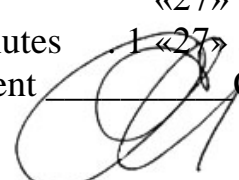


Ministry of Public Health of Ukraine
“Ukrainian Medical Stomatological Academy”

“APPROVED”
at the meeting of the Department
of Medical Informatics, Medical Biophysics
«27» august 2020
Minutes 1 «27» august 2020
Head of department  O.V.Silkova

METHODICAL GUIDANCE

IRUVSHQYHOI directed work when preparing and during the practical session

Academic Subject	Medical Information Science
Module No 2	Medical knowledge and decision making in medicine and dentistry
Topic	%DVHV RI PHGLFDO SUREOHPV¶DOJRULWKPLJDWLRO their properties. Types of algorithms.
Year of study	2
6SHFLDOLW\	Foreign Student Training (0HGFLQH6WRPDWRORJ\
Number of academic hours	2

1. Relevance of the topic:

The topic is very important for future doctors in their professional activity, positively influences the students in their attitude to the future profession, and forms professional skills and experience as well as taking as a principle the knowledge of the subject learned.

2. The specific aims:

To have general knowledge of the topic studied;

To understand, to remember and to use the knowledge received;

To form the professional experience by reviewing, training and authorizing it;

To be able to carry out laboratory and experimental work.

3. Basic knowledge and skills necessary to study the topic (inter-disciplinary integration).

Previous (providing disciplines)	Obtainable skills
Informatics bases	To describe principles of algorithm construction ; To draw schematically flowchart basic elements; To use these concepts at tasks decision: flowchart analysis

4. The tasks for students' individual work

4.1. The list of basic term, parameters, characteristics, which student should master while preparin for the class.

Term	Definition
Algorithm	A set of rules which determine effective solution procedure of any problem, which is one of certain class of problems.
Formal algorithms	Algorithms using methods that make a decisions by logic rules from certain hypotheses about research object.
Heuristic algorithms	They bases on intuition reasons, that bases on the previous experience.

4.2 Theoretical questions for the class (to the topic):

1. The algorithm definition.
2. Algorithms types.
3. Algorithmic languages classification.
4. Types of algorithms.
5. Construction of algorithm stages.
6. Stages of medical tasks solution.
7. Main properties of algorithms.
8. Order of construction of algorithms
9. Linear, Branched , Cyclic algorithms.
10. Algorithm structural schemes.
11. Stages of construction of algorithm with structural scheme use.

4.3 Practical tasks pertaining to the topic and to be completed during the class:

Test

1. WHAT IS THE ALGORITHM?
 - a) a set of rules
 - b) a list of instructions leading to a result
 - c) a list of actions
 - d) table of formulas
 - e) a set of narrative sentences
2. WHAT IS CALLED A FRAGMENT OF AN ALGORITHM CONSISTING OF COMMANDS THAT CAN BE EXECUTED MORE THAN ONCE?
 - a) linear
 - b) a condition

- c) branching
- d) a cycle
- e) an array

3. WHAT IS THE NAME OF ALGORITHMS, IN WHICH IT IS NECESSARY TO DECIDE WHAT EXACTLY ACTIONS TO PERFORM?

- a) linear
- b) cycles
- c) forms
- d) branching
- e) arrays

4. WHAT IS THE NAME OF THE ALGORITHM RECORD IN THE LANGUAGE OF A PARTICULAR ARTIST?

- a) an algorithm
- b) the program
- c) the team
- d) scheme
- e) performer

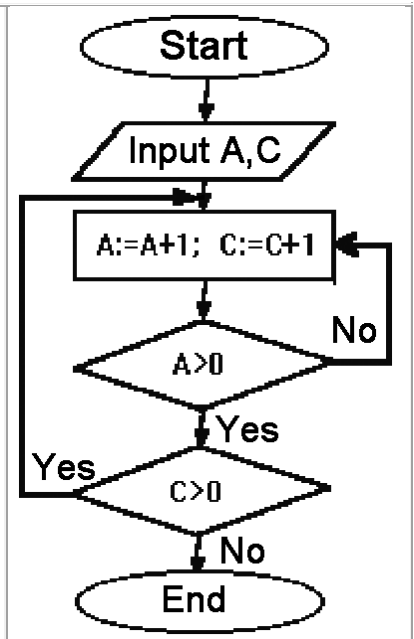
5. WHAT FIGURE IN THE BLOCK DIAGRAM WE USING FOR THE INPUT DATA?

