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(54) **NOVEL POTENT INDUCERS OF TERMINAL DIFFERENTIATION AND METHODS OF USE THEREOF**

NEUE STARKE INDUKTOREN DER TERMINALEN DIFFERENZIERUNG UND VERFAHREN FÜR IHRE VERWENDUNG

NOUVEAUX INDUCTEURS PUISSANTS DE LA DIFFERENCIATION TERMINALE ET LEURS PROCEDES D'UTILISATION

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(56) References cited:
EP-A- 0 576 941
WO-A-93/07148
US-A- 2 279 560
US-A- 2 279 973

- **BRESLOW ET AL.: "Potent cytodifferentiating agents related to hexamethylenebisacetamide" PROC.NATL.ACAD.SCI.U.S.A., vol. 88, no. 13, 1991, pages 5542-6, XP002048759**

EP 0 760 657 B9

Description

[0001] This application is a continuation-in-part of U.S. Serial No. 07/771,760, filed October 4, 1991, the contents of which are hereby incorporated by reference in this disclosure. The invention described herein was made in the course of work under Grant Number CA-57227-01 from the National Institutes of Health. The United States Government has certain rights in this invention.

Background of the Invention

[0002] Throughout this application various publications are referenced by arabic numerals within parentheses. Full citations for these publications may be found at the end of the specification immediately preceding the claims. The disclosures of these publications in their entireties are hereby incorporated by reference into this application in order to more fully describe the state of the art to which this invention pertains.

[0003] Cancer is a discrder in which a population of cells has become, in varying degrees, unresponsive to the control mechanisms which normally govern proliferation and differentiation. For many years there have been two principal strategies for chemotherapeutic treatment of cancer: a) blocking hormone-dependent tumor cell proliferation by interference with the production or peripheral action of sex hormones; and b) killing cancer cells directly by exposing them to cytotoxic substances, which injure both neoplastic and normal cell populations.

[0004] Relatively recently, cancer therapy is also being attempted by the induction of terminal differentiation of the neoplastic cells (1). In cell culture models differentiation has been reported by exposure of cells to a variety of stimuli, including: cyclic AMP and retinoic acid (2,3), aclarubicin and other anthracyclines (4).

[0005] There is abundant evidence that neoplastic transformation does not necessarily destroy the potential of cancer cells to differentiate (1,5,6). There are many examples of tumor cells which do not respond to the normal regulators of proliferation and appear to be blocked in the expression of their differentiation program, and yet can be induced to differentiate and cease replicating. A variety of agents, including some relatively simple polar compounds (5,7-9), derivatives of vitamin D and retinoic acid (10-12), steroid hormones (13), growth factors (6,14), proteases (15,16), tumor promoters (17,18), and inhibitors of DNA or RNA synthesis (4,19-24), can induce various transformed cell lines and primary human tumor explants to express more differentiated characteristics.

[0006] Early studies by the present inventors identified a series of polar compounds that were effective inducers of differentiation in a number of transformed cell lines (8,9). Of these, the most effective inducer, was the hybrid polar/apolar compound N,N'-hexamethylene bisacetamide (HMBA) (9). The use of this polar/apolar compound to induce murine erythroleukemia cells (MELC) to undergo erythroid differentiation with suppression of oncogenicity has proved a useful model to study inducer-mediated differentiation of transformed cells (5,7-9). HMBA-induced MELC terminal erythroid differentiation is a multistep process. Upon addition of HMBA to MELC (745A-DS19) in culture, there is a latent period of 10 to 12 hours before commitment to terminal differentiation is detected. Commitment is defined as the capacity of cells to express terminal differentiation despite removal of inducer (25). Upon continued exposure to HMBA there is progressive recruitment of cells to differentiate. The present inventors have reported that MELC cell lines made resistant to relatively low levels of vincristine become markedly more sensitive to the inducing action of HMBA and can be induced to differentiate with little or no latent period (26).

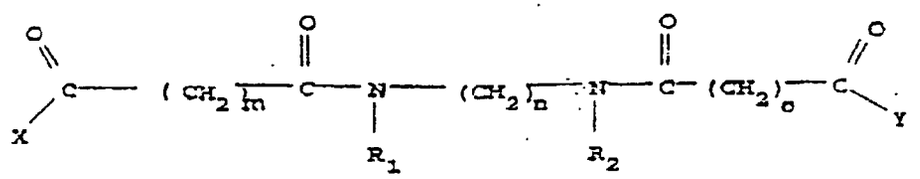
[0007] HMBA is capable of inducing phenotypic changes consistent with differentiation in a broad variety of cells lines (5). The characteristics of the drug induced effect have been most extensively studied in the murine erythroleukemia cell system (MELC) (5,25,27,28). MELC induction of differentiation is both time and concentration dependent. The minimum concentration required to demonstrate an effect in vitro in most strains is 2 to 3 mM; the minimum duration of continuous exposure generally required to induce differentiation in a substantial portion (>20%) of the population without continuing drug exposure is about 36 hours.

[0008] The primary target of action of HMBA is not known. There is evidence that protein kinase C is involved in the pathway of inducer-mediated differentiation (29). The in vitro studies provided a basis for evaluating the potential of HMBA as a cytodifferentiation agent in the treatment of human cancers (30). Several phase I clinical trials with HMBA have been completed (31-36). Clinical trials have shown that this compound can induce a therapeutic response in patients with cancer (35,36). However, these phase I clinical trials also have demonstrated that the potential efficacy of HMBA is limited, in part, by dose-related toxicity which prevents achieving optimal blood levels and by the need for intravenous administration of large quantities of the agent, over prolonged periods.

[0009] Recently, the present inventors have reported a number of compounds related to HMBA with polar groups separated by apolar linkages that, on a molar basis, are as active (37) or 100 times more active than HMBA (38). As a class, however, it has been found that the symmetrical dimmers such as HMBA and related compounds are not the best cytodifferentiating agents.

