

## Notice

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## DESCRIPTION RU2052223C1

A METHOD FOR OBTAINING STABLE ISOTOPES BY NUCLEAR TRANSMUTATION OF THE LOW-TEMPERATURE NUCLEAR SYNTHESIS TYPE OF ELEMENTS IN MICROBIOLOGICAL CULTURES

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### [0001]

The invention relates to methods for producing stable isotopes and can be used in nuclear spectroscopy and applied nuclear physics technology. A method is known for obtaining specific stable isotopes by isolating them from the original natural multicomponent mixture of isotopes using diffusion, mass spectrometric or laser methods (Andreev B.M. et al. Separation of stable isotopes by physicochemical methods. M. 1982; Basov N.G. etc. New methods of isotope separation. Advances in Physical Sciences, 1977, v.121, p.427).

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## [0002]

The disadvantage of this method is the impossibility of obtaining the necessary stable isotopes if they are absent from the original multicomponent medium.

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In addition, the method is very expensive and labor-intensive.

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## [0003]

A method is known for obtaining isotopes in the process of low-temperature nuclear synthesis, which occurs when palladium or titanium crystals are saturated with deuterium during the electrolysis of heavy water (Review: Tsarev V.A. Low-temperature nuclear synthesis.

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Advances in Physical Sciences, 1992, v.160, pp.19-20).

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## [0004]

The method is based on the phenomenon of low-temperature nuclear fusion, which consists

in the fact that when optimal conditions are created (temperature and structure of the palladium or titanium matrix, the degree of saturation of the matrix with deuterium, etc.), the D+D fusion reaction takes place without imparting to the interacting deuterons the high kinetic energy required in hot (thermonuclear) fusion reactions to overcome the Coulomb barrier.

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## [0005]

A method is known for obtaining stable isotopes through nuclear synthesis of elements in microbiological cultures, including the preparation of a nutrient medium for the growth of microbiological cultures, deficient in the isotope obtained as a result of transmutation, and containing the initial isotopic components necessary for transmutation; growing microbiological cultures in a nutrient medium that require these isotopes for their growth; isolating the grown culture from the nutrient medium and isolating stable isotopes [2]. The known method describes a procedure for growing microbiological cultures of *Aspergillus niger* IFO 4066, *Penicillium chrysogenum* IFO 4689; *Phizopus nigricans* IFO 5781; *Mucor rouxii* IFO 0369; *Saccharomuces cerevisiae* IFO 0308; *Torulopsis utilis* IFO 0396; *Saccharomyces ellipideus* IFO 0213; *Hansenula anomala* IFO 0118 in nutrient media, which are an aqueous solution of a number of chemical compounds and deficient in one of the components necessary for crop growth (potassium, magnesium, iron, calcium) and, for control, in standard media for them.

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In experiments on the implementation of the method, it was shown that when these cultures were grown in environments deficient in the corresponding element (in these environments, these specific elements were not present at all), these elements were present in the resulting culture, which can only be associated with their synthesis during nuclear transmutation from other elements and isotopes present.

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For example, magnesium was formed according to the reaction scheme  $\text{Na}^{23+p1} \rightarrow \text{Mg}^{24}$ . The disadvantage of the known method is the low probability of the required nuclear transmutation reaction due to non-optimized conditions for temperature and ion-molecular composition of the nutrient medium, which is manifested in a small number of atoms or ions.

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## [0006]

Experience in conducting research on low-temperature nuclear fusion shows that such reactions proceed successfully only with a special selection of the properties of the environment and temperature.

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In addition, the number of possible types of stable isotopes obtained in the known method and corresponding to one of the main elements that make up the grown microbiological culture is insufficient. There are many types of isotopes whose production is of great interest, but which are not components of microbiological cultures.

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## [0007]

The aim of the invention is to increase the rate of production of stable isotopes and to increase the number of types of stable isotopes obtained.

