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71	FULL NAME(S) OF APPLICANT(S)
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54	TITLE OF INVENTION
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(2-Azabicyclo[2.2.1] hept-7-yl)methanol derivatives as nicotinic acetylcholine receptor agonists

57	ABSTRACT (NOT MORE THAN 150 WORDS)
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NUMBER OF SHEETS	37
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The sheet(s) containing the abstract is/are attached.

If no classification is furnished, Form P.9 should accompany this form.

~~The figure of the drawing to which the abstract refers is attached.~~

(57) Abstract: The invention relates to substances of general formula (I), wherein X is selected from the following group: NH, NR₄, O and S, R¹ is selected from the following group: hydrogen, linear and branched, substituted and unsubstituted C₁-C₁₀-alkyl groups, substituted and unsubstituted C₅-C₁₀-aryl groups, substituted and unsubstituted C₄-C₁₀-heteroaryl groups, acyl groups, thioacyl groups, carbonyl carboxy groups, N-organyl-substituted carbamoyl groups and organosulfonyl groups, R², R³, independently of each other, are chosen from the following group: C₁-C₁₀-alkyl groups, C₅-C₁₂-aryl groups and C₄-C₁₂-heteroaryl groups, these groups being unsubstituted or having one or more substituents which are chosen independently of each other from the following group: halogens, alkoxy groups, aryloxy groups, nitro groups, C₁-C₅-alkoxycarbonyl groups, alkyl or acyl groups and cyano groups, optionally substituted with fluorine, and R⁴ is selected from the following group: hydrogen, linear and branched, substituted and unsubstituted C₁-C₁₀-alkyl groups, substituted and unsubstituted C₅-C₁₀-aryl groups, substituted and unsubstituted C₄-C₁₀-heteroaryl groups, acyl groups, thioacyl groups, carbonyl carboxy groups, N-organyl-substituted carbamoyl groups and organosulfonyl groups; or a physiologically compatible salt thereof.

as originally filed

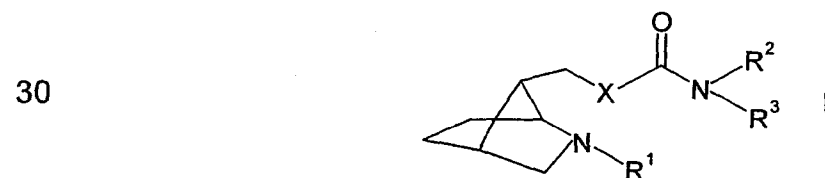
5 **(2-Azabicyclo [2.2.1] hept-7-yl)methanol derivatives of nicotinic
 acetylcholine receptor agonists**

10 The present invention relates to substances which can be employed for
treating diseases in which stimulation of the nicotinic acetylcholine re-
ceptors leads to an improvement in the pathological state. The substances
of the invention comprise an optionally substituted (2-azabicyclo[2.2.1]
hept-7-yl-methyl) unit which is connected to a carbamate, thiocarbamate or
urea unit.

15 Some members of the well-characterized class of acetylcholine receptors
are thought to be responsible for certain pathological states of the central
nervous system. Known active substances able to interact with the class of
acetylcholine receptors are, for example, pilocarpine, nicotine, lobeline and
epibatidine.

20 However, there is still a need for compounds which can be employed for
treating pathological states caused by a dysfunction of nicotinic acetyl-
choline receptors.

25 The object of the present invention is to provide compounds with which it is
possible to treat these pathological states. This object is achieved by sub-
stances of the general formula (I)



35 in which
the broken line represents a double bond which is optionally present,
X is selected from the group consisting of NH, NR⁴, O and S,

5 R¹ is selected from the group consisting of hydrogen, linear and branched, substituted and unsubstituted C₁-C₁₀-alkyl groups, substituted and unsubstituted C₅-C₁₀-aryl groups, substituted and unsubstituted C₄-C₁₀-heteroaryl groups, acyl groups, thioacyl groups, carbonylcarboxy groups, N-organylsubstituted carbamoyl groups and organosulfonyl groups,

10 R², R³ and R⁴ are selected, independently of one another, from the group consisting of C₁-C₁₀-alkyl groups, C₅-C₁₂-aryl groups and C₄-C₁₂-heteroaryl groups, these groups being unsubstituted or having one or more substituents which are selected, independently of one another, from the group consisting of halogens, alkoxy groups, aryloxy groups, nitro groups, C₁-C₅-alkoxycarbonyl groups, optionally fluorine-substituted alkyl or acyl groups and cyano groups.

15 It has been found that the substances of the formula (I) are employed specifically for the treatment of diseases in which stimulation of the nicotinic acetylcholine receptors leads to an improvement in the pathological state. Examples are known to the skilled person and comprise
20 schizophrenia, dementia, including in this connection in particular Alzheimer's disease, neurodegenerative diseases, Parkinson's disease and Tourette's syndrome. The substances likewise have neuroprotective activity, which should make use possible for stroke or intoxications.

25 It is preferred in one embodiment of the present invention when X in the substances of formula (I) is NH, NR⁴ or O, in particular O,

30 R¹ is selected from the group consisting of hydrogen, linear and branched C₁-C₅-alkyl groups which are unsubstituted or may have as substituents one or more halogen atoms, optionally alkyl-substituted C₆-C₁₀-aryl groups and/or C₁-C₅-alkoxycarbonyl groups, or C₆-C₁₂-aryl groups and C₅-C₁₀-heteroaryl groups which may be unsubstituted or have as substituents in each case one or more halogen atoms and/or alkyl groups, or aliphatic
35 C₁-C₅-acyl and thioacyl groups, aromatic C₆-C₉-aroyl and thioaroyl groups, carbamoyl groups of the type R⁵-N(H)-C(O)- and sulfonyl groups of the type R⁵-SO₂-,

R^2 , R^3 and R^4 are selected, independently of one another, from the group consisting of C_1 - C_4 -alkyl groups, the C_5 - C_9 -aryl groups and C_5 - C_8 -hetero-aryl groups which are unsubstituted or have one or more substituents
5 which are selected from the group consisting of C_1 - C_4 -alkoxy groups, C_6 - C_9 -aryloxy groups, nitro groups, C_1 - C_2 -alkoxycarbonyl groups, cyano groups, fluoride, chloride, fluoromethyl groups and acetyl groups.

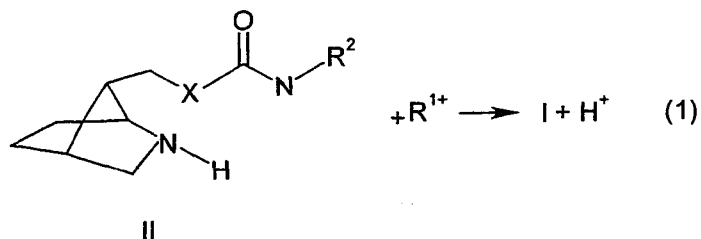
R^5 is selected from the group consisting of C_1 - C_3 -alkyl groups, C_1 - C_3 -fluoroalkyl groups and phenyl groups which can be unsubstituted or
10 substituted by one or more methyl or trifluoromethyl groups.

In a further embodiment of the present invention it is preferred for the compounds of the formula (I) to have no double bond.
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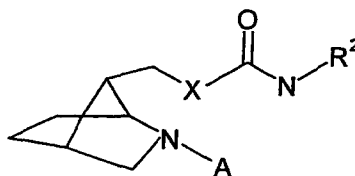
The compounds of the formula (I) are generally prepared by methods known per se, as described in the literature (for example J. March, Advanced Organic Chemistry, 3rd edition, John Wiley & Sons, New York or Houben-Weyl, Methoden der Organischen Chemie [Methods of Organic
20 Chemistry], Georg-Thieme-Verlag, Stuttgart), in particular under reaction conditions known and suitable for said reactions. It is moreover possible to have recourse to variants which are known per se and which are not mentioned in detail hereinafter.

25 According to the present invention, the substances of the formula (I) are preferably prepared by reacting a substance of the formula (II) which is derived from the formula (I) by replacing a group R^1 with a hydrogen atom with a cation R^{1+} which is derived from the group R^1 and has a suitable counterion. This is depicted in the following equation (1):

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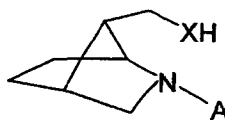
In equation (1), the substituents R^1 and R^2 have the meaning indicated for formula (I). The compounds of the formula (II) are prepared from the compounds of the formula (III) in which A is a suitable protective group for the amino function.



III

A benzyl group is preferably used as protective group. The substances of the invention can be prepared from these compounds (III) by elimination of the protective group, which preferably takes place by hydrogenation, for example using palladium on activated carbon.

The substances of the formula (III) in turn can be obtained from compounds corresponding to formula (IV), specifically by reaction with the appropriate isocyanate $R^2\text{NCO}$ having the required radical R^2 .



IV

The compounds (IV) are known in the case where $X = O$, see, for example, WO 92/05172 and literature cited therein. The compounds (IV), in which X is S can be prepared from the corresponding compounds (IV) with $X = O$ by processes known from the literature.

In the case of the compounds (IV) with $X = \text{NH}$ or NR^4 , these can be obtained from the corresponding alcohols ($X = O$) in various ways. For example, the corresponding alcohol is reacted with a sulfonyl chloride, for example toluenesulfonyl chloride, and the resulting sulfonic acid residue is then reacted with an azide. The corresponding azide of the particular azabicyclo[2.2.1]heptane is obtained in this way. This azide can be reduced

with conventional reducing agents, for example LiAlH_4 , to the corresponding primary amine, resulting in a compound (IV) with $\text{X} = \text{NH}$.

5 The primary amine can also be obtained directly from said alcohol in a complex reaction. In this, the alcohol is reacted with hydrazoic acid HN_3 and an azodicarboxylate in the presence of a suitable phosphine, for example triphenylphosphine.

10 The primary amine can also be converted into the secondary amine having a substituent R^4 , for example by acylation and reduction of the carbonyl function, resulting in the required compound (IV) with $\text{X} = \text{NR}^4$.

15 The compounds of the formula (I) have at least one asymmetric carbon atom which may have different configurations. They can therefore exist in various optically active forms or else as racemates or mixture of racemates.

20 A base of the formula (I) can be converted with an acid into the relevant acid addition salt. Suitable and preferred for this reaction are acids which provide physiologically acceptable salts. Thus, it is possible to use inorganic acids, for example sulfuric acid, hydrovalic acids such as hydrochloric acid or hydrobromic acid, phosphoric acids such as orthophosphoric acid, nitric acid, sulfamic acid. Organic acids are likewise suitable, for example aliphatic, alicyclic, araliphatic, aromatic or heterocyclic mono-

25 basic or polybasic carboxylic, sulfonic or sulfuric acids, such as formic acid, acetic acid, propionic acid, pivalic acid, diethylacetic acid, malonic acid, succinic acid, pimelic acid, fumaric acid, maleic acid, lactic acid, tartaric acid, malic acid, benzoic acid, salicylic acid, 2-phenylpropionic acid, citric acid, gluconic acid, ascorbic acid, nicotinic acid, isonicotinic

30 acid, methane- and ethanesulfonic acids, benzenesulfonic acid, p-toluenesulfonic acid, naphthalene mono- and disulfonic acids, lauryl sulfuric acid. Acid addition salts which are not physiologically acceptable (picrates) may be suitable for isolating and purifying the bases of the formula (I).

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A base of the formula (I) can with some compounds (for example in the case of $X = NH$) be liberated from one of its salts with strong bases such as sodium or potassium hydroxide, sodium or potassium carbonate.

5 The compounds (I) set forth above are used to produce pharmaceuticals with which stimulation of the nicotinic acetylcholine receptors beneficially alters the pathological state.

10 These nicotinic acetylcholine receptors can in principle be divided into two main classes depending on the locations where they occur.

15 These are, on the one hand, the neuromuscular receptors. These are further divided into $(\alpha_1\alpha_1\beta\epsilon\delta)$ and $(\alpha_1\alpha_1\beta\gamma\delta)$ receptors. On the other hand there are the neuronal nicotinic acetylcholine receptors which are found in the ganglia. With these, a distinction is made between the $(\beta_2-\beta_5)$ receptors and the $(\alpha_2-\alpha_9)$ receptors, in this connection also see "Basic Neurochemistry", Ed. Siegel et al., Raven Press, New York 1993.

20 The substances of the formula (I) are able, more or less well, depending, for example, on the structure of the particular molecule employed, to enter into an interaction with each of these receptors. The substances of the formula (I), especially those described as preferred hereinafter, interact particularly well with the nicotinic α_7 receptor.

25 The in-vitro detection of the interaction with the nicotinic α_7 -receptor can be carried out analogously to J.M. Ward et al., FEBS 1990, 270, 45-48 or D.R.E. Macallan, FEB 1998, 226, 357-363. Further in-vitro tests for nicotinic receptors are described in F.E. D'Amour et al., Manual for Laboratory Work in Mammalian Physiology, 3rd Ed., The University of Chicago Press
30 (1965), W. Sihver et al., Neuroscience 1998, 85, 1121-1133 or B. Latli et al., J.Med. Chem. 1999, 42, 2227-2234.

35 Diseases which can be treated with the substances of the formula (I) comprise schizophrenia, dementia, in particular Alzheimer's disease, neurodegenerative disorders, Parkinson's disease, Tourette's syndrome, age-related memory weakness, alleviation of withdrawal symptoms, also, owing to

the neuroprotective action, use for stroke and damage to the brain from toxic compounds.

5 The present invention further relates to pharmaceutical preparations comprising one or more compounds of the formula (I) and/or their physiologically active salts. For this purpose, they can be converted into a suitable dosage form together with at least one carrier or excipient and, where appropriate, in combination with one or more other active substances. These preparations can be employed as pharmaceuticals in human and
10 veterinary medicine. Suitable carrier substances are organic or inorganic substances which are suitable for enteral (for example oral), parenteral or topical administration and which do not react with the novel compounds. Examples comprise water, vegetable oils, benzyl alcohols, polyethylene glycols, gelatin, carbohydrates such as lactose or starch, magnesium
15 stearate, talc and petrolatum. Tablets, coated tablets, capsules, syrups, suspensions, drops or suppositories are used in particular for enteral administration, solutions, preferably oily or aqueous solutions, also suspensions, emulsions or implants, are used for parenteral administration, and ointments, creams, plasters or powders are used for topical applications. The novel compounds can also be lyophilized and the resulting
20 lyophilizates can be used, for example, to produce products for injection.

The indicated preparations can be sterilized and/or contain excipients such as lubricants, preservatives, stabilizers and/or wetting agents, emulsifiers,
25 salts to influence the osmotic pressure, buffer substances, colorings, flavorings and/or odorants. They may, if appropriate, also contain one or more other active substances which do not correspond to formula (I), for example one or more vitamins.

30 The substances of the invention are generally administered in analogy to known, commercially available products (for example tacrine), preferably in dosages between about 5 mg and 100 mg, in particular between 10 and 40 mg per dose unit. The daily dose is preferably between about 0.5 and 1 mg/kg of body weight.

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5 The specific dose for each individual patient depends on a wide variety of factors, for example, on the efficacy of the specific compound employed, on the age, body weight, general state of health, sex, on the diet, on the time and route of administration, on the excretion rate, medicinal substance combination and severity of the particular disorder to which the therapy is applied.

Oral use is preferred.

10 The invention will now be illustrated in the following examples:

Examples:

Example 1:

15 200.00 mg (0.920 mmol) of (2-benzyl-2-aza-bicyclo[2.2.1]hept-7yl)methanol were dissolved in 3 ml of dry THF and then 176.00 mg (0.920 mmol) of ethyl 3-isocyanatobenzoate in 1 ml of dry THF were added at room temperature. After stirring for 6 hours at room temperature, 125 mg
20 (0.30 mmol) of tris-(2-aminoethyl)amine-polystyrene and 250 mg (0.30 mmol) of methyl isocyanate-polystyrene (each from NovaBiochem) were added and stirred at 50°C overnight. After the resins had been filtered off, the solvent was removed and the required product was purified by chromatography with ethyl acetate as mobile phase. In this way,
25 220.00 mg (0.539 mmol) of ethyl 3-(2-benzyl-2-azabicyclo[2.2.1]hept-7-ylmethoxycarbonylamino)benzoate were obtained in the form of a colorless solid.

30 150.00 mg (0.367 mmol) of this compound were then taken up in 2 ml of methanol and, after addition of 10.00 mg of palladium on activated carbon, stirred under a hydrogen atmosphere for 18 hours. Removal of the catalyst by filtration and removal of the solvent resulted in a colorless residue (103.00 mg, 0.324 mmol) containing ethyl 3-(2-azabicyclo[2.2.1]hept-7-ylmethoxycarbonylamino)benzoate.

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15.919 mg (0.050 mmol) of this compound were dissolved in 0.5 ml of THF, then 10.119 mg (0.10 mmol) of triethylamine were added, and subsequently 6.125 mg (0.060 mmol) of acetic anhydride were added dropwise. The solution was stirred at room temperature for 18 hours and quenched with water, and the organic phase after addition of ethyl acetate (2 ml) was isolated. Removal of the solvent and drying resulted in 18.00 mg of crude ethyl 3-(2-acetyl-2-aza-bicyclo[2.2.1]hept-7-yl-methoxycarbonylamino)benzoate in the form of a colorless oil, which can be further purified by conventional methods. M^+ (EI): 361

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The following were obtained analogously:

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2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (2,6-dichlorophenyl)-carbamate; M^+ (EI): 406

2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (4-phenoxyphenyl)carbamate; M^+ (EI): 430

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2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (2-nitrophenyl)carbamate; M^+ (EI): 382

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2-Azabicyclo[2.2.1]hept-7-ylmethyl (3,4-dichlorophenyl)carbamate; M^+ (EI): 316

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2-Azabicyclo[2.2.1]hept-7-ylmethyl (3,5-bis(trifluoromethyl)phenyl)-carbamate; M^+ (EI): 383

2-Azabicyclo[2.2.1]hept-7-ylmethyl (2,4-dimethoxyphenyl)carbamate; M^+ (EI): 307

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Ethyl 3-(2-azabicyclo[2.2.1]hept-7-ylmethoxycarbonylamino)benzoate; M^+ (EI): 319

- 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (4-fluoro-3-nitrophenyl)-
carbamate; M^+ (EI): 400
- 5 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3,5-bistrifluoromethyl-
phenyl)carbamate; M^+ (EI): 473
- 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3,4,5-trimethoxyphenyl)-
carbamate; M^+ (EI): 428
- 10 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3,4-dichlorophenyl)-
carbamate; M^+ (EI): 406
- Ethyl 3-[2-(4-trifluoromethylphenylcarbamoyl)-2-azabicyclo[2.2.1]hept-7-yl-
methoxycarbonylamino]benzoate; M^+ (EI): 506
- 15 Ethyl 3-[2-(toluene-4-sulfonyl)-2-azabicyclo[2.2.1]hept-7-yl-
methoxycarbonylamino]benzoate; M^+ (EI): 474
- Ethyl 3-(2-ethoxycarbonylmethyl-2-azabicyclo[2.2.1]hept-7-yl-
methoxycarbonylamino)benzoate; M^+ (EI): 405
- 20 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3-cyanophenyl)carbamate;
 M^+ (EI): 362
- 25 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (2,6-dichloropyridin-4-yl)-
carbamate; M^+ (EI): 407
- 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3-acetylphenyl)carbamate;
 M^+ (EI): 379
- 30 1-(2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl)-3-(3,4,5-trimethoxy-
phenyl)urea; M^+ (EI): 427
- 1-(2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl)-3-(2-nitrophenyl)urea;
35 M^+ (EI): 381.

Example 2:

5 1) 0.5 g of (2-benzyl-2-azabicyclo[2.2.1]hept-7-yl)methanol in 2 ml of dried pyridine was added at 0°C to an efficiently stirred solution of 0.6 g of tosyl chloride in 5 ml of dried pyridine. The mixture was stirred at 0°C for 12 h, poured into ice and stirred for a further hour. The resulting oil was extracted with ethyl acetate, and the organic phase was washed twice with water, then dried and evaporated to dryness. The resulting (2-benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl) toluene-4-sulfonate was employed without further purification in stage 2).

Yield: 99.3% of theory ESI-MS: 372

15 2) The product obtained in step 1) (0.583 g) was dissolved in 3 ml of dimethylformamide and added at room temperature to a suspension of NaN₃ (0.715 g) in 10 ml of dimethylformamide. After the addition was complete, the mixture was stirred at 85° for 18 h, poured into ice-water and extracted with ethyl acetate. The organic phase was dried and concentrated under reduced pressure to a colorless oil which comprised pure 7-azidomethyl-2-benzyl-2-azabicyclo[2.2.1]heptane.

Yield: 84.1% of theory ESI-MS: 243

25 3) A solution of the product obtained in step 2) (0.320 g) in 5 ml of THF was added dropwise to a suspension of 0.114 g of LiAlH₄ in 10 ml of THF. After the addition was complete, the mixture was stirred at room temperature overnight. A 2N NaOH solution was added and the mixture was filtered and washed with ethyl acetate, the organic phase was separated off, and the aqueous phase was re-extracted with ethyl acetate. The combined organic phases were dried and the solvent was removed. Part of the resulting (2-benzyl-2-azabicyclo[2.2.1]hept-7-yl)-methylamine was converted into the corresponding dihydrochloride.

Yield: 80.5% of theory ESI-MS: 217

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Example 3:

5 A 0.4M solution of 0.108 g of hydrazoic acid in 6.25 ml of toluene was added to a solution of (2-benzyl-2-azabicyclo[2.2.1]hept-7-yl)methanol (217 mg) in 1 ml of anhydrous THF. Then a solution of 0.461 g of diisopropyl azodicarboxylate in 1.5 ml of THF and a solution of 1.31 g of triphenylphosphine in 2 ml THF were added. The temperature of this solution was kept at 25°C by addition of this latter solution in doses. The solution was stirred at temperatures between 25 and 50°C for a total of 19 h, then 10 0.5 ml of water was added, the mixture was stirred at 50°C for a further 6 h, the solvent was removed in vacuo, and the resulting residue was mixed with 10 ml of methylene chloride and 10 ml of 1N HCl. The aqueous phase was removed and washed repeatedly with methylene chloride. Removal of the water under reduced pressure resulting in (2-benzyl-2-azabicyclo[2.2.1]hept-7-yl)methylamine in the form of a colorless oil.

15

Yield: 52% of theory

Example 4:

20 The amine obtained in examples 2 and 3 (30 mg) was dissolved in 1 ml of THF and, at room temperature, 28.131 mg of triethylamine were added and 17.355 mg of acetic anhydride were added dropwise. The solution was stirred at room temperature for 18 h and quenched with water, and the organic phase after addition of ethyl acetate was isolated. Drying and removal of the solvent resulted in (2-benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl)acetamide.

25

Yield: 89% of theory ESI-MS: 259

30 Example 5:

3.795 mg of LiAlH₄ were introduced into 1 ml of THF, and 20 mg of the amide obtained in example 4, which were dissolved in 1 ml of THF, were added dropwise. The mixture was stirred at 0°C for 1 h and then at room temperature. Water was then added to the mixture, followed by an aqueous NH₃ solution, and the mixture was filtered and extracted with ethyl

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acetate. The organic phase was dried and the solvent was evaporated. 18 mg of (2-benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl)ethylamine were obtained in this way.

5 Yield: 96% of theory ESI-MS: 245

(2-Benzyl-2-azabicyclo[2.2.1]hept-7-yl)methanediol has likewise been prepared, ESI-MS: 234

10 The following examples relate to pharmaceutical preparations containing substances of the formula (I) or one of their acid addition salts:

Example A: Tablets

15 A mixture of 1 kg of ethyl 3-(2-acetyl-2-azabicyclo[2.2.1]hept-7-ylmethoxycarbonylamino)benzoate, 4 kg of lactose, 1.2 kg of potato starch, 0.2 kg of talc and 0.1 kg of magnesium stearate is compressed to tablets in a conventional way so that each tablet contains 10 mg of active substance.

20 **Example B: Coated tablets**

Tablets are compressed in analogy to example A and are then provided in a conventional way with a coating of sucrose, potato starch, talc, tragacanth and coloring.

25

Example C: Capsules

2 kg of ethyl 3-(2-acetyl-2-azabicyclo[2.2.1]hept-7-ylmethoxycarbonylamino)benzoate are packed into hard gelatin capsules in a conventional way so that each capsule contains 20 mg of active substance.

30

Example D: Ampules

A solution of 1 kg of ethyl 3-(2-acetyl-2-azabicyclo[2.2.1]hept-7-yl-methoxycarbonylamino)benzoate [lacuna] in 60 l of double-distilled water is sterilized by filtration, dispensed into ampules, lyophilized under sterile

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conditions and sealed sterile. Each ampule contains 10 mg of active substance.

5 Tablets, coated tablets, capsules and ampules containing another compound of the formula (I) and/or one or more physiologically acceptable acid addition salts of a compound of the formula (I) can be obtained analogously.

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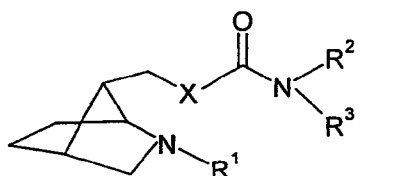
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Patent claims

1. A substance of the general formula

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in which

the broken line represents a double bond which is optionally present,
X is selected from the group consisting of NH, NR⁴, O and S,

15

R¹ is selected from the group consisting of hydrogen, linear and
branched, substituted and unsubstituted C₁-C₁₀-alkyl groups, sub-
stituted and unsubstituted C₅-C₁₀-aryl groups, substituted and unsub-
stituted C₄-C₁₀-heteroaryl groups, acyl groups, thioacyl groups,
carbonylcarboxy groups, N-organyl-substituted carbamoyl groups and
organosulfonyl groups,

20

R², R³ and R⁴ are selected, independently of one another, from the
group consisting of C₁-C₁₀-alkyl groups, C₅-C₁₂-aryl groups and C₄-C₁₂-
heteroaryl groups, these groups being unsubstituted or having one or
more substituents which are selected, independently of one another,
from the group consisting of halogens, alkoxy groups, aryloxy groups,
nitro groups, C₁-C₅-alkoxycarbonyl groups, optionally fluorine-substitu-
ted alkyl or acyl groups and cyano groups,

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or a physiologically acceptable salt thereof.

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2. A substance as claimed in claim 1, in which X is NH, NR⁴ or O, in
particular O,

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R¹ is selected from the group consisting of hydrogen, linear and
branched C₁-C₅-alkyl groups which are unsubstituted or may have as
substituents one or more halogen atoms, optionally alkyl-substituted

5 C₆-C₁₀-aryl groups and/or C₁-C₅-alkoxycarbonyl groups, or C₆-C₁₂-aryl groups and C₅-C₁₀-heteroaryl groups which may be unsubstituted or have as substituents in each case one or more halogen atoms and/or alkyl groups, or aliphatic C₁-C₅-acyl and thioacyl groups, aromatic C₆-C₉-aroyl and thioaroyl groups, carbamoyl groups of the type R⁵-N(H)-C(O)- and sulfonyl groups of the type R⁵-SO₂-,

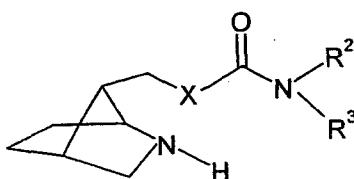
10 R², R³ and R⁴ are selected, independently of one another, from the group consisting of C₁-C₄-alkyl groups, the C₅-C₉-aryl groups and C₅-C₉-heteroaryl groups which are unsubstituted or have one or more substituents which are selected from the group consisting of C₁-C₄-alkoxy groups, C₆-C₉-aryloxy groups, nitro groups, C₁-C₂-alkoxycarbonyl groups, cyano groups, fluoride, chloride, fluoromethyl groups and acetyl groups.

15 R⁵ is selected from the group consisting of C₁-C₃-alkyl groups, C₁-C₃-fluoroalkyl groups and phenyl groups which can be unsubstituted or substituted by one or more methyl or trifluoromethyl groups, or a physiologically acceptable salt thereof.

- 20 3. 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (2,6-dichlorophenyl)-carbamate,
2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (4-phenoxyphenyl)-carbamate,
25 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (2-nitrophenyl)carbamate,
Ethyl 3-(2-benzyl-2-azabicyclo[2.2.1]hept-7-ylmethoxycarbonylamino)-benzoate,
2-Azabicyclo[2.2.1]hept-7-ylmethyl (3,4-dichlorophenyl)carbamate,
2-Azabicyclo[2.2.1]hept-7-ylmethyl (3,5-bistrifluoromethylphenyl)-
30 carbamate,
2-Azabicyclo[2.2.1]hept-7-ylmethyl (2,4-dimethoxyphenyl)carbamate,
Ethyl 3-(2-azabicyclo[2.2.1]hept-7-ylmethoxycarbonylamino)benzoate,
2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (4-fluoro-3-nitrophenyl)-
35 carbamate,
2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3,5-bistrifluoromethylphenyl)carbamate,

- 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3,4,5-trimethoxyphenyl)-
carbamate,
2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3,4-dichlorophenyl)-
carbamate,
5 Ethyl 3-[2-(4-trifluoromethylphenylcarbamoyl)-2-azabicyclo[2.2.1]hept-
7-ylmethoxycarbonylamino]benzoate,
Ethyl 3-[2-(toluene-4-sulfonyl)-2-azabicyclo[2.2.1]hept-7-ylmethoxy-
carbonylamino]benzoate,
10 Ethyl 3-(2-ethoxycarbonylmethyl-2-azabicyclo[2.2.1]hept-7-yl-meth-
oxycarbonylamino)benzoate,
2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3-cyanophenyl)car-
bamate,
2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (2,6-dichloropyridin-4-yl)-
carbamate,
15 2-Benzyl-2-azabicyclo[2.2.1]hept-7-ylmethyl (3-acetylphenyl)car-
bamate,
1-(2-Benzyl-2-aza-bicyclo[2.2.1]hept-7-ylmethyl)-3-(3,4,5-trimethoxy-
phenyl)urea,
1-(2-Benzyl-2-aza-bicyclo[2.2.1]hept-7-ylmethyl)-3-(2-nitrophenyl)urea,
20 or a physiologically acceptable salt thereof.

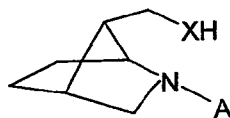
4. A process for preparing a compound as claimed in any of claims 1 to 3,
which comprises reaction of a compound of the general formula (II)



II

in which X, R² and R³ have the meaning defined in claims 1 or 2, with a
cation R¹⁺ which is derived from the group R¹ where the latter has the
meaning set forth in claim 1 or 2 and has a suitable counter ion.

5. A process as claimed in claim 4, which additionally comprises the
action of a compound of the general formula IV



IV

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in which X has the meaning set forth in claims 1 or 2, and A is a suitable protective group, preferably a benzyl group, with an isocyanate of the formula $R^2-N=C=O$, in which R^2 has the meaning set forth in claims 1 or 2, and, where appropriate, elimination of the group A, preferably by hydrogenation.

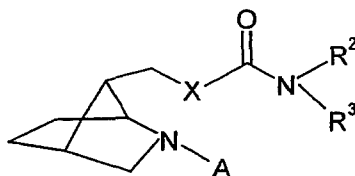
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6. A process as claimed in claim 5, wherein the compound of the formula (IV) with $X = NH$ or NR^4 is prepared from the compound with the formula (IV), in which X is O by converting the latter compound into a suitable sulfonic ester, reacting the latter with an azide, and reducing the azide obtained in this way in a manner known per se to a primary amine, or reacting the alcohol with hydrazoic acid and an azodicarboxylate in the presence of a suitable phosphine, preferably triphenylphosphine, to give a primary amine, and converting the primary amine where appropriate in a manner known per se into the required secondary amine with the meaning of R^4 given in claim 1, preferably by acylation and subsequent reduction.

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7. A substance of the general formula III



III

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in which X is selected from the group consisting of NH , NR^4 , O and S,

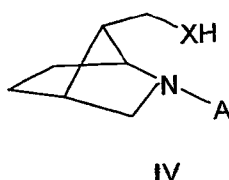
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R^2 , R^3 and R^4 are selected, independently of one another, from the group consisting of C_1 - C_{10} -alkyl groups, C_5 - C_{12} -aryl groups and C_4 - C_{12} -

heteroaryl groups, these groups being unsubstituted or having one or more substituents which are selected, independently of one another, from the group consisting of halogens, alkoxy groups, aryloxy groups, nitro groups, C₁-C₅-alkoxycarbonyl groups, optionally fluorine-substituted alkyl or acyl groups and cyano groups,

and A is hydrogen or a suitable protective group, preferably a benzyl group.

8. A substance of the general formula (IV)



in which A is a suitable protective group, preferably a benzyl group, and X is NH or NR⁴, where

R⁴ is selected from the group consisting of C₁-C₁₀-alkyl groups, C₅-C₁₂-aryl groups and C₄-C₁₂-heteroaryl groups, these groups being unsubstituted or having one or more substituents which are selected, independently of one another, from the group consisting of halogens, alkoxy groups, aryloxy groups, nitro groups, C₁-C₅-alkoxycarbonyl groups, optionally fluorine-substituted alkyl or acyl groups and cyano groups,

and A is hydrogen or a suitable protective group, preferably a benzyl group.

9. A pharmaceutical comprising a compound as claimed in any of claims 1 to 3 or a physiologically acceptable salt thereof in addition to conventional additional substances and excipients.
10. The use of a compound as claimed in any of claims 1 to 3 or of physiologically acceptable salt thereof for producing a pharmaceutical

for the treatment of diseases in which stimulation of the nicotinic acetylcholine receptors leads to an improvement in the pathological state.

- 5 11. The use as claimed in claim 10, wherein the diseases are selected
from the group consisting of schizophrenia, dementia, in particular
Alzheimer's disease, neurodegenerative disorders, Parkinson's
disease, Tourette's syndrome, age-related memory weakness, alle-
10 viation of withdrawal symptoms, stroke and damage to the brain due to
toxic compounds.

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