[0010] EP-A-0 576 941 discloses the compound 5-{N-[2,5-di(benzyloxy)benzoyl]amino}pentylcarbohydroxamic acid and its use as a medicament.

[0011] WO 93/07/48 describes compounds which induce terminal differentiation having the structure



[0012] In Proc. Natl. Acad. Sci. (1991) vol 58 pp 5542-5546 cytodifferentiating agents are disclosed which are bishydroxamic acid derivatives.

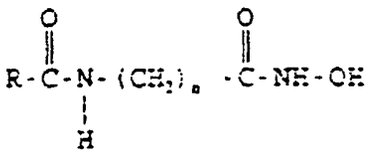
[0013] Acta Cient. Venez (1981) 232(5) pp 411-16 discloses the compound 6-benzamidohexanoyldihydroxanic acid.

[0014] It has unexpectedly been found that the best compounds comprise two polar end groups separated by a flexible chain of methylene groups, wherein one or both of the polar end groups is a large hydrophobic group. Preferably, the polar end groups are different and only one is a large hydrophobic group. These compounds are unexpectedly a thousand times more active than HMBA and ten times more active than HMBA related compounds.

[0015] This new class of compounds of the present invention may be useful for selectively inducing terminal differentiation of neoplastic cells and therefore aid in treatment of tumors in patients.

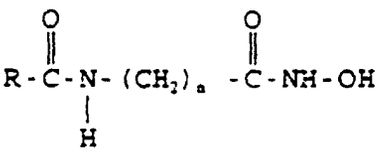
Summary of the Invention

[0016] The present invention provides a compound having the structure:



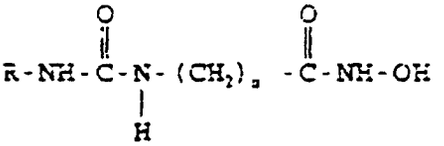
wherein R is a piperidine, thiazole or phenyl, group which is substituted with a methyl, cyano, nitro, thio, trifluoromethyl, amino, aminocarbonyl, methylcyano, chloro, fluoro, bromo iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,8-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyl, t-butyl, phenyl, carboxyl, hydroxyl, methyoxy, phenyloxy, phenylaminooxy, phenylaminocarbonyl, methyoxycarbonyl, methylaminocarbonyl, dimethylamino, dimethylamino-carbonyl, or hydroxylaminocarbonyl group and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

[0017] The present invention also provides a compound having the structure:



wherein R is a substituted or unsubstitued 2-pyridine, 3-pyridine, or 4-pyridine and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

[0018] The present invention further provides a compound having the structure:



wherein R is a substituted or unsubstituted phenyl, pyridine, piperidine or thiazole group and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

[0019] In addition, the present invention provides an in vitro method of selectively inducing terminal differentiation of neoplastic cells and thereby inhibiting proliferation of such cells which comprises contacting the cells under suitable conditions with an effective amount of any of the compounds above, effective to selectively induce terminal differentiation.

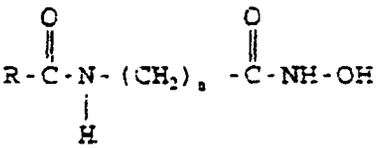
[0020] The present invention also provides the use of the compounds above, for the preparation of a phamaceutical composition effective to selectively induce terminal differentiation of such neoplastic cells and thereby inhibit their proliferation for the treatment of patients having a tumor characterized by proliferation of neoplastic cells.

[0021] The present invention also provides a pharmaceutical composition comprising a therapeutically acceptable amount of any of the compounds above, or pharmaceutically acceptable salts thereof, and a pharmaceutically acceptable carrier.

[0022] Lastly, the present invention provides the pharmaceutical composition defined above, alone or in combination with an antitumor agent, in sustained release form.

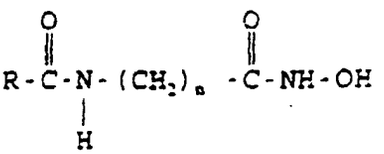
Detailed Description of the Invention

[0023] The present invention provides a compound having the structure:



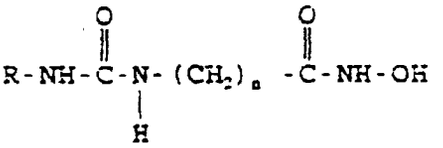
wherein R is a piperidine or thiazole or phenyl, group which is substituted with a methyl, cyano, nitro, thio, trifluoromethyl, amino, aminocarbonyl, methylcyano, chloro, fluoro, bromo, iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,6-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyl, t-butyl, phenyl, carboxyl, hydroxyl, methyoxy, phenyloxy, phenylaminooxy, phenylaminocarbonyl, methyoxycarbonyl, methylaminocarbonyl, dimethylamino, dimethylamino-carbonyl, or hydroxylaminocarbonyl group and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

[0024] The present invention also provides a compound having the structure:



wherein R is a substituted or unsubstitued 2-pyridine, 3-pyridine, or 4-pyridine and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

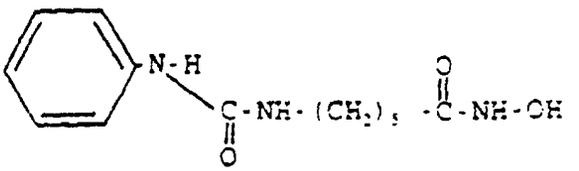
[0025] The present invention further provides a compound having the structure:



wherein R is a substituted or unsubstituted phenyl, pyridine, piperidine or thiazole group and n is an integer from about 4 to about 8 or a pharmaceutically acceptable salt thereof.