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**[0008]**

This is achieved by the fact that in the known method of obtaining stable isotopes through nuclear transmutation of the type of low-temperature nuclear synthesis of elements in microbiological cultures, which includes the preparation of a nutrient medium for the growth of microbiological cultures, deficient in the isotope obtained as a result of transmutation, and containing the initial isotopic components necessary for transmutation; growing microbiological cultures in the nutrient medium, which require these isotopes for their growth and development; isolation of the grown culture from the nutrient medium and the isolation of stable isotopes, the nutrient medium is affected by factors that increase the concentration of free atoms or ions of hydrogen in it due to the destruction of interatomic bonds.

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**[0009]**

In addition, the nutrient medium can be formed on the basis of heavy water D<sub>2</sub>O.

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**[0010]**

In addition, the composition of the nutrient medium includes the initial isotopic components necessary for transmutation, for which the result of the synthesis reaction are unstable isotopes that are deficient for the nutrient medium, which are necessary for the growth and formation of microbiological cultures and are maternal in relation to the final daughter stable isotopes.

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**[0011]**

As a factor that destroys interatomic bonds, the addition of a LiOH or LiOD solution to the nutrient medium, as well as ionizing radiation, is used.

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**[0012]**

The essence of the technical result achieved by the invention is as follows.

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**[0013]**

All processes of nuclear transmutation based on low-temperature nuclear fusion (LTNF) in biological cultures occur at a very low (on the scale of conventional thermonuclear fusion, which requires a temperature of the order of many millions of degrees) energy of relative motion of interacting particles, which is certainly insufficient to directly overcome the Coulomb barrier of the reaction.

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There are several different physical models describing the mechanism of cold fusion. A

necessary condition for the cold fusion reaction to occur is the formation of local structural inhomogeneities in the medium, within which reactions occur to form new isotopes.

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In the works (Vysotsky V.I. Kuzmin O.N. Theory, mechanism and dynamics of barrier-free catalysis in solids.

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Preprint of the Institute of Theoretical Physics of the Academy of Sciences of the Ukrainian SSR ITF-90-82R, Kyiv, 1991; Vysotsky V.I. Kuzmin R.N. Mechanisms of barrier-free interaction in CN based on the phenomena of nonequilibrium Fermi condensate for a small ensemble and pulsed two-deuteron localization in microcavities of optimal shape and size.

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In the book: International Symposium Cold Nuclear Fusion and New Energy Sources.

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Minsk, 1994, pp. 288-295) it was shown that the NTS phenomenon can most effectively occur in microcavities and microcracks with a characteristic size of  $2R_1 \approx 10-15 \text{ \AA}$  or within volumetric inhomogeneities with a potential profile close to parabolic with a ratio of their radii  $R_0$  and  $U_0$  in the form  $U_0/R_0^2 \approx 0.05-0.1 \text{ eV/\AA}$ . The NTS process can occur during the interaction of not only light isotopes (e.g.,  $D+D$ ,  $p+p$ ), but also with the participation of a heavy isotope and an atom (or ion) of hydrogen or deuterium  $D$ .

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**[0014]**

The probability of synthesis processes is greatly influenced by the temperature of the environment and atoms, since it determines both the probability of populating the optimal

energy levels for NTS in the microcavity and the time that particles remain in the microcavity: at high temperatures, an incoming particle leaves the microcavity very quickly, while at low temperatures, the probability of particles entering a microcavity where another particle already exists is low.

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If there are several particles in a microcavity, then the temperature greatly influences their relative motion.

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**[0015]**

All the prerequisites for the occurrence of NTS also occur during the growth of microbiological cultures.

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In the growth area, due to the process of reproduction, formation and orientation of biomacromolecules, a rapid structural transformation of the developing culture occurs.

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Structural microheterogeneities with sizes changing over time continuously arise.