- a) a circle
- b) a rectangle
- c) parallelogram
- d) an oval
- e) diamond

Practical work:

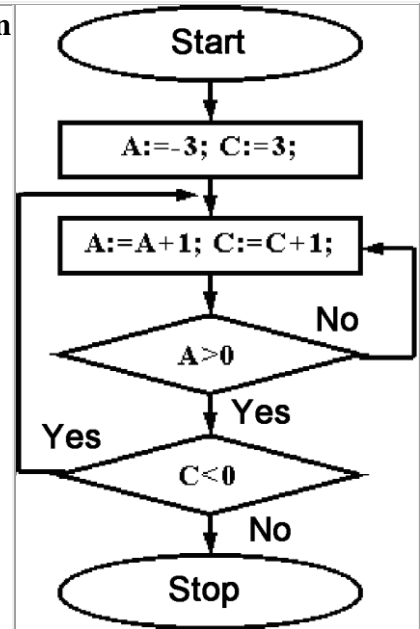
1. At what initial values of variables the algorithm will finish work?

- 1) A=-2; C=-3
- 2) A=-3; C=-2
- 3) A=-3, C=-3
- 4) A=-2; C=-1
- 5) A=-4, C=-3



2. Determine target values of variables A and C after execution of algorithm:

- 1) 1, 7
- 2) 0, -4
- 3) 1, 3
- 4) 0, -5
- 5) Cycling



Content of the topic:

Algorithm (by al-Horezmi, IX century) is set of rules, by which actions for achievement of aim do.

Algorithm is a set of rules which determine effective solution procedure of any problem, which is one of certain class of problems.

There may be rules of calculation for the mathematics task, or rules that determine order of examining of sick human. Algorithm uses for solution perfect class of problems, in which input data can vary but rules of solution are constant.

Algorithm may be described in symbolic shape or in words.

Description of algorithm for the machine's perception is named program. Programming languages (or algorithmic languages) was developed for such descriptions.

Such languages base on the few numbers of elementary rules which permit to do processing information with definite order. They take into account real possibility of computer. Still recently there were particularity of input and output of data, types of memory devices and all. Now such problems were solved by unification of requirements to the control systems of peripheral devices and types of memory.

There are several groups of algorithmic languages.

Machine languages, which depend on command systems of certain computer, are used on the stage of developing of computer and its software.

Assembler languages (in difference degrees) are oriented onto direct control by technical parts of computer. They use all possibilities of computer effectively, allow writing compact and fast programs. Examples are C++ and C#. But programming with assembler is very complicated and long-timed.

Problem-oriented languages named **high-level languages** are more useful for users. They are intended for solution of problems (tasks) of certain class. Old such languages are FORTRAN, ALGOL, COBOL, PL/1, BASIC and many others. Some of them don't use now. Some (or them new generations) use in certain branches, for example, control of complex calculations of weather prognosis in powerful computer, in military devices, in banking affairs and in many other situations. It may be companies or institutions, in which workers have very lot of experience and software or want to be independence from giant software product companies.

Relatively young languages are included in big software products. In Microsoft company software it is BASIC in difference variations. In Fox company software present own language; similar languages present in Delphy, Oracle, and others.

New group of languages is used in network technologies including Internet. Very popular example is Java.

But many old languages are developed and included instruments for the work with networks. First of all there are languages from SCBD (system of databases control).

Algorithms can be divided into two types:

heuristic and formal.

Formal algorithms use methods that make a decisions by logic rules from certain hypotheses about research object. Exact instructions are present in such rules about how to obtain output data from input data.

Heuristic methods bases on intuition reasons, that bases on the previous experience. Their result may be not optimal, not exact, but it may give fast and successful solution of problem, if experience of solution of similar task is present.

Heuristic methods are used more often during solution of recognition problems: in reading programs, in programs of image recognition, in self-learning recognition systems.

Construction and using of algorithms of physiologic and biochemical processes in healthy and ill organism, control algorithms for the system of public health safety - are main problems of

medical cybernetics.

Construction of algorithm of some process (for example, diagnosis) is consecutive realization of next steps.

1. Preliminary analysis of process determines probability of computer using for the realization of algorithms.
2. Structuring describe researched process.
3. Making or choosing of mathematical equations that describe relations of process parameters.
4. Determination of process characteristic.
5. Making process model and checking conformity of mathematical description to real process.
6. Construction of algorithm of process.

