally substituted by 1, 2, 3, or 4 A\textsuperscript{1}.

18. A compound of claim 1 wherein:
Q is aryl or heteroaryl, each substituted by 1 Cy\textsuperscript{1} and optionally substituted by 1, 2, 3, or 4 A\textsuperscript{1}; and
Cy\textsuperscript{1} is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\textsuperscript{2}.

19. A compound of claim 1 wherein:
Q is aryl substituted by 1 Cy\textsuperscript{1} and optionally substituted by 1, 2, 3, or 4 A\textsuperscript{1}; and
Cy\textsuperscript{1} is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\textsuperscript{2}.

20. A compound of claim 1 wherein:
Q is phenyl substituted by 1 Cy\textsuperscript{1} and optionally substituted by 1, 2, 3, or 4 A\textsuperscript{1}; and
Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).

21. A compound of claim 1 wherein:
Q is phenyl substituted by 1 Cy\(^1\) at a meta-position and optionally substituted by 1, 2, 3, or 4 A\(^1\); and Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).

22. A compound of claim 1 wherein:
R\(^1\) is H, C\(_{1-6}\) alkyl or C\(_{1-6}\) haloalkyl;
R\(^2\) is chloro or OR\(^3\);
R\(^3\) is C\(_{1-6}\) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl, wherein each of the C\(_{1-6}\) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, C\(_{1-4}\) alkyl, C\(_{1-4}\) haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, CN, aryloxy, cycloalkyloxy, heteroaryloxy and heterocycloalkyloxy;
L is (CR\(^5\)R\(^6\))\(_q\);
R\(^5\) and R\(^6\) are each, independently, H, halo, C\(_{1-4}\) alkyl, C\(_{1-4}\) haloalkyl CN, NO\(_2\), OH, C\(_{1-4}\) alkoxy;
Q is aryl or heteroaryl, each substituted by 1 Cy\(^1\) and optionally substituted by 1, 2, 3, or 4 A\(^1\); and
Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).

23. A compound of claim 22 wherein q is 2.

24. A compound of claim 22 wherein:
Q is phenyl substituted by 1 Cy\(^1\) and optionally substituted by 1, 2, 3, or 4 A\(^1\); and
Cy\(^1\) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 A\(^2\).

25. A compound of claim 1 wherein the compound has the formula II:
wherein \( t \) is 0 or 1.

26. A compound of claim 25 wherein \( q \) is 2 and \( \text{Cy}^1 \) is aryl or heteroaryl, each optionally substituted with 1, 2, 3, 4 or 5 \( \text{A}^2 \).

27. A compound of claim 25 wherein:

\( R^1 \) is \( H \), \( C_{1-6} \) alkyl or \( C_{1-6} \) haloalkyl;

\( R^2 \) is chloro or \( \text{OR}^3 \); and

\( R^3 \) is \( C_{1-6} \) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl,

wherein each of the \( C_{1-6} \) alkyl, arylalkyl, heteroarylalkyl, cycloalkylalkyl or heterocycloalkylalkyl is optionally substituted by 1, 2, 3, 4 or 5 substituents independently selected from halo, \( C_{1-4} \) alkyl, \( C_{1-4} \) haloalkyl, aryl, cycloalkyl, heteroaryl, heterocycloalkyl, \( \text{CN} \), arylmethoxy, cycloalkylmethylene, heteroarylmethoxy and heterocycloalkylmethoxy.

28. A compound selected from:

4-\{2-\[3-(2-Furyl)phenyl\]ethyl\}-6-(3-methylbutoxy)pyrimidin-2-amine trifluoroacetate;

4-(Cyclohexylmethoxy)-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-2-amine trifluoroacetate;

4-\{2-\[1,3-Dioxan-2-yl\]ethoxy\}-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-2-amine trifluoroacetate;

2-\{2-Amino-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-4-yl\}oxymethyl]benzonitrile trifluoroacetate;

4-\{2-[3-(2-Furyl)phenyl]ethyl\}-6-(2-phenoxyethoxy)pyrimidin-2-amine trifluoroacetate;

4-Chloro-6-[2-[3-(2-furyl)phenyl]ethyl]pyrimidin-2-amine;
or a pharmaceutically acceptable salt, alternative salt, tautomer, or in vivo-hydrolysable precursor thereof.