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When these dimensions, over a certain period of time, turn out to be close to the characteristic optimal values  $R_1$  or  $R_0$ , the prerequisites for the synthesis and transmutation of elements are created within the microheterogeneities.

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## [0016]

This process of continuous structuring with the inevitable passage of characteristic sizes of microheterogeneities  $R$  through optimal values of  $R_1$  or  $R_0$  at different points in time inevitably covers all areas of the growing microbiological culture without exception.

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This circumstance fundamentally distinguishes a developing microculture from the nearly static crystals of palladium or titanium (used for traditional NTS experiments), where the size, shape, and number of microheterogeneities are virtually fixed and there is no mechanism for self-adjustment to optimal NTS conditions. If the nutrient medium contains the initial isotopic components necessary for transmutation, then when they enter a volume of microheterogeneities with optimal parameters, a synthesis reaction occurs, producing an isotope that was initially absent from the nutrient medium (it was deficient in this isotope), but is essential for further culture growth. This isotope is immediately absorbed by the microbiological culture and integrated into its structure. This process is continuously repeated throughout the growth area. After growth is complete, the resulting isotope can be isolated from the final culture.

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## [0017]

For this process to be most efficient, it is necessary that at least one of the original isotopic components be in the form of free atoms or ions, and not bound in a molecule.

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Such a dissociation process can be random (fluctuating), but in this case it will be

characterized by a very low probability  $f \exp(-E_d/kT)$ , where  $E_d$  is the dissociation energy,  $T$  is the temperature.

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## [0018]

In the proposed invention, to ensure such a requirement, the nutrient medium is exposed to factors that promote the rupture of interatomic bonds and, as a consequence, an increase in the concentration of free hydrogen atoms or ions.

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In the case of NTS in conventional crystals, this role is performed by adding 0.1 mol/l KiOD to heavy water in which electrolysis is carried out with palladium or titanium electrodes. In the proposed invention of microbiological transmutation, a similar addition of a LiOH or LiOD solution to an aqueous solution of the nutrient medium is also possible. It is also possible to use other factors, such as weak ionizing radiation, which promotes the formation of free radicals H and H<sup>+</sup> according to the schemes:  $H_2O + \hbar\omega \rightarrow H_2O^{++}$ . In addition, the capabilities of the proposed method are significantly expanded, i.e. it becomes possible to obtain new types of isotopes or use other starting components if heavy water D<sub>2</sub>O is used as the basis for the nutrient medium instead of ordinary (light) water H<sub>2</sub>O in the prototype. This makes it possible to carry out nuclear transmutation reactions based on NTS with the participation of deuterium D.

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## [0019]

In addition to the direct transmutation of the initial isotopic components present in the nutrient medium into a stable isotope absent from this medium (deficient), which is

necessary for the development of the microbiological culture and is therefore immediately assimilated by it, the proposed method includes the operation of obtaining from the initial isotopic components the initially deficient unstable isotopes, which are assimilated to the required stable isotope.

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In this case, it becomes possible to obtain stable isotopes that are not necessary for the growth of microbiological cultures and are not part of their composition.

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## **[0020]**

The invention is illustrated by the following specific examples of its implementation.

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## **[0021]**

Example 1.

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Prepare a nutrient medium containing sucrose (10%), ammonium tartrate (1%),  $\text{MgSO}_4 \times 7 \text{H}_2\text{O}$  (0.25%),  $\text{Ca HPO}_4 \times 2 \text{H}_2\text{O}$  (0.008%),  $\text{K}_3\text{PO}_4$  (0.5%),  $\text{MnSO}_4 \times 7 \text{H}_2\text{O}$  (0.001%), water  $\text{H}_2\text{O}$  (up to 100%).

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0.1 mol/l LiOH is added to the nutrient medium solution to increase the concentration of

free hydrogen atoms. After adding the *Saccharomyces cerevisiae* strain T-8 yeast seed culture to the medium, it is grown on a shaker at a temperature of 30°C for 24-72 hours. The growing cells are collected by centrifugation. The sediment is dried, the microbial mass is disintegrated and the stable isotope is determined using known physicochemical methods.