Various methods of evaluation (statistical, for example) apply on 4-th stage for determination of process characteristics. Different mathematical methods are applied in accordance with particularity of certain problem.

Forming algorithms of medical problems

Stages of tasks solution:

- 1) Choosing of solution method; its details, learning;
- 2) formulation of problem and solution method for a programming specialist;
- 3) solution of problem by programming engineering group (with exact rules).

First stage usually is relatively easy: solution method is known from the practice or from the literature. If solution method is unknown, at first it is necessary try to seek in scientific research.

If several methods can be used, researcher chooses more effective, easier, faster, more powerful, more safe (reliable) method.

Second stage is harder and more complex. If method exists, its execution do not guarantee accuracy of results (and of human, and of computer, as a program is formed by human). As result, following rules of method description can be proposed:

- 1) to form a set of start values, which are need for start of the solution process;
- 2) to divide the solution process onto the clear stages;
- 3) to describe an order of the stages;
- 4) to describe a sign of finish (a sign of result obtaining);
to describe a result of the problem solution.

Description of method by this rules is named problem solution algorithm.

Main properties of algorithms:

discontinuity: algorithm is sequence of stages which follows one after another; in other words it is sequence of the steps (acts, commands);

certainty: every command of an algorithm has only one sense, one method of execution and is understandable to executor; every command signifies one action with exactly described details;

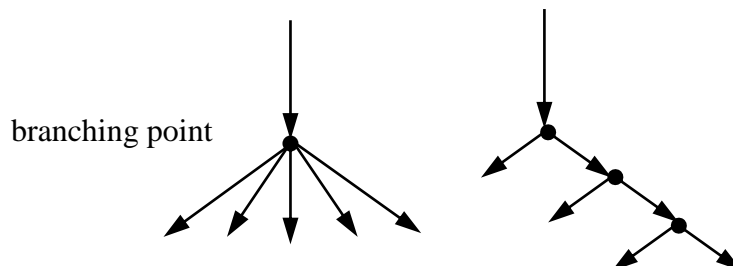
effectiveness and **finite-state**: algorithm must reach result after finite (limited) quantity of the steps;

mass: every algorithm which formed for one problem of certain class need to be useful for solution of all problems of this class with all possible values of initial data.

Person or computer can works according to an algorithm. If worker is computer then algorithm must be translated to the algorithm language.

3 kinds of algorithm description:

- 1) on natural language;
- 2) by scheme (graph method);



- 3) on an algorithm language.

MAKING UP OF STRUCTURE SCHEMES OF MEDICAL PROBLEMS ALGORITHMS

Order of construction of algorithms

During construction of algorithms there is need to carry out several types of work: to divide every process on several stages which are connected one with another.

Then to carry out next steps:

- 1) analysis of every stage;
- 2) choosing of method of problem partial solution;
- 3) forming algorithms of every stage;
- 4) learning by executors of practical using of algorithms (if solution don't need using of computing methods) or informing executor (human-programmer, for example) about method of problem solution (with following forming of program for practice using).

On 2-nd step complicated task is choosing most effective method (by principles of minimization of time, expenditure of labour, minimization of mistake probability and similar).

For exact execute of 4 step it is need to use next rules on 3-th step:

- 1) to determine initial values for task and necessary result;
- 2) to divide process of solution onto simple stages;
- 3) to note order of execution of simple stages;
- 1) to note sign of task solution end.

You can use 3 main types of algorithms:

- 1) linear [successive; serial; consecutive];
- 2) alternative (branching).
- 3) cyclic;

Linear algorithm - it is algorithm with blocks that follow one after one (linearity). Term "block" mean series or combination of instructions. Such algorithm is executed step by step.

Branched algorithm has points of condition checking, after that actions have different ways (branches) in accordance to result of checking. **Alternative algorithm** is special case of branched algorithm with two branches. And, on the contrary, branched algorithm can be divided on the series of alternative sections with checking of own condition in every check point.

Cyclic algorithm – it is algorithm with repeating parts, when sequence of mathematical and logic repeat certain (finished) quantity of times.

Cyclic algorithm is such, in which identical actions (sequence of mathematical and logic actions, other instructions) repeat many times. Quantity of repetitions is certain, finished and can change in dependence on initial values of task. Every new repetition of the cycle must begin (or run out) on check point, in which some condition is checked. For cycle organization it is necessary:

- 1) before entrance into the algorithm body it is need to set initial value of **cycle parameter**;
- 2) Before every new repetition to change value of cycle parameter;
- 3) Then to check condition of cycle ending and in dependence on result to return control into cycle beginning or to exit from cycle..