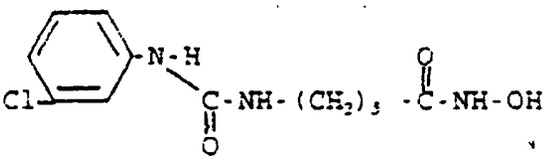
[0026] In a preferred embodiment of the compound defined above, R is a substituted phenyl group. In a more preferred embodiment, the phenyl group is substituted with a methyl, cyano, nitro, thio, trifluoromethyl, amino, aminocarbonyi, methylcyano, chloro, fluoro, bromo, iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,6-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyl, t-butyl, phenyl, carboxyl, hydroxyl, methyoxy, phenyloxy, benzyloxy, phenylaminooxy, phenylaminocarbonyl, methyoxycarbonyl, methylaminocarbonyl, dimethylamino, dimethylamino-carbonyl, or hydroxylaminocarbonyl group.

[0027] In a further preferred embodiment the compound defined above has the structure:



or a pharmaceutically acceptable salt thereof.

[0028] In a further preferred embodiment the compound defined above has the structure:



or a pharmaceutically acceptable salt thereof.

[0029] The present invention further provides an in vitro method of selectively inducing terminal differentiation of neoplastic cells and thereby inhibiting proliferation of such cells which comprises contacting the cells under suitable conditions with an effective amount of any of the compounds above, effective to selectively induce terminal differentiation.

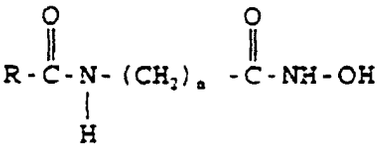
[0030] The contacting must be performed continuously for a prolonged period of time, i.e. for at least 49 hours, preferably for about 4-5 days or longer.

[0031] The method is to be practiced in vitro, contacting may be effected by incubating the cells with the compound. The concentration of the compound in contact with the cells should be from about 1 μM to about 25 mM, preferably from 4 μM to about 5 mM. The concentration depends upon the individual compound and the state of the neoplastic cells.

[0032] The method may also comprise initially treating the cells with an antitumor agent so as to render them resistant to an antitumor agent and subsequently contacting the resulting resistant cells under suitable conditions with an effective amount of any of the compounds above, effective to selectively induce terminal differentiation of such cells.

[0033] The antitumor agent may be one of numerous themotherapy agents such as an alkylating agent, an antimetabolite, a hormonal agent, an antibiotic, colchicine, a vinca alkaloid, L-asparaginase, procarbazine, hydroxyurea, mitotane, nitrosoureas or an imidazole carboxamide. Suitable agents are those agents which promote depolarization of tubulin. Preferably the antitumor agent is colchicine or a vinca alkaloid; especially preferred are vinblastine and vincristine. In embodiments where the antitumor agent is vincristine, the cells preferably are treated so that they are resistant to vincristine at a concentration of about 5 mg/ml. The treating of the cells to render them resistant to an antitumor agent may be effected by contacting the cells with the agent for a period of at least 3-5 days. The contacting of the resulting cells with any of the compounds above is performed as described previously.

[0034] The present invention also provides the use of any of the compounds above, or pharmaceutically acceptable salts thereof for the preparation of a pharmaceutical composition of effective to selectively induce terminal differentiation of such neoplastic cells and thereby inhibit their proliferation treating a patient having a tumor characterized by proliferation of neoplastic cells. More over the invention also provides use of compound having the structure:



wherein R is a substituted or unsubstituted phenyl, piperidine or thiazole group and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof for the preparation of a pharmaceutical composition for selectively inducing terminal differentiation in neoplastic cells.

[0035] And preferably, wherein the selective induction inhibits the proliferation of the neoplastic cells in the treatment of patients having a tumor characterized by proliferation of the neoplastic cells.

[0036] The use of the present invention is intended for the treatment of human patients with tumors. However, it is also likely that the use would be effective in the treatment of tumors in other mammals. The term tumor is intended to include any cancer caused by the proliferation of neoplastic cells, such as lung cancer, acute lymphoid myeloma, bladder melanoma, renal carcinoma, breast carcinoma, or colorectal carcinoma. The administration of the compound to the patient may be effected orally or parenterally. To date, administration intravenously has proven to be effective. The administration of the compound must be performed continuously for a prolonged period of time, such as for at least 3 days and preferably more than 5 days. In the most preferred embodiments, the administration is effected continuously for at least 10 days and is repeated at intervals wherein at each interval the administration is continuously effected for at least 10 days. For example, the administration may be effected at intervals as short as 5-10 days, up to about 25-35 days and continuously for at least 10 days during each such interval. The optimal interval period will vary depending on the type of patient and tumor. For example, in the incidence of acute leukemia, the so called myelodysplastic syndrome, continuous infusion would seem to be indicated so long as the patient tolerated the drug without toxicity and there was a positive response.

[0037] The amount of the compound administered to the patient is less than an amount which would cause toxicity in the patient. In the certain embodiments, the amount of the compound which is administered to the patient is less than the amount which causes a concentration of the compound in the patient's plasma to equal or exceed the toxic level of the compound. Preferably, the concentration of the compound in the patient's plasma is maintained at about 1.0 mM. It has been found with HMBA that administration of the compound in an amount from about 5 gm/m^2/day to about 30 gm/m^2/day, particularly about 20 gm/m^2/day, is effective without producing toxicity in the patient. The optimal amount of the compound which should be administered to the patient in the practice of the present invention will depend on the particular compound used and the type of cancer being treated.

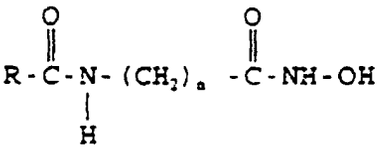
[0038] This invention, in addition to the above listed compounds, is intended to encompass the use of homologs and analogs of such compounds. In this context, homologs are molecules having substantial structural similarities to the above-described compounds and analogs are molecules having substantial biological similarities regardless of structural similarities.

[0039] The use may also comprise initially administering to the patient an amount of an antitumor agent to render the cells resistant to an antitumor agent and subsequently administering to the patient an effective amount of any of the compounds above, or pharmaceutically acceptable salts thereof, effective to selectively induce terminal differentiation of such neoplastic cells and thereby inhibit their proliferation.

[0040] The antitumor agent may be one of numerous chemotherapy agents such as an alkylating agent, an antimetabolite, a hormonal agent, an antibiotic, colchicine, a vinca alkaloid, L-asparaginase, procarbazine, hydroxyurea, mitotane, nitrosoureas or an imidazole carboxamide. Suitable agents are those agents which promote depolarization of tubulin. Preferably the antitumor agent is colchicine or a vinca alkaloid; especially preferred are vinblastine and vincristine. In embodiments where the antitumor agent is vincristine, an amount is administered to render the cells are resistant to vincristine at a concentration of about 5 mg/ml. The administration of the agent is performed essentially as described above for the administration of any of the compounds. Preferably, the administration of the agent is for a period of at least 3-5 days. The administration of any of the compounds above is performed as described previously.

[0041] The present invention also provides a pharmaceutical composition comprising a therapeutically acceptable amount of any of the compounds above, or pharmaceutically acceptable salts thereof, and a pharmaceutically acceptable carrier, such as sterile pyrogen-free water. Preferably, the therapeutically acceptable amount is an amount effective

to selectively induce terminal differentiation of suitable neoplastic cells and less than an amount which causes toxicity in a patient. Furthermore the present invention also provides a pharmaceutical composition comprising a pharmaceutically acceptable carrier and a therapeutically effective amount of a compound having the structure



wherein R is an unsubstituted phenyl and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

[0042] The present invention provides the pharmaceutical composition above in combination with an antitumor agent. The antitumor agent may be any of the agents previously described.

[0043] Lastly, the present invention provides the pharmaceutical composition above, alone or in combination with an antitumor agent, in sustained release form. By "sustained release form" applicants mean incorporation of the pharmaceutical compositions in a pharmaceutically acceptable formulation which provides for the sustained release of a therapeutically effective amount of the compounds of this invention over a period of time necessary to derive the intended therapeutic effect. Sustained release formulations of pharmaceutical compositions allow for less frequent administration of the compound and provide for administration of the pharmaceutical composition at or near the target area in a subject's system. Sustained release formulations and methods of incorporating pharmaceutical compositions therein are well known to those of ordinary skill in the art. ***[deletion(s)]*** Examples include, but are not limited to such formulations as incorporation into ion exchange resins (U.S. Patent No. 5,296,228 to Chang et al.), xanthan gums (U. S. Patent No. 5,292,534 to Valentine et al., microspheres (U.S. Patent No. 5,288,502 to McGinity et al.) hydrogels (U. S. Patent No. 5,266,325 to Kuzma et al.) and solid forms such as wax-like or fat-like hydrophobic substances containing water insoluble polymers (U.S. Patent No. 5,270,055 to Moest). Methods of administering compounds for sustained release are also known in the art and include, but are not limited to, surgical implantation of microencapsulated pharmaceutical compounds near the intended target site (U.S. Patent No. 5,290,271 to Jernberg) and incorporation of compound into transdermal patches (U.S. Patent No. 5,298,256 to Flockhart et al. and U.S. Patent No. 5,290,561 to Farhadieh et al.). The text of the above cited patents and the references disclosed therein are hereby encorporated by reference in their entirety into this disclosure.

[0044] The invention is illustrated in the Experimental Details section which follows. This section is set forth to aid in an understanding of the invention but is not intended to, and should not be construed to, limit in any way the invention as set forth in the claims which follow thereafter.

Experimental Details

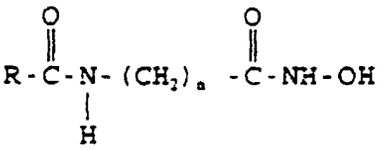
Cells and Materials

[0045] MELC 745A-DS19 cells and the variants of MELC derived from this cell line, namely, the vincristine-resistant MELC V3.17 and VCR.C(2)15 cell lines (26), and the dimethylsulfoxide-resistant cell line, DR10 (39), were maintained in alpha minimal essential medium containing 10% fetal calf serum (16). Cell cultures for all experiments were initiated with cells in logarithmic growth phase (day 2 cultured cells) at a density of 10^5 cells/ml. Inducer compounds were added in the final concentrations indicated below, dissolved in culture medium without fetal calf serum unless otherwise indicated. Cell density and benzidine reactively were determined as described (16).

[0046] Commitment to terminal differentiation, characterized by limited cell division (colony size <32 cells) and accumulation of hemoglobin (benzidine reactive colonies) was assayed by a colony cloning assay using 2% methylcellulose as described (25) (see Table 1 for results).

Compounds having the structure:

[0047]



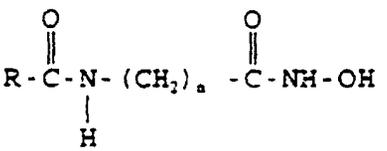
7-Benzoylamidoheptancylhydroxamic acid, R = phenyl, n=6.

[0048] In a 25 mL flask, a solution of 0.371 g of 7- aminoheptanoic acid with 0.3145 g NaOH in 12 mL water was chilled to 0°C, and than 0.5 mL of benzoyl chloride in 6 mL dry THF was added dropwise over 30 minutes. After 3.5 hrs stirring the THF was evaporated and the solution was acidified to pH 1. The resulting precipitate of 7- benzolylaminoheptanoic acid was collected and washed with ether. It was characterized by NMR and mass spectroscopy (M+1=250). Then 0.20 g of this amide acid was treated for 3 hours with 0.1750 g of carbonyl diimidazole in 10 mL dry THF. To this stirring solution was added 0.1114 g of hydroxylamine hydrochloride, and the solution was stirred overnight at room temperature. Then 3 ml of 0.1 N HCl was added, the THF was evaporated, and the residue was taken up in 5 mL ethyl acetate and 3 mL brine. The produce amide hydroxamic acid was present as an ivory colored solid in the organic layer; it was collected by filtration in 60% yield. It was characterized by NMR and mass spectrum (M+1=265) and had m.p. = 105°C.