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## [0022]

Example 2.

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Prepare a nutrient medium containing sucrose (10%), ammonium tartrate (1%),  $\text{MgSO}_4 \times 7 \text{H}_2\text{O}$  (0.25%),  $\text{Ca HPO}_4 \times 2 \text{H}_2\text{O}$  (0.008%),  $\text{K}_3\text{PO}_4$  (0.5%),  $\text{MnSO}_4 \times 7 \text{H}_2\text{O}$  (0.001%), water  $\text{H}_2\text{O}$  (up to 100%).

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## [0023]

The nutrient medium solution is irradiated with ionizing radiation at a dose of less than 10 kGy, which simultaneously makes it possible to achieve sterility of the medium.

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After adding the seed culture of *Saccharomyces* yeast (*Saccharomyces cerevisiae* strain T-8) to the medium, cultivation is carried out on a shaker at a temperature of 30°C for 24-72 hours. The grown cells are collected by centrifugation. The sediment is dried, the microbial mass is disintegrated and the stable isotope is determined using known physicochemical methods.

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**[0024]**

Example 3.

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Prepare a nutrient medium deficient in potassium, consisting of sucrose 3; NaNO<sub>3</sub> 0.03; MgSO<sub>4</sub> x 7 H<sub>2</sub>O 0.05; FeSO<sub>4</sub> x 7 H<sub>2</sub>O 0.001; CaHPO<sub>4</sub> 0.008; Na<sub>2</sub>HPO<sub>4</sub> 0.1; NaCl 0.05; water H<sub>2</sub>O up to 100. This medium is saturated with the main stable isotope of argon Ar<sup>40</sup>. 0.1 mol /l LiOH is added to the nutrient medium to increase the concentration of free hydrogen atoms. A culture of mold, the prototype Mucor rontic, is grown in this environment.

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**[0025]**

During the synthesis reaction Ar<sup>40</sup>+p1\_ k41, a rare stable isotope K is formed in the volume of the developing microbiological culture, which is absorbed by the mold and, after its growth, is isolated by known chemical methods.

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**[0026]**

The grown cells are collected by centrifugation, the sediment is dried, and the obtained isotope is isolated from the sediment using known chemical methods.

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## [0027]

Example 4.

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Prepare a nutrient medium deficient in potassium, containing the following: sucrose 3; NaNO<sub>3</sub> 0.03; MgSO<sub>4</sub> x 7 H<sub>2</sub>O 0.05; FeSO<sub>4</sub>x x 7 H<sub>2</sub>O 0.001; CaHPO<sub>4</sub> 0.008; Na<sub>2</sub>HPO<sub>4</sub> 0.1; NaCl 0.05; water H<sub>2</sub>O up to 100.

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This medium is saturated with the main stable isotope of argon Ar<sup>40</sup>.

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The nutrient medium is irradiated with ionizing radiation at a dose of less than 10 kGy, which allows for the simultaneous achievement of sterility of the medium. A culture of mold, the prototype *Mucor rontic*, is grown in this environment.

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## [0028]

During the synthesis reaction Ar<sup>40</sup>+p<sub>1</sub>\_ k<sup>41</sup>, a rare stable isotope K is formed in the volume

of the developing microbiological culture, which is absorbed by the mold and, after its growth, is isolated by known chemical methods.

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**[0029]**

The growing cells are collected by centrifugation, the sediment is dried, and the obtained isotope is isolated from the sediment using known methods.

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**[0030]**

Example 5.

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A culture of *Saccharomyces* yeast is selected from among those that require manganese or nickel for growth.

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A nutrient medium is prepared for these crops, containing all the chemical elements necessary for their growth, as well as stable isotopes of Cr or Co, but not containing manganese or nickel.