Cycle parameter is some value, which change (grows or diminishes) at every cycle repetition on certain **step**.

Medicine problems have principle of the construction of algorithm just like written above.

Every process (diagnostic, treatment, and research) is divided onto inner stages, which connect one with another.

Then analysis is carried out. There are distinguished algorithms. i.e. rules of realizing of each stage. After then algorithms are used in the practice or utilized automation of the process, carried out construction of programs and it using in the computers.


An example of the algorithmic actions is actions of a doctor in reanimation department of clinic during examining of each patient:

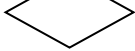
- 1) a doctor collects all need data about state of patient;
- 2) a doctor analyzes data and compares they with normal data;
- 3) if any parameter or complex of parameters isn't in accord with limited values, doctor seek complex of action for the achievement of the correct state of patient in the available conditions; if all complex of parameters corresponds to limited values, a doctor assigns a patient to other clinic department in accordance to diagnosis.

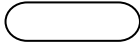
Stages of construction of algorithm with structural scheme use

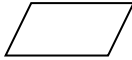
First step of writing of program is generalized description of algorithm. It is block-scheme or structural scheme of problem. Structural scheme (block diagram, flow diagram, skeleton diagram, flowgraph, operations flowchart, flowchart, flowgraph) use conventional signs on this step. Such sign is the shape specific for certain kind of actions.

Most important signs are:

Process.  It corresponds to series of successively executing actions or calculations.

Solution.  It denotes checking of condition. Further actions depend on result of solution.

Completion.  It is start and finish of algorithm.

Input-output (without details). 

Knot. ● It is place of merging of two (or more) branches of algorithm.

Elements of block-scheme are bound by arrows shows direction of transition.

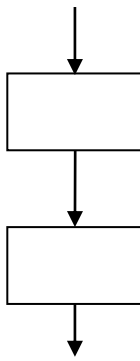
Basic structures of algorithm in scheme:

1. successive carrying out;
2. conditional carrying out (alternating);
3. branching, which is succession of conditional carrying out.
4. cycle (repetition, loop, iteration);

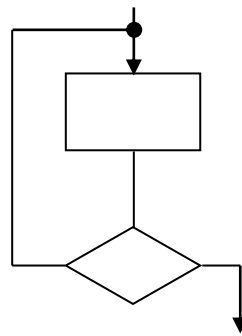
There are images of their structures.

1. Successive

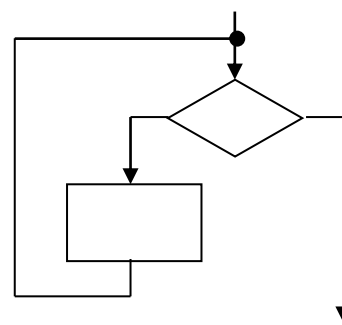
carrying out



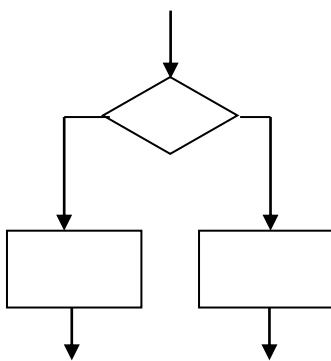
2a. Cycle “after”



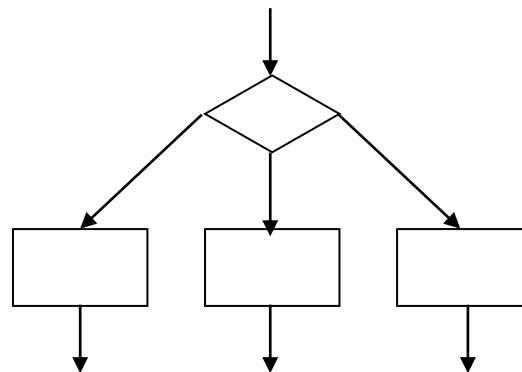
2b. Cycle “before”



3. Alternating



4. Branching



Part of algorithm, whose execution depends on condition, has name **“loop body”**. Iteration is one repetition of this part of algorithm.

Cycle “after” is cycle with condition check after one execution of loop body. This cycle has feature: loop body will be in progress as minimum once.