29. A pharmaceutical composition comprising as active ingredient a therapeutically effective amount of a compound according to any one of claims 1 to 28 in association with pharmaceutically acceptable excipients, carriers or diluents.

30. A compound according to any one of claims 1 to 28, or a pharmaceutically acceptable salt thereof, for use as a medicament.

31. Use of a compound of any one of claims 1 to 28 as a medicament for treating or preventing an Aβ-related pathology.

32. Use of a compound of any one of claims 1 to 28 as a medicament for treating or preventing an Aβ-related pathology, wherein said Aβ-related pathology is Downs syndrome, a β-amyloid angiopathy, cerebral amyloid angiopathy, hereditary cerebral hemorrhage, a disorder associated with cognitive impairment, MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with Alzheimer disease, dementia of mixed vascular origin, dementia of degenerative origin, pre-senile dementia, senile dementia, dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration.

33. Use of a compound of any one of claims 1 to 28 in the manufacture of a medicament for treating or preventing an Aβ-related pathology.

34. Use of a compound of any one of claims 1 to 28 in the manufacture of a medicament for treating or preventing an Aβ-related pathology, wherein said Aβ-related pathology is Downs syndrome, a β-amyloid angiopathy, cerebral amyloid angiopathy, hereditary cerebral hemorrhage, a disorder associated with cognitive impairment, MCI ("mild cognitive impairment"), Alzheimer Disease, memory loss, attention deficit symptoms
associated with Alzheimer disease, neurodegeneration associated with Alzheimer disease, dementia of mixed vascular origin, dementia of degenerative origin, pre-senile dementia, senile dementia, dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration.

35. A method of inhibiting activity of BACE comprising contacting said BACE with a compound of any one of claims 1 to 28.

36. A method of treating or preventing an Aβ-related pathology in a mammal, comprising administering to said patient a therapeutically effective amount of a compound of any one of claims 1 to 28.

37. The method of claim 36, wherein said Aβ-related pathology is Downs syndrome, a β-amyloid angiopathy, cerebral amyloid angiopathy, hereditary cerebral hemorrhage, a disorder associated with cognitive impairment, MCI (“mild cognitive impairment”), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer disease, neurodegeneration associated with Alzheimer disease, dementia of mixed vascular origin, dementia of degenerative origin, pre-senile dementia, senile dementia, dementia associated with Parkinson’s disease, progressive supranuclear palsy or cortical basal degeneration.

38. The method of claim 36, wherein said mammal is a human.

39. A method of treating or preventing an Aβ-related pathology in a mammal, comprising administering to said patient a therapeutically effective amount of a compound of any one of claims 1 to 28 and at least one cognitive enhancing agent, memory enhancing agent, or choline esterase inhibitor.

40. The method of claim 39, wherein said Aβ-related pathology is Downs syndrome, a β-amyloid angiopathy, cerebral amyloid angiopathy, hereditary cerebral hemorrhage, a disorder associated with cognitive impairment, MCI (“mild cognitive impairment”), Alzheimer Disease, memory loss, attention deficit symptoms associated with Alzheimer
disease, neurodegeneration associated with Alzheimer disease, dementia of mixed vascular origin, dementia of degenerative origin, pre-senile dementia, senile dementia, dementia associated with Parkinson's disease, progressive supranuclear palsy or cortical basal degeneration.

41. The method of claim 39, wherein said mammal is a human.
This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)
    Claims Nos.: 31-32, 35-41
    because they relate to subject matter not required to be searched by this Authority, namely:
    Claims 31-32 and 35-41 relate to a method of treatment of the human or animal body by surgery or by therapy /Rule 39.1(iv). Nevertheless, a search has been made for these claims, based on the alleged effects of the compounds.

2.  Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)
    because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3.  Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)
    because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

**IPC:** see extra sheet  
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

**IPC:** C07D, A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**EPO-INTERNAL, WPI DATA, PAJ, CHEM ABS DATA**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>A</td>
<td>WO 0018758 A1 (MITSUBISHI CHEMICAL CORPORATION), 6 April 2000 (06.04.2000)</td>
<td>1-41</td>
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<tr>
<td>A</td>
<td>WO 0162233 A2 (F. HOFFMANN LA ROCHE AG), 30 August 2001 (30.08.2001)</td>
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☐ Further documents are listed in the continuation of Box C.  
☒ See patent family annex.