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In the process of growing these crops with the simultaneous influence of one of the factors increasing the concentration of free atoms (as in example 1), the reactions  $Cr^{52+p1}$   $Mn^{53}$  or

Co58+p1\_ Ni60 will occur, the products of which Mn53 or Ni60 will be absorbed by the growing culture. After completion of the growing cycle of these cultures, the synthesized stable isotopes Mn53 or Ni60 are isolated by chemical methods, the grown cells are collected, the sediment is dried, and the obtained isotope is isolated from the sediment.

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## [0031]

Example 6.

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They form a nutrient medium that is deficient in iron (for example, containing sucrose 3% NaNO<sub>3</sub> 0.3; K<sub>2</sub>HPO<sub>4</sub> 0.1; KCl 0.05; MgSO<sub>4</sub> x 7 H<sub>2</sub>O 0.05; CaHPO<sub>4</sub> 0.008; MnSO<sub>4</sub> x 7 H<sub>2</sub>O 0.001; heavy water D<sub>2</sub>O up to 100). 0.1 mol/l LiOH is added to the nutrient medium solution to increase the concentration of free hydrogen atoms. A yeast culture, prototype *Saccharomyces cerevisiae* strain T-8, is grown in this medium at T=30°C, the grown cells are collected by centrifugation, the sediment is dried, and the obtained isotope Fe57, formed during the HTS reaction Mn55+d2\_ Fe57, is isolated using known methods. Example 7. They form a nutrient medium that is deficient in iron (for example, in the composition: sucrose 3; NaNO<sub>3</sub> 0.3; K<sub>2</sub>HPO<sub>4</sub> 0.1; KCl 0.05; MgSO<sub>4</sub> x 7 H<sub>2</sub>O 0.05; CaHPO<sub>4</sub> 0.008; MnSO<sub>4</sub> x 7 H<sub>2</sub>O 0.001; heavy water D<sub>2</sub>O up to 100). The nutrient medium is irradiated with ionizing radiation at a dose of less than 10 kGy, which allows for the simultaneous achievement of sterility of the medium.

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## [0032]

A culture of the prototype yeast *Saccharomyces cerevisiae* strain T-8 is grown in this medium

at  $T=30^{\circ}\text{C}$ , the grown cells are collected by centrifugation, the precipitate is dried and the obtained isotope  $\text{Fe}57$  is isolated using known methods, formed during the reaction of HTS  $\text{Mn}55+d2\_ \text{Fe}57$ . Example 8.

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A method for obtaining stable isotopes through the decay of an unstable parent isotope synthesized in the process of NTS in a medium deficient in this parent isotope, which is incorporated into the microbiological culture during its growth.

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### [0033]

A nutrient medium is constructed that is deficient in nitrogen and contains 3% sucrose,  $\text{K}_2\text{HPO}_4$  0.1;  $\text{KCl}$  0.05;  $\text{MgSO}_4 \times 7 \text{H}_2\text{O}$  0.05;  $\text{FeSO}_4 \times 7 \text{H}_2\text{O}$  0.001;  $\text{CaPHO}_4$  0.008;  $\text{MnSO}_4 \times 7 \text{H}_2\text{O}$  0.001; light water  $\text{H}_2\text{O}$  up to 100.

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0.1 mol/l  $\text{LiOH}$  is added to the nutrient medium solution to increase the concentration of free hydrogen atoms. *Saccharomyces cerevisiae*, strain T-8, is grown in this medium at  $T=30^{\circ}\text{C}$ . During the NTS reaction (with the participation of the main stable isotope of carbon  $\text{C}12$ , which is part of sucrose)  $\text{C}12+p1\_ \text{N}13$ , an unstable isotope  $\text{N}13$  is formed, which has a half-life of 10 min. This isotope is immediately absorbed by growing mold from the nitrogen-deficient nutrient medium after its appearance and is fixed in the mold. After a time of instability  $\tau$ , the  $\text{N}13$  isotope spontaneously decays according to the scheme:  $\text{N}13+ \beta+_ \text{C}13$  and is transformed into the final rare stable isotope  $\text{C}13$ , which, after the entire mold has grown, is isolated in a known manner.