Cycle “before” is cycle with condition check before execution of loop body. In this case it is possible situation without execution of loop body operators.

When general structure is clear, **step** of construction of algorithm is analysis of inner structure of algorithm and its detailing.


Finals description (program) consist of elementary language operators (separate phrases), which are named as code statements or program statements too.

Every algorithm works with information in computer memory, not with real objects. Correspondingly, minimal memory volume with separate certain element of information is marked by special address (for inner computer using) or by name (for human using). This name is **variable**. Word **“variable”** is used as value (contents) of memory can change during algorithm work. Very often we tell about this memory unit as about a memory cell (really it can be block of many separate cells, which are used as a single whole). When we change value of variable, check or send information – we carry out some elementary action – we mark this action by **operator sign**.

Variables in algorithmic languages are marked by names, consisted of letters and figures, at some languages – and selected signs can be used too. Program-translator forms queries to operating system that put into conformity with every name one free memory cell address.

Text like **“ $A = 3$ ”** or **“ $A := 3$ ”** in shape  means that number 3 is sended to the memory cell with name A. Sign **:=** is named appropriation.

Sentention like **“ $A := A + 5$ ”** or **“ $A = A + 5$ ”** means: take value written in the memory cell A, ass 5 to this value, than send result into the cell A. After this command execution old value A will be replaced by new.

Text like **“ $A = 3$ ”** in shape  is check condition and read as **“Is A equal 3?”** Two

possible answers “Yes” and “No” mark two output arrows – two algorithm branches.

In other commands new value will be used up to next command of information sending to cell A.

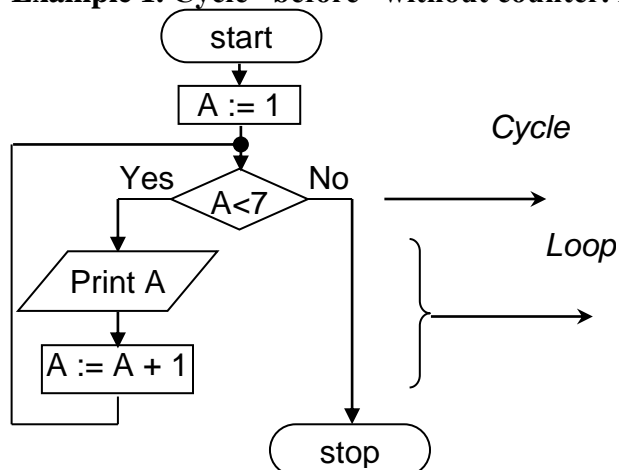
When algorithm includes cycle, for counting of cycle body repetitions very often we must use cycle counter (index counter, loop counter, repetition counter, step counter). It is special temporary integer variable, typically marked as *i*, *j*, or *k*. Loop body is sequence of actions (calculations, information input or output and other) executed between two condition check events.

It is necessary for cycle creation:

- 1) before cycle to set counter start value;
- 2) during every cycle passing to change counter value (typically add or subtract 1 – step value);
- 3) in every cycle repetition to check condition of cycle end; by result of check-up either pass on to cycle beginning, or go out cycle to next stage.

For operators conventional signs are used too.

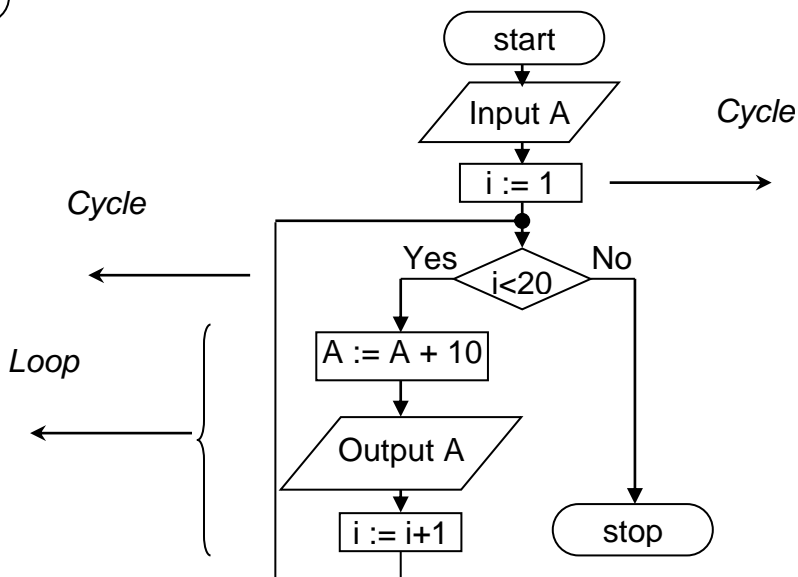
Example 1. Cycle “before” without counter. Printing of numbers from 1 to 7.