* Special categories of cited documents:  
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  "O" document referring to an oral disclosure, use, exhibition or other means  
  "P" document published prior to the international filing date but later than the priority date claimed  
  "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
  "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone  
  "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art  
  "&" document member of the same patent family

Date of the actual completion of the international search: 1 March 2007

Date of mailing of the international search report: 02-03-2007

Name and mailing address of the ISA/Swedish Patent Office:  
Box 5055, S-102 42 STOCKHOLM  
Facsimile No. +46 8 666 02 86

Authorized officer: Solveig Gustavsson/Els  
Telephone No. +46 8 782 25 00
International patent classification (IPC)

C07D 239/47 (2006.01)
A61K 31/505 (2006.01)
A61K 31/506 (2006.01)
A61P 25/28 (2006.01)
C07D 239/42 (2006.01)

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Use the application number as username.
The password is AHOWYRIBWI.

Paper copies can be ordered at a cost of 50 SEK per copy from
PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.
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<th>WO</th>
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<tr>
<td>WO 0018758 A1 06/04/2000</td>
<td>AT 256123 T</td>
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<td></td>
<td>AU 5759999 A</td>
<td>17/04/2000</td>
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<tr>
<td></td>
<td>CA 2345065 A</td>
<td>06/04/2000</td>
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<td></td>
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<tr>
<td></td>
<td>CN 1328552 A,T</td>
<td>26/12/2001</td>
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<tr>
<td></td>
<td>DE 69913545 D,T</td>
<td>16/09/2004</td>
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<td>DK 1115721 T</td>
<td>19/04/2004</td>
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<tr>
<td></td>
<td>EP 1115721 A,B</td>
<td>18/07/2001</td>
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<td>SE 1115721 T3</td>
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<td>ES 2214045 T</td>
<td>01/09/2004</td>
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<td>JP 2002525366 T</td>
<td>13/08/2002</td>
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<td></td>
<td>PT 1115721 T</td>
<td>30/04/2004</td>
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<td></td>
<td>TW 241298 B</td>
<td>11/10/2005</td>
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<tr>
<td>WO 0162233 A2 30/08/2001</td>
<td>AT 293962 T</td>
<td>15/05/2005</td>
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<td>AU 780527 B</td>
<td>24/03/2005</td>
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<td>AU 5464301 A</td>
<td>03/09/2001</td>
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<td></td>
<td>BR 0108611 A</td>
<td>06/05/2003</td>
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<td>CA 2398274 A</td>
<td>30/08/2001</td>
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<td>CN 1438890 A,T</td>
<td>27/08/2003</td>
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<td>CZ 20023199 A</td>
<td>14/05/2003</td>
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<td>DE 60110391 D,T</td>
<td>26/01/2006</td>
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<tr>
<td></td>
<td>EP 1261327 A,B</td>
<td>04/12/2002</td>
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<td>SE 1261327 T3</td>
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<td>ES 2240449 T</td>
<td>16/10/2005</td>
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<td>HR 20020673 A</td>
<td>31/12/2004</td>
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<td>HU 0300029 A</td>
<td>28/05/2003</td>
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<td>IL 150912 D</td>
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<td>MA 26878 A</td>
<td>20/12/2004</td>
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<td>MX PA02008240 A</td>
<td>29/11/2002</td>
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<td>NO 20024006 A</td>
<td>22/08/2002</td>
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<td>NZ 520241 A</td>
<td>28/05/2004</td>
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<td>27/12/2004</td>
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<td>RU 2002123338 A</td>
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<td></td>
<td>US 6586441 B</td>
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<td></td>
<td>US 20010027196 A</td>
<td>04/10/2001</td>
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<td></td>
<td>ZA 200206077 A</td>
<td>30/10/2003</td>
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| WO 2004016605 A1 26/02/2004 | AU 2002950853 D | 00/00/0000 |
|                            | AU 2003265170 A | 00/00/0000 |