CDAlert

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IODINE DEFICIENCY DISORDERS : A PUBLIC HEALTH PROBLEM

INTRODUCTION

Iodine, an essential micronutrient with daily requirement of 100-150 µg, plays an important role in normal human growth and development. It has been widely recognized that deficiency of iodine not only contributes to goitre but also is an important risk factor for preventable mental retardation; it affects reproductive functions and impairs child's learning ability. The disorder affects people of all ages, both sexes and different socio-economic status**. The disorders produced as a result of nutritional iodine deficiency are classified as "Iodine Deficiency Disorders (IDD) or IDD syndroms"**. The net consequence of iodine deficiency is diminished performance of the community, which ultimately affects the production of the nation. Therefore, virtual elimination of IDD has been set as the most important achievable international health goal. It is estimated that around 1.6 billion people are at the risk of IDD worldwide. Out of these 600 million people live in SEAR alone (Fig. 1). At least 17.2 million in this region are affected by goitre and 3.6 million by cretinism.

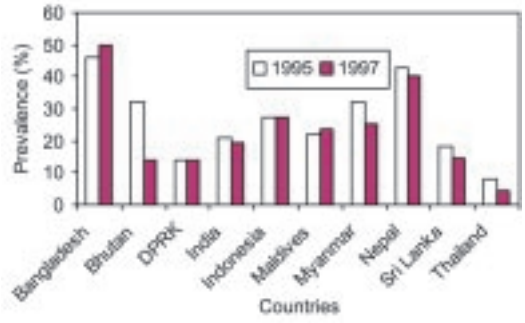


Fig.1 Prevalence (%) of IDD in SEAR countries on the basis on TGR

Data source - WHO Publication, 2000.

What is iodine?

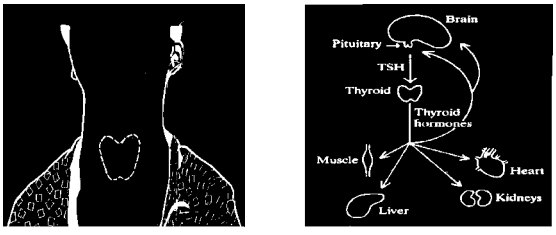
Iodine is an element. It occurs in variety of chemical forms, the most important being iodide (I^-), iodate (IO_3^-), and elemental iodine.

Where is iodine found?

Iodine is naturally present in the soil, water and air. Only a small amount of iodine around 1ppm is present in sea water. During the primordial development of the earth large amounts of Iodine were leached out from surface soil by glaciation, snow, or rain and were carried by the wind, rivers and floods into the sea. The healthy adult human body contains 15-20 mg of iodine of which about 70-80% is in thyroid gland.

What does iodine do?

Iodine is an essential part of the chemical structure of thyroid hormone. The thyroid is a butterfly-shaped gland in the front part of the neck (Fig. 2A). It makes two hormones namely thyroxine (T4) and tri-iodothyronine (T3). The thyroid hormones are released into the blood stream and blood carries them to target organs, particularly the liver, kidneys, heart and the developing brain (Fig. 2B).



A B

Fig.2 A-Position of Thyroid Gland
B- Relation of Thyroid Gland with different organs

Spectrum of IDD

Goitre is only the tip of iceberg (Fig. 3). The IDD pyramid illustrates the fact that the *visible* effects of IDD i.e. goitre, squint and cretinism etc. account as much as 10% of the ramifications. At least 90% of IDD consequences remain hidden. Iodine deficiency leads to physical and mental retardation, abortion, still births, deaf-mutism, dwarfism, squint, cretinism, goitre of all ages and neuromotor defects etc. The various disorders associated with iodine deficiency are shown in Table-1 and Fig. 4.

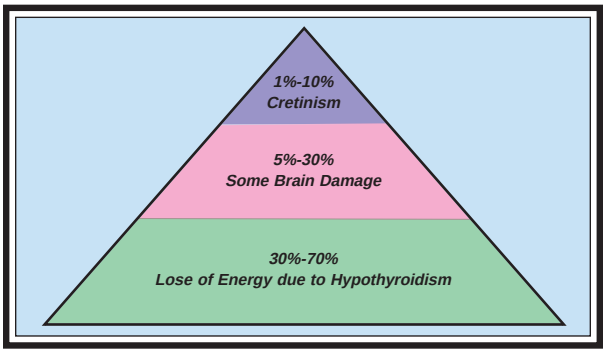


Fig.3 IDD Pyramid

Table 1: Spectrum of Iodine Deficiency Disorders

Foetus	Abortions Stillbirths Congenital Anomalies Increased Perinatal Mortality Increased Infant Mortality Neurological Cretinism: - *mental deficiency* *deaf-mutism* *spastic diplegia squint* Myxoedematous Cretinism: - *dwarfism* *mental deficiency* Psychomotor defects
Neonate	Neonatal goitre Neonatal chemical hypothyroidism
Child and Adolescent	Goitre Juvenile hypothyroidism Impaired mental function Retarded physical development
Adult	Goitre with its complications Hypothyroidism Impaired mental function

A **B** **C**

Fig.4 A (Cretin), B (Physical Retardation), C (Mental Retardation)

Magnitude of IDD in Indian scenario

In India, about 200 million people are estimated to be at risk of IDD, as they live in the areas where Iodine Deficiency is prevalent. As many as 70 million people are suffering from goitre and other iodine deficiency disorders. Sample surveys conducted by IDD & Nutrition Cell of DGHS, ICMR, State Health Directorate and other medical institutions in 321 districts of the total 582 districts of 35 States and Union Territories have found 260 districts to be endemic for IDD (IDD prevalance > 10%). In fact, at present no State/UTs is free from iodine deficiency disorders.

National IDD Control Programme

Realizing the magnitude of the problem, Govt. of India launched hundred percent centrally assisted **National Goitre Control Programme (NGCP)** in 1962. The NGCP was renamed as **National Iodine Deficiency Disorders Control Programme (NIDDCP)** in August, 1992 with a view to cover a wide spectrum of Iodine Deficiency Disorders.

Objectives of NIDDCP

- Survey to assess the magnitude of the IDD
- Supply of iodated salt in place of common salt
- Resurvey after every 5 years to assess the magnitude of the IDD and the impact of iodated salt on it
- Laboratory monitoring of iodated salt and urinary iodine excretion
- Health education and publicity

It has been well established that consumption of iodated salt is the best and simplest way to prevent and control IDD. Based on the recommendations of the Central Council of Health in 1984, the Government took a policy decision to iodate the entire edible salt in the country by 1992. The programme commenced in April 1986 in a phased manner. Since then sincere efforts were made to enhance the production, demand and supply of iodated salt. All States/UTs have been advised to ban sale of non-iodated salt under the Prevention of Food Adulteration Act 1954. At the same time, suitable measures have been adopted for educating the masses regarding the importance of iodated salt in the prevention and control of IDD. The Ministry of Health & Family Welfare is the nodal Ministry for policy decisions on National Iodine Deficiency Disorders Control Programme (NIDDCP).

Nutrition and IDD Cell

The Central **Nutrition and IDD Cell** at the Directorate General of Health Services (DGHS) is responsible for the implementation of NIDDCP in the country. Its main activities are:

- Technical guidance to the States/UTs.
- Inter-sectoral co-ordination at Central level and maintenance of close liaison with the Ministry of Industry/Transport etc.
- Coordination of the various facets of NIDDCP in States/UTs.
- Undertaking independent sample surveys in various States/UTs.
- Imparting training to the State Health Personnel, involved in NIDDCP.
- Collection, compilation and analysis of relevant data from States/UTs with a view to render more effective and meaningful advice.
- Monitoring of the quality control of iodated salt at production level through the Salt Commissioner and at the distribution and consumer level through the State Health Directorate.
- Monitoring the procurement and distribution of iodated salt in States/UTs.
- Managing the IEC activities in apex level.
- Managing the financial and other physical aspects of State level IDD Cells.

The **Salt Commissioner's Office** under the Ministry of Industry is responsible for licensing, production and distribution of iodated salt to States/UTs. This Office is also responsible for monitoring the quality of iodated salt at production level and the distribution of the same in the country. The Salt Commissioner, in consultation with the Ministry of Railways, arranges for movement of iodated salt from the production centers to the States/UTs on a priority basis.

IDD Cell of State/UTs

Each State/UT Government has an IDD Control Cell which carries out periodic surveys regarding the prevalence of goiter and reports to DGHS, Ministry of Health & Family Welfare. These State Cells coordinate with the Central IDD and Nutrition Cell at the Directorate General of Health Services. The State Health Departments are responsible for:

- Checking iodine levels of iodated salt with wholesalers and retailers within the State and coordinating with the Food and Civil Supplies Department.
- The distribution of iodated salt within the state through open market and public distribution system.
- Creating demand for iodated salt.
- Monitoring consumption of iodated salt.
- Conducting goiter surveys to identify the magnitude of IDD in various districts.
- Conducting training.
- Dissemination of information, education and communication.

Programme Activities

- Salt Commissioner has issued license to 840 private units to produce iodated salt. About 532 units have already commenced the production so far. We have an annual production capacity of more than 120 lakhs Metric Ton (MT) against our present requirement of 50 lakh MT for the entire country.
- The annual production of iodated salt was raised from 5 lakh MT in 1985-86 to 46.10 lakh MT in 2004-05. This is expected to further rise to 50 lakh MT in the near future.
- The Salt Commissioner, in consultation with the Ministry of Railways, arranges for the transportation of iodated salt from the production centers to the consuming states under priority category B, a priority second to that of Defence.

- To ensure the use of only iodated salt, recently in May 2005 the Central Govt. has announced complete ban on the sale of non-iodated salt and has issued notification for public comments.
- Standard for iodated salt have been laid down under the Prevention of Food Adulteration Act, 1954. These stipulate that the iodine content of salt at the production and consumption level should be at least 30 and 15 ppm respectively.
- Realizing the importance of iodine deficiency in relation with human resource development, NIDDCP has been included in Prime Minister's 20 Point Programme.
- For effective monitoring and the proper implementation of the NIDDCP, 30 States and UTs have established an IDD control cell in their respective Directorates.
- The States/UTs carry out health education and publicity campaigns to promote the consumption of iodated salt.
- The Nutrition and IDD Cell of the Dte.G.H.S. in association with the state IDD cell is conducting IDD surveys in all States and UTs and is imparting training to the recruited staff of States/UTs for the same.
- A National Reference Laboratory for the monitoring of IDD has been set up at the Biochemistry division of the National Institute of Communicable Diseases, Delhi, for imparting training to medical and para-medical personnel and to monitor the iodine content in survey samples of salt and urine.
- It has been envisaged to set up an IDD monitoring lab in all the States/UTs for monitoring the iodine content of salt and urinary iodine excretion, which are the most effective tools for proper implementation of the IDD control programme.
- For ensuring quality control of iodated salt at consumption level, testing kits for 'on the spot' qualitative testing have been distributed to all the District Health Offices in endemic States for consumer level awareness about the presence of iodine in iodated salt.
- To review the technical aspects of NIDDCP, Programme Implementation Committee under the chairmanship of Director General of Health Services has been constituted.
- Since the NIDDCP encompasses integrated efforts of a large number of disciplines, the focus of Programme activities has now shifted from a solely medical effort to multidisciplinary participation. To ensure meaningful inter-sectoral coordination and other administrative actions, a Central Steering Committee has been set up under the chairmanship of the Secretary (Health)
- It has been proposed in the Xth Plan to have State Level IDD monitoring laboratories for the monitoring of iodine content of salt and urinary iodine excretion that are the most effective tools for the proper implementation of the National IDD Control Programme.

Financial Assistance to States/UTs

Central Government provides financial assistance to States/UTs for the following activities:-

- To establish IDD control cell at the State Health Directorates,
- To establish IDD monitoring laboratories
- To conduct health education activities in regional languages.
- To conduct surveys for assessing the magnitude of goiter and other IDD.

Information, Education & Communication (IEC)

Following activities are being carried out to intensify the IEC activities: -

- Radio/TV spots have been prepared and their broadcast/telecast is being carried out.
- A 25-minute video film on IDD has been prepared and is being distributed to the States.
- Posters have been developed for distribution to States & UTs.
- Posters depicting the various facets of IDD manifestation have also been prepared.
- Salt Testing Kits for the qualitative testing for the presence of iodine in salt are being used for creating awareness among people, including those living in remote, rural areas and urban slums.
- IEC activities have also been intensified in coordination with the Song & Drama Division, Dte. of Field Publicity, DAVP, Doordarshan & AIR with a view to promote consumption of iodated salt among the masses.

The National IDD Control Programme is now being seen as a social process with a number of

components (Fig. 5). Notable among these components is political will with another important features of communication and education of the community about the problem of IDD.

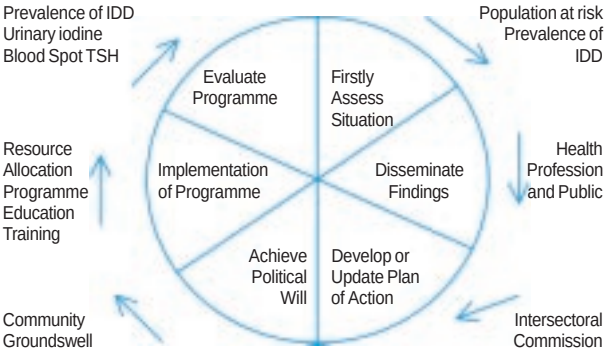


Fig.5 The wheel represents the continuous feed back process involved in NIDDCP

Factors contributing to iodine deficiency disorders

Iodine, an element present in the upper layer of earth, is an essential component of the hormones produced by thyroid gland. The glaciers, snow, rains, winds, floods sweep away the topsoil and make the soil iodine deficient. Deforestation, and industrialization, urbanization and even excessive agriculture of the land are also making the soil iodine depleted. The crops grown on iodine-deficient soil or water are also deficient in this micronutrient. Thus people living in iodine deficient area will not get the sufficient quantity of iodine for normal functioning of **thyroid gland**. The increase in the size of thyroid gland is in fact a compensatory mechanism evolved by the body to help to meet the challenge of iodine deficiency. A declined supply of this micronutrient during fetal or early postnatal life results in decreased synthesis of thyroxin, an essential hormone produced by thyroid glands. This in turn leads to a condition called Neonatal Chemical Hypothyroidism (NCH) with symptoms like retardation of physical, neuromotor, auditory, and intellectual maturation.

Monitoring of NIDDCP

The following levels of laboratory monitoring of the NIDDCP:

- The primary level is the estimation of the iodine content of salt by the titration method.
- The secondary level of monitoring is the estimation of urinary iodine excretion for the bio-availability of iodine.

Epidemiological criteria for IDD severity

Measurement of IDD provides key information required for the elimination of iodine deficiency. Two most valuable methods for assessing the severity of iodine deficiency disorders are:

- to assess the **prevalence of goiter**, and
- to estimate **urinary iodine excretion**.

Goitre prevalence

Goitre prevalence can be easily carried out in the field and requires no special equipment. The examiners need not be medical professionals, but they should be trained and initially supervised by the experienced examiners to obtain the uniformity of the results. Incidence of more than 10% prevalence of goitre in a community is an indicator of endemicity of IDD (Table-3).

The classification of goitre grade is given in Table-2 and Fig. 6.

Table 2: Classification of goiter

Grade 0	No palpable or visible goiter / **no goiter**
Grade 1	A mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in normal position. It moves upwards in the neck as the subject swallows. Nodular alternation(s) can occur even when the thyroid is not visibly enlarged / **goiter palpable but not visible**.
Grade 2	A swelling in the neck that is visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated / **goiter visible and palpable.**

Grade-0 Grade-1 Grade-2

Fig.6 Patients showing different grades of goiter

Table 3: Epidemiological criteria for assessing the severity of IDD based on prevalence of goitre in school-age children			
	Mild IDD	**Moderate IDD**	**Severe IDD**
Prevalence of goitre (TGR)	10.0 - 19.9%	20.0 - 29.9%	>30.0%

Urinary Iodine Excretion

Almost all iodine in the body is eventually excreted in the urine. Thus measurement of iodine in urine provides a good index of iodine taken. The epidemiological criteria of urinary iodine excretion for IDD monitoring is given in Table-4.

Table 4: Epidemiological criteria for assessing severity of IDD based on median urinary iodine levels	
Median Value (mg/l)	**Severity of IDD**
< 20	Severe
20-49	Moderate
50-99	Mild
>100	No deficiency

Clinical and laboratory investigation

The goiter surveys and urinary iodine determinations are the two most valuable means of assessing iodine deficiency in a population. Additional information can sometimes be obtained from casual observation of cretinism or widespread mental retardation. Occasionally, further laboratory investigations may be required for research purposes or in conjunction with other evaluations. While these tests can be valuable but are slightly complex and expensive and are not usually necessary for general evaluation.

Thyroid Hormones

The blood levels of the major thyroid hormones namely thyroxine T_4, triiodothyronine T_3, and thyroid stimulating hormone TSH can be measured by radioimmunoassy or by ELISA techniques.

Ultrasonography

It can provide a more accurate assessment of thyroid size. However, it requires a trained operator, expensive equipment, and is not often practical for routine use in surveys.

Intervention strategies in prevention and control of IDD

It is well-established fact that with the exception of certain types of goiter, Iodine Deficiency Disorders are permanent and incurable. However, all these disorders can easily be prevented before they occur. **The simplest method to prevent the broad spectrum of IDD is to consume only iodated salt daily.** This is the most effective and inexpensive mode to prevent IDD. The supply of iodated salt is to ensure availability of not less than 150 micrograms of iodine per person per day. It makes the average consumption of iodated salt per person per day is about 10 gms. Since salt is consumed by all everyday, the supply of iodated salt will ensure the availability of iodine for normal body function. The iodated salt must be properly packed and covered and should not be exposed to direct heat, sun, and rain to avoid loss of iodine. It is always better to add it after cooking. In order to make the national programme of IDD elimination possible, it is important to take up effective steps in the following directions:

- Advocacy efforts to create awareness that all populations, city dwellers and villagers as well as all socio-economic groups, are equally affected. The impact of iodine deficiency on the next generation and its potential economic impact need to be highlighted.
- Education of the masses through IEC materials will assure a demand for iodized salt.
- Formulation of legalization that only salt with specific iodine content should be produced or imported, guarantees that only iodized

salt is available in the market.

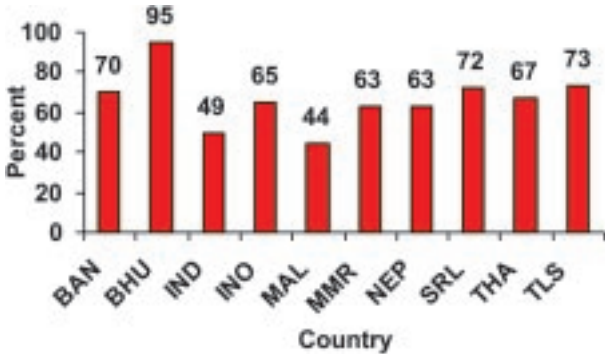
- Quality assurance procedures should be opted for production, distribution and marketing of salt.
- A strategy needs to be established to verify the extent and nature of the IDD problem.

Methods for Iodine Supplementation

Iodized salt is the choice for intervention in prevention and control of IDD. The reason for this is simple as salt being the cheapest and essential item consumed by each and every individual in more or less equal amount. Therefore, to ensure success of a **National Iodine Deficiency Disorders Programme (NIDDCP)**, it is mandatory to check that the salt being used by the community is adequately iodized.

Salt supply in the country

The country has made enormous progress with the production of iodized salt and has 840 iodization plants, with a total installed capacity of 120 million tons. The annual requirement for the country is around 5 million tons for human consumption. Over 75% of iodized salt comes from Gujarat and Rajasthan. The percentage of households consume adequately iodized salt in SEA Region is shown in Fig. 7.



Source: UNICEF End Decade Database, Feb.2004

Fig.7: Iodised salt coverage in the SEA Region

Myth about iodine excess

Most people who have previously been iodine sufficient can safely tolerate fairly large amounts of iodine. Some individuals have nodules that escape the body's usual controls, they can start making too much thyroid hormone when their dietary iodine increases, to produce a condition called iodine-induced hyperthyroidism.

Iodine excess can also cause thyroid under activity, because large amounts of iodine block thyroid ability to make hormone. Individuals vary widely in their tolerance to iodine. People with tendency towards so called autoimmune thyroid diseases, such as Graves' disease or Hashimoto' thyroiditis etc may be more sensitive to iodine. It is not well established that high levels of iodine in the population may increase the incidence of papillary thyroid cancer. Fortunately, papillary thyroid cancer is usually a mild form of cancer rarely causes death. Most people can tolerate at least 1mg (1000mg) of iodine daily without adverse effects. People underlying autoimmune thyroid disease or who have previously been iodine deficient, may tolerate less iodine. In Japan, the average intake of iodine is 3000mg per day. This is almost 20 times more than the recommended intake of iodine in our country and no side effects are reported. Since iodine, when taken in a large quantity, is easily excreted into urine, the consumption of iodated salt is absolutely safe for each and everyone. Increase incidence of iodine induced hyperthyroidism (IIH) is found transient, minimal and self limiting and even commonly affect the people >40 years of age. Iodine excess is undesirable, but its consequences are not nearly so severe as those of iodine deficiency, because the latter affects human development and can produce permanent brain damage. Hence, it is not at all correct to stop or avoid consumption of iodized salt due to fear of excess of iodine.

Iodine Deficiency Disorders and Human Resource Development

Iodine deficiency during pregnancy leads to decreased availability of iodine to the foetus. This, in turn, leads to the decreased synthesis of thyroxine, an essential hormone manufactured by the thyroid gland of the foetus. The decreased availability of thyroxine prevents the normal development of the foetal brain and body, a condition, which at birth can be diagnosed with the help of sophisticated investigations and is known as Neonatal Chemical Hypothyroidism (NCH). Such foetal brain damage is permanent and irreversible and irrevocably limits intellectual growth in later years. Thus the most important global and economic significance of iodine deficiency is the

mental impairment that lowers intellectual prowess of children at home, at school and at work, and ultimately affects productivity in adult life, reducing the potential of whole communities. This may even drastically affect our domestic animals and animal industry.

There is a typical example of Jixian village, China that showed very encouraging results by the iodised salt programme dating from 1978 on wide spectrum of iodine deficiency (Table-5).

Table 5: Effects of iodine deficiency control in Jixian village, China

	Before (1978)	After (1986)
Goitre Prevalence	80%	4.5%
Cretinism Prevalence	11%	None
School ranking	14th Last	3rd
School failure	>50%	2%
Value of farm production (Yuan)	19,000	180,000
Per capita income (Yuan)	43	550

Indicators for sustainable elimination of IDD

- There should be more than 90% households using adequately iodised salt with iodine content of 15 ppm or more.
- Median urinary iodine excretion (UIE) should be atleast 100 mg/l with less than 20% of values below 50 mg/l.
- At least 8 out of 10 specified indicators should be met.
  - An effective functional national body for the elimination of IDD.
  - Political commitment to universal salt iodisation and elimination of IDD.
  - Appointment of a responsible officer for the IDD elimination programme.
  - Legislation or regulations on universal salt iodisation.
  - Commitment to assessment and reassessment of progress in the elimination of IDD.
  - A programme on public education and social mobilisation on the importance of IDD and consumption of iodised salt.
  - Regular data on salt iodine content at the factory, retail and household levels.
  - Regular laboratory data on urinary iodine in school aged children with appropriate sampling for high-risk area.
  - Cooperation from the salt industry in the maintenance of quality control, and
  - A database for recording of results or regular monitoring procedures, particularly for salt and urinary iodine content.

Global target

Iodine deficiency has been known to exist for centuries, and even now, IDD pose a significant public health challenge in the South-East Asia Region (SEAR). Year 2005 is the target set by the international community for IDD elimination by adopting the resolution in 58th World Health Assembly in Geneva in May 2005. Although many countries have achieved this goal, still many more have to achieve. So far, only Bhutan has achieved this goal in South-East Asia Region. In other SEAR countries, however, progress towards achieving this goal seems to have slowed down. There are several reasons, important amongst them being complacency and false sense of having achieved Universal Salt Iodisation (USI) with a decrease in visible signs of iodine deficiency, e.g. goitre. Therefore, there is need for an urgent attention on the status of IDD control programmes in the South East Asia (SEA) Region if goal of IDD elimination is to be attained.

...about CD*Alert*

CD*Alert* is a monthly newsletter of the National Institute of Communicable Diseases (NICD) , Directorate