How it work? At first, value 1 is sended into variable A cell. Then at beginning of loop condition is checked: if value A is not more then 7, it is printed, than A grows on 1.

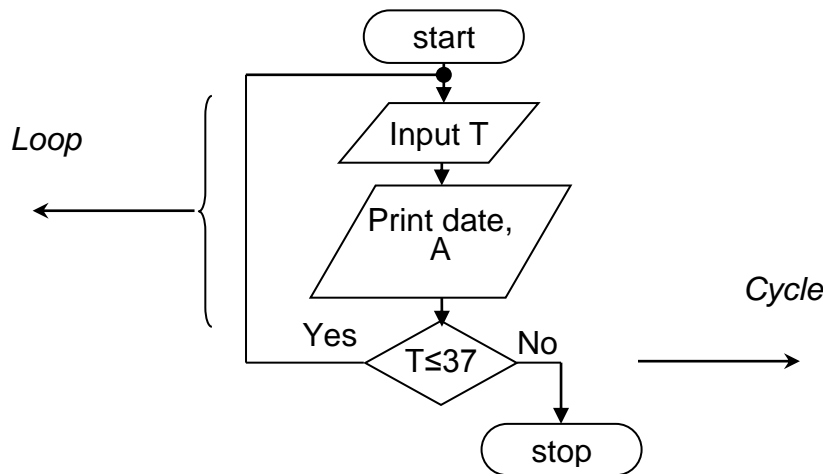
Process repeats as many times, as condition will be satisfied: in this flowchart it is 7 times.

Example 2. Cycle “before” with counter. Printing of twenty numbers from initial A to A + 200 with step 10.



In these both examples condition is checked before cycle body execution. It is named cycle “before”.

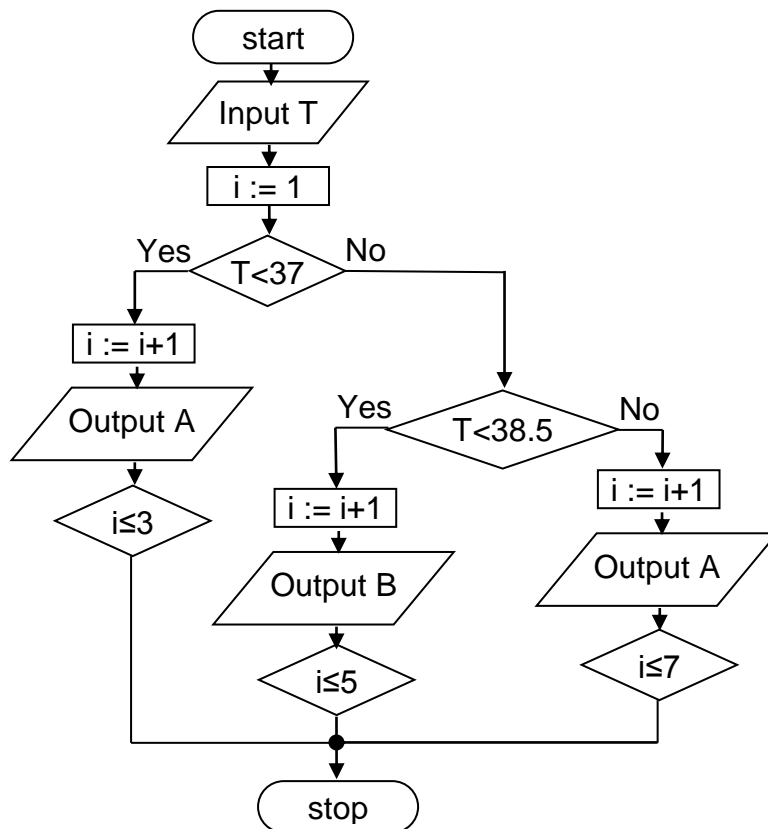
Example 3. Cycle “after” without counter. Everyday control of the patient temperature up to it normalization.



Cycles can have “home loop”. Home loops (nested loops, nesting loops) are cycles that are allocated in the outer cycle. Home loop can have inner nested loops too. Quantity of loop inclusions is not limited usually.

Example 4. Branching.

Use of one of three medical preparations in dependence on patient body temperature. If patient temperature is normal, give him preparation A during 3 days; If patient temperature is in limits 37° – $38,5^{\circ}$, give him preparation B during 5 days; If patient temperature is more than $38,5^{\circ}$, give him preparation C during 7 days.



Tasks for self-check:

Task 1:

1. THE GEOMETRIC FIGURE OF A RECTANGLE IS USED IN BLOCK DIAGRAMS TO DENOTE:

- a) start of the algorithm

- b) the end of the algorithm
- c) input or output data
- d) decision-making
- e) performance of action

2. WHAT FIGURE IN THE BLOCK DIAGRAM REPRESENT THE BEGINNING OR END OF THE ALGORITHM?

- a) trapezium
- b) a rectangle
- c) parallelogram
- d) an oval
- e) diamond

2. THE ALGORITHM CAN BE CONSIDERED AS:

- a) Description of the solution of the quadratic equation
- b) List of class in the journal
- c) School timetable
- d) Vehicle technical passport
- e) None of the listed options

3. WHAT IS THE ALGORITHM?

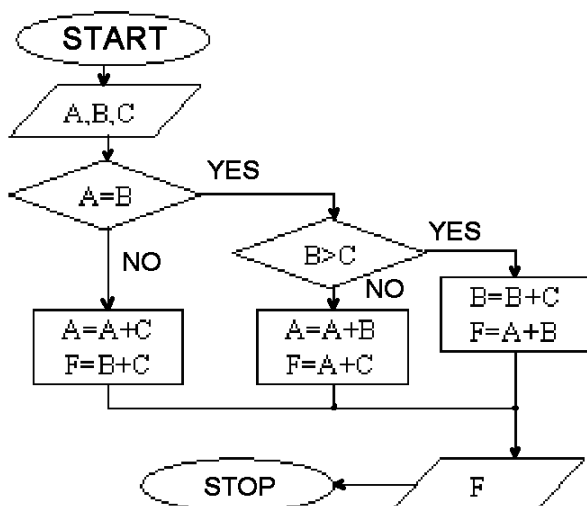
- a) The rules for carrying out certain actions
- b) Oriented graph specifying the order of the execution of commands
- c) The sequence of actions leading to the solved task
- d) A set of commands for a computer
- e) All of the above

4. THE GEOMETRIC FIGURE OF PARALLELOGRAMS IS USED IN BLOCK DIAGRAMS TO DENOTE ...

- a) start of the algorithm
- b) the end of the algorithm
- c) input or output data
- d) decision-making
- e) performance of action

Task 2.

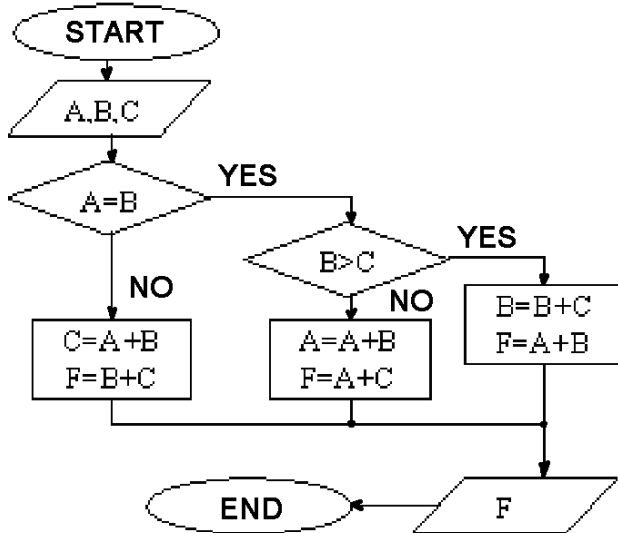
Value of variable F calculated by the block diagram for the entry (entered data) **1, 1, 3** equal to: 1) 7 2) 3 3) 4 4) 5 5) 6



Task 3.

Value of variable F calculated by the block diagram for the entry (entered data) **2,2,3** equal to:

1) 5 2) 6 3) 7 4) 9 5) 8



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Additional.

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3. www.ncbi.nlm.nih.gov (Національна бібліотека медицини США)
4. www.cochrane.ru (Розділ Кохранівського співтовариства)

The methodical guidance has been completed by **S.Y. Olenets**