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### [0034]

### Example 9.

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A method for obtaining stable isotopes through the decay of an unstable parent isotope synthesized in the process of NTS in a medium deficient in this parent isotope, which is incorporated into the microbiological culture during its growth.

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### [0035]

A nutrient medium is constructed that is deficient in nitrogen and contains the following ingredients: sucrose 3; K<sub>2</sub>HPO<sub>4</sub> 0.1; KCl 0.05; MgSO<sub>4</sub> x 7 H<sub>2</sub>O 0.05; FeSO<sub>4</sub> x 7 H<sub>2</sub>O 0.001; CaHPO<sub>4</sub> 0.008; MnSO<sub>4</sub>x x 7 H<sub>2</sub>O 0.001, light water H<sub>2</sub>O up to 100.

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The nutrient medium is irradiated with ionizing radiation at a dose of less than 10 kGy, which allows for the simultaneous achievement of sterility of the medium. *Saccharomyces cerevisiae*, strain T-8, is grown in this medium at T=30°C. During the NTS reaction (with the participation of the main stable isotope of carbon C<sub>12</sub>, which is part of sucrose) C<sub>12</sub>+p<sub>1</sub>\_N<sub>13</sub>, an unstable isotope N<sub>13</sub> is formed, which has a half-life of 10 min. This isotope is immediately absorbed by growing mold from the nitrogen-deficient nutrient medium after its appearance and is fixed in the mold. After a time  $\tau$ , the unstable isotope N<sub>13</sub> spontaneously decays according to the scheme N<sub>13</sub>\_β<sup>+</sup>+C<sub>13</sub> and is transformed into the final rare stable isotope C<sub>13</sub>, which, after the entire mold has grown, is isolated in a known manner.

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## [0036]

Example 10.

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According to a scheme similar to examples 8 and 9, it is possible to obtain the isotope  $O^{17}$  in the process of growing microbiological cultures that require fluorine for growth in a nutrient medium that is deficient in fluorine, but contains the stable isotope  $O^{16}$ . The types of reactions leading to the assimilation of intermediate unstable isotopes obtained during NTS are the following:  $O^{16} + p \rightarrow F^{17} \rightarrow \beta^{++} O^{17} \tau \approx 65 \text{ s}$  After completion of the culture growth cycle and the decay of the parent nuclei, the obtained stable isotopes are isolated using known physicochemical methods.

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## [0037]

Example 11.

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According to the scheme similar to examples 8 and 9, it is possible to obtain the isotope  $Si^{29}$  in the process of growing microbiological cultures that require phosphorus for growth in a nutrient medium that is deficient in phosphorus, but contains the stable isotope  $Si^{28}$ . The types of reactions leading to the assimilation of intermediate unstable isotopes obtained during NTS are the following:  $Si^{28} + p \rightarrow P^{29} \rightarrow \beta^{++} Si^{29} \tau \approx 4 \text{ s}$  After completion of the culture growth cycle and the decay of the parent nuclei, the obtained stable isotopes are isolated using known physicochemical methods.

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[0038]

Example 12.

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According to the scheme similar to examples 8 and 9, it is possible to obtain the Fe57 isotope in the process of growing microbiological cultures that require cobalt for growth in a nutrient medium that is deficient in cobalt, but contains the stable Fe56 isotope. The types of reactions leading to the assimilation of intermediate unstable isotopes obtained during the NTS are the following:  $Fe^{56} + p \rightarrow Co^{57} + \beta^{++} + Fe^{57}$   $\tau = 271$  days After completion of the culture growth cycle and the decay of the parent nuclei, the obtained stable isotopes are isolated using known physicochemical methods.

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