[0049] In a similar fashion analogs were prepared with n=5 or 6, and with R=p-cyanophenyl, m-cyanophenyl, and thiophenyl, by the use of the appropriate carboxylic acid chloride and 7-aminoheptanoic acid or 6-aminohexanoic acid in the first step.

Compounds having the structure:

[0050]



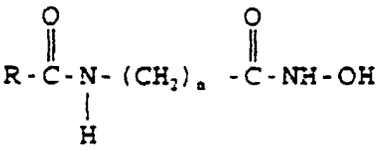
Suberoyl-(4-pyridyl)-amide hydroxamic acid, R = 4-pyridyl, n=6.

[0051] To an ice-cold solution of 6 mL suberoyl chloride in 20 mL THF was added 1.37 mL methanol and 4.7 mL triethylamine in 40 mL THF dropwise with stirring. After 19 hours a solution of 3.2032 g 4-aminopyridine and 4.7 mL triethylamine in 250 mL THF was added dropwise with stirring and ice cooling. After 24 hours a small amount of white solid was removed by filtration, the THF was evaporated, and the crude product was chromatographed to afford 2.8879 g of the methyl ester of this amide ester was added to a solution of 0.9866 g hydroxylamine hydrochloride in 17 mL methanol with 0.8887 g NaOH, and the filtered solution was allowed to stand at room temperature for two days. The precipitated salt to the hydroxamic acid was washed with a little ethanol and stirred in 0.1242 g acetic acid in 10 mL water. After 48 hours 0.2291 g of the hydroxamic acid had crystallized, and it was collected and recrystallized from methanol to afford the pure product, m.p. 202-203°C. It was characterized by NMR and mass spectrum (M+1=266).

[0052] In a similar fashion the 2-pyridyl and 3-pyridyl analogs were prepared, using the appropriate amines.

Compounds having the formula:

[0053]



m-Chlorophenylureido-6-hexanohydroxamic acid, R = m-chlorophenyl, n=5.

[0054] To 3.0 g of 6-aminocaproic acid in 150 mL THF was added 3.5 mL triethylamine, then 3 mL m-chlorophenyl isocyanate. After overnight standing the solution was filtered and concentrated by evaporation. Then partitioning between water and ether, followed by acidification of the aqueous layer to pH 3.0, afforded a precipitate of the ureidocarboxylic acid in 35% yield, characterized by NMR and mass spectrum (M-1=285). This was then converted to the hydroxamic acid product by treating 0.0418 g of the acid with 0.321 g carbonyl diimidazole in 25 mL THF. After 2 hours at room temperature, the solution was treated with 0.1948 g hydroxylamine hydrochloride and stirred for 20 hours. Then 16 mL 0.1 N HCl and 25 mL ethyl acetate were added and the THF was evaporated. The product appeared as crystals in the organic layer, and was collected in 38% yield. It had m.p. 162-163°C, and was characterized by NMR and elemental analysis: C, 51. 62; H, 5.82; N, 13.47. Calc'd C, 52.0; H, 6.05; N, 14.00.

[0055] In a similar fashion the unsubstituted phenyl analog was prepared from phenyl isocyanate.

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[0056]

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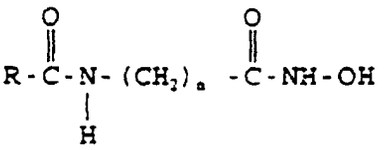
Claims

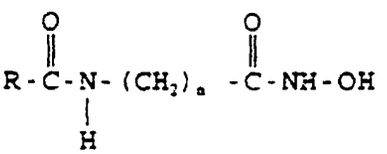
1. A compound having the structure:



wherein R is a piperidine or thiazole group or a phenyl group which is. substituted with a methyl, cyano, nitro, thio, trifluoromethyl, amino, aminocarbonyl, methylcyano, chloro, fluoro, bromo, iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,6-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyl, t-butyl, phenyl, carboxyl, hydroxyl, methyloxy, phenyloxy, phenylaminooxy, phenylaminocarbonyl, methyloxycarbonyl, methylaminocarbonyl, dimethylamino, dimethylamino-carbonyl, or hydroxylaminocarbonyl group and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

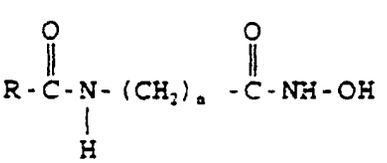
2. 7-Benzoylamidoheptanoyl hydroxamic acid or a pharmaceutically acceptable salt thereof.

3. A compound having the structure:



wherein R is a substituted or unsubstituted 2-pyridine, 3-pyridine, or 4-pyridine and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

4. A compound having the structure:

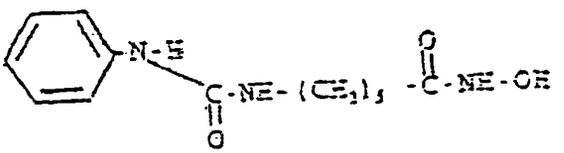


wherein R is a substituted or unsubstituted phenyl, pyridine, piperidine or thiazole group and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

5. The compound of claim 4, wherein R is a substituted phenyl group.

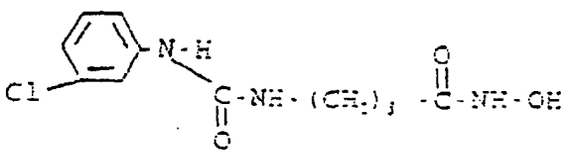
6. The compound of claim 5, wherein the phenyl group is substituted with a methyl, cyano, nitro, thio, trifluoromethyl, amino, aminocarbonyl, methylcyano, chloro, fluoro, bromo, iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,6-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyl, t-butyl, phenyl, carboxyl, hydroxyl, methyloxy, phenyloxy, benzyloxy, phenylaminooxy, phenylaminocarbonyl, methyloxycarbonyl, methylaminocarbonyl, dimethylamino. dimethylaminocarbonyl, or hydroxylaminocarbonyl group.

7. The compound of claim 4 having the structure:



or a pharmaceutically acceptable salt thereof.

8. The compound of claim 7 having the structure:



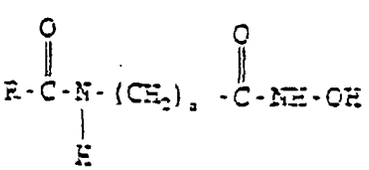
or a pharmaceutically acceptable salt thereof.

9. An in vitro method of selectively inducing terminal differentiation of neoplastic cells and thereby inhibiting proliferation of such cells which comprises contacting the cells under suitable conditions with an effective amount of the compounds of any one of claims 1 - 8 or a pharmaceutically acceptable salt thereof, effective to selectively induce terminal differentiation.

10. The use of the compounds of any one of claims 1 - 8 or a pharmaceutically acceptable salt thereof for the preparation of a pharmaceutical composition effective for the treatment of patients having a tumor **characterized by** proliferation of neoplastic cells.

11. A pharmaceutical composition comprising a pharmaceutically acceptable carrier and a therapeutically effective amount of the compounds of any one of claims 1 - 8 or a pharmaceutically acceptable salt thereof.

12. A pharmaceutical composition comprising a pharmaceutically acceptable carrier and a therapeutically effective amount of a compound having the structure



wherein R is an unsubstituted phenyl and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof.

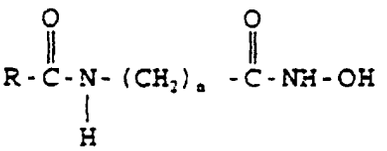
13. The pharmaceutical composition of claim 11 or 12, wherein the effective amount is an amount effective to selectively induce terminal differentiation of suitable neoplastic cells and less than an amount which causes toxicity in a patient.

14. The pharmaceutical composition of claim 11 or 12 in combination with an antitumor agent.

15. The pharmaceutical composition of claim 12 in sustained release form.

16. The pharmaceutical composition of claim 14 in sustained release form.

17. Use of compound having the structure:

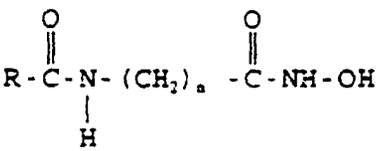


wherein R is a substituted or unsubstituted phenyl, piperidine or thiazole group and n is an integer from 4 to 8 or a pharmaceutically acceptable salt thereof for the preparation of a pharmaceutical composition effective for the treatment of patients having a tumor **characterized by** proliferation of neoplastic cells.

18. The use of Claim 17, wherein the neoplastic cells are selectively induced to undergo terminal differentiation.

Patentansprüche

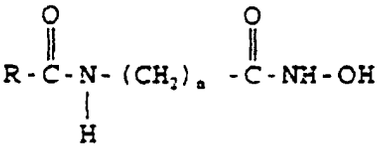
1. Verbindung mit der Struktur:



wobei R eine Piperidin- oder Thiazolgruppe oder eine Phenylgruppe ist, die mit einer Methyl-, Cyano-, Nitro-, Thio-, Trifluormethyl-, Amino-, Aminocarbonyl-, Methylcyano-, Chlor-, Fluor-, Brom-, Iod-, 2,3-Difluor-, 2,4-Difluor-, 2,5-Difluor-, 3,4-Difluor-, 3,5-Difluor-, 2,6-Difluor-, 1,2,3-Trifluor-, 2,3,6-Trifluor-, 2,4,6-Trifluor-, 3,4,5-Trifluor-, 2,3,5,6-Tetrafluor-, 2,3,4,5,6-Pentafluor-, Azid-, Hexyl-, t-Butyl-, Phenyl-, Carboxyl-, Hydroxyl-, Methyloxy-, Phenyloxy-, Phenylaminooxy-, Phenylaminocarbonyl-, Methyloxycarbonyl-, Methylaminocarbonyl-, Dimethylamino-, Dimethylaminocarbonyl- oder Hydroxylaminocarbonylgruppe substituiert ist, und n eine ganze Zahl von 4 bis 8 ist, oder ein pharmazeutisch verträgliches Salz davon.

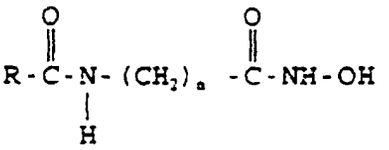
2. 7-Benzoylamidoheptanoyl-hydroxamsäure oder ein pharmazeutisch verträgliches Salz davon.

3. Verbindung mit der Struktur:



wobei R ein substituiertes oder unsubstituiertes 2-Pyridin, 3-Pyridin oder 4-Pyridin und n eine ganze Zahl von 4 bis 8 ist, oder ein pharmazeutisch verträgliches Salz davon.

4. Verbindung mit der Struktur:

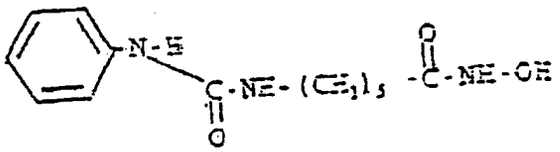


wobei R eine substituierte oder unsubstituierte Phenyl-, Pyridin-, Piperidin- oder Thiazolgruppe und n eine ganze Zahl von 4 bis 8 ist, oder ein pharmazeutisch verträgliches Salz davon.

5. Verbindung nach Anspruch 4, wobei R eine substituierte Phenylgruppe ist.

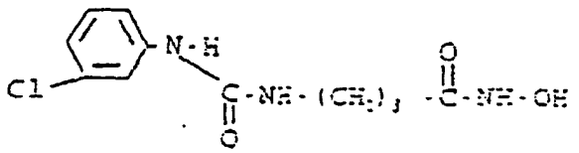
6. Verbindung nach Anspruch 5, wobei die Phenylgruppe mit einer Methyl-, Cyano-, Nitro-, Thio-, Trifluormethyl-, Amino-, Aminocarbonyl-, Methylcyano-, Chlor-, Fluor-, Brom-, Iod-, 2,3-Difluor-, 2,4-Difluor-, 2,5-Difluor-, 3,4-Difluor-, 3,5-Difluor-, 2,6-Difluor-, 1,2,3-Trifluor-, 2,3,6-Trifluor-, 2,4,6-Trifluor-, 3,4,5-Trifluor-, 2,3,5,6-Tetrafluor-, 2,3,4,5,6-Pentafluor-, Azid-, Hexyl-, t-Butyl-, Phenyl-, Carboxyl-, Hydroxyl-, Methyloxy-, Phenyloxy-, Benzyloxy-, Phenylaminooxy-, Phenylaminocarbonyl-, Methyloxycarbonyl-, Methylaminocarbonyl-, Dimethylamino-, Dimethylaminocarbonyl- oder Hydroxylaminocarbonylgruppe substituiert ist.

7. Verbindung nach Anspruch 4 mit der Struktur:



oder ein pharmazeutisch verträgliches Salz davon.

8. Verbindung nach Anspruch 7 mit der Struktur:



oder ein pharmazeutisch verträgliches Salz davon.

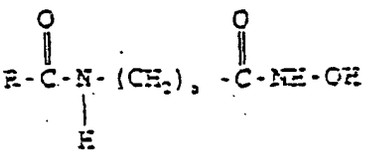
9. In-vitro-Verfahren zur selektiven Induktion der terminalen Differenzierung von neoplastischen Zellen und damit zur

Hemmung der Proliferation derartiger Zellen, umfassend das Inkontaktbringen der Zellen unter geeigneten Bedingungen mit einer wirksamen Menge der Verbindungen nach einem der Ansprüche 1 bis 8 oder eines pharmazeutisch verträglichen Salzes davon, wirksam zur selektiven Induktion der terminalen Differenzierung.

10. Verwendung der Verbindungen nach einem der Ansprüche 1 bis 8 oder eines pharmazeutisch verträglichen Salzes davon für die Herstellung eines Arzneimittels, das zur Behandlung von Patienten mit einem Tumor wirksam ist, wobei der Tumor durch die Proliferation neoplastischer Zellen gekennzeichnet ist.

11. Arzneimittel, umfassend einen pharmazeutisch verträglichen Träger und eine therapeutisch wirksame Menge der Verbindungen nach einem der Ansprüche 1 bis 8 oder eines pharmazeutisch verträglichen Salzes davon.

12. Arzneimittel, umfassend einen pharmazeutisch verträglichen Träger und eine therapeutisch wirksame Menge einer Verbindung mit der Struktur:



wobei R eine unsubstituierte Phenylgruppe und n eine ganze Zahl von 4 bis 8 ist, oder ein pharmazeutisch verträgliches Salz davon.

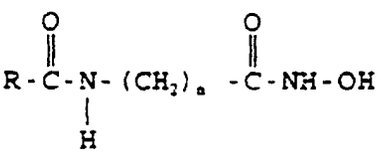
13. Arzneimittel nach Anspruch 11 oder 12, wobei die wirksame Menge eine Menge ist, die zur selektiven Induktion der terminalen Differenzierung von geeigneten neoplastischen Zellen wirksam ist und geringer ist als eine Menge, die Toxizität in einem Patienten verursacht.

14. Arzneimittel nach Anspruch 11 oder 12 in Kombination mit einem Antitumormittel.

15. Arzneimittel nach Anspruch 12 in langzeitwirkender Form.

16. Arzneimittel nach Anspruch 14 in langzeitwirkender Form.

17. Verwendung der Verbindung mit der Struktur:

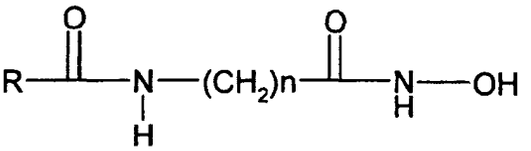


wobei R eine substituierte oder unsubstituierte Phenyl-, Piperidin- oder Thiazolgruppe und n eine ganze Zahl von 4 bis 8 ist, oder eines pharmazeutisch verträglichen Salzes davon für die Herstellung eines Arzneimittels, das zur Behandlung von Patienten mit einem Tumor wirksam ist, wobei der Tumor durch die Proliferation neoplastischer Zellen gekennzeichnet ist.

18. Verwendung nach Anspruch 17, wobei die neoplastischen Zellen für eine terminale Differenzierung selektiv induziert sind.

Revendications

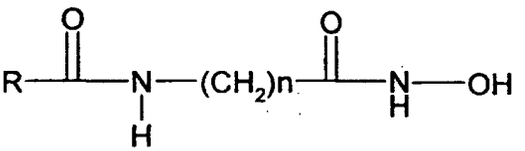
1. Composé présentant la structure :



dans laquelle R est un groupe piperidine ou thiazole ou un groupe phényl qui est substitué par un groupe méthyle, cyano, nitro, thio, trifluorométhyle, amino, aminocarbonyl, méthylcyano, chloro, fluoro, bromo, iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,6-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyle, t-butyle, phényl, carboxyle, hydroxyle, méthoxy, phényloxy, phénylaminooxy, phénylaminocarbonyl, méthoxycarbonyl, méthylaminocarbonyl, diméthylamino, diméthylamino-carbonyle ou hydroxylaminocarbonyle, et n est un entier de 4 à 8 ou un de ses sels pharmaceutiquement acceptables.

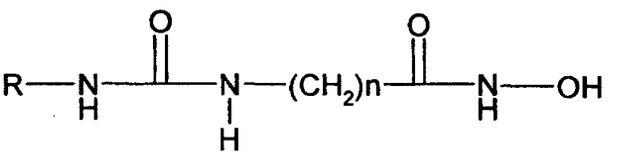
2. L'acide 7-benzoylamidoheptanoyl hydroxamique ou un de ses sels pharmaceutiquement acceptables.

3. Composé de structure :



dans laquelle R est un groupe, substitué ou non substitué, 2-pyridine, 3-pyridine ou 4-pyridine, et n est un entier de 4 à 8 ou un de ses sels pharmaceutiquement acceptables.

4. Composé de structure :

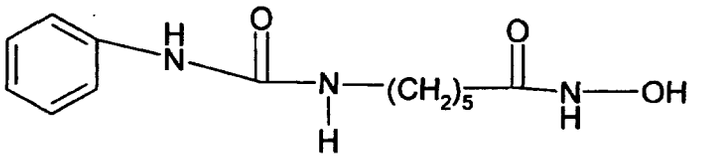


dans laquelle R est un groupe, substitué ou non substitué, phényl, pyridine, piperidine ou thiazole, et n est un entier de 4 à 8 ou un de ses sels pharmaceutiquement acceptables.

5. Composé selon la revendication 4, dans lequel R est un groupe phényl substitué.

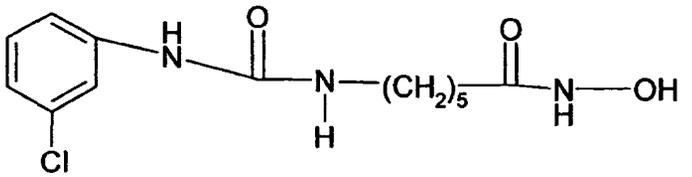
6. Composé selon la revendication 5, dans lequel le groupe phényl est substitué par un groupe méthyle, cyano, nitro, thio, trifluorométhyle, amino, aminocarbonyl, méthylcyano, chloro, fluoro, bromo, iodo, 2,3-difluoro, 2,4-difluoro, 2,5-difluoro, 3,4-difluoro, 3,5-difluoro, 2,6-difluoro, 1,2,3-trifluoro, 2,3,6-trifluoro, 2,4,6-trifluoro, 3,4,5-trifluoro, 2,3,5,6-tetrafluoro, 2,3,4,5,6-pentafluoro, azido, hexyle, t-butyle, phényl, carboxyle, hydroxyle, méthoxy, phényloxy, benzyloxy, phénylaminooxy, phénylaminocarbonyl, méthoxycarbonyl, méthylaminocarbonyl, diméthylamino, diméthylamino-carbonyle ou hydroxylaminocarbonyle.

7. Composé selon la revendication 4 de structure :



ou un de ses sels pharmaceutiquement acceptables.

8. Composé selon la revendication 7 de structure :



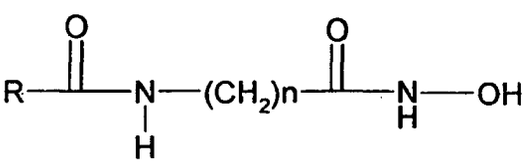
ou un de ses sels pharmaceutiquement acceptables.

9. Méthode in vitro pour induire sélectivement une différenciation terminale des cellules néoplasiques et inhiber ainsi la prolifération de telles cellules, qui comprend la mise en contact des cellules dans des conditions appropriées avec une quantité efficace des composés de l'une quelconque des revendications 1-8 ou un de leurs sels pharmaceutiquement acceptables, efficace pour induire sélectivement une différenciation terminale.

10. Utilisation de composés de l'une quelconque des revendications 1-8 ou un de leurs sels pharmaceutiquement acceptables pour la préparation d'une composition pharmaceutique destinée au traitement de patients présentant une tumeur **caractérisée par** une prolifération des cellules néoplasiques.

11. Composition pharmaceutique comprenant un support pharmaceutiquement acceptable et une quantité thérapeutiquement efficace de composés de l'une quelconque des revendications 1-8 ou un de leurs sels pharmaceutiquement acceptables.

12. Composition pharmaceutique comprenant un support pharmaceutiquement acceptable et une quantité thérapeutiquement efficace d'un composé ayant la structure :



dans laquelle R est un phényl non substitué et n est un entier de 4 à 8 ou un de ses sels pharmaceutiquement acceptables.

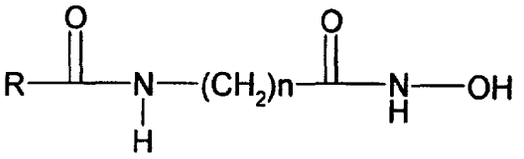
13. Composition pharmaceutique selon la revendication 11 ou 12, dans laquelle la quantité efficace est une quantité efficace pour induire sélectivement une différenciation terminale des cellules néoplasiques appropriées et est une quantité moins élevée que celle qui cause une toxicité au patient.

14. Composition pharmaceutique selon la revendication 11 ou 12 en combinaison avec un agent anti-tumoral.

15. Composition pharmaceutique selon la revendication 12 sous une forme à libération prolongée.

16. Composition pharmaceutique selon la revendication 14 sous une forme à libération prolongée.

17. Utilisation d'un composé ayant la structure :



dans laquelle R est un groupe, substitué ou non substitué, phényl, piperidine ou thiazole et n est un entier de 4 à 8 ou un de ses sels pharmaceutiquement acceptables pour la préparation d'une composition pharmaceutique efficace pour le traitement de patients ayant une tumeur **caractérisée par** une prolifération des cellules néoplasiques.

18. Utilisation selon la revendication 17, dans laquelle les cellules néoplasique sont induites sélectivement de manière à passer en différenciation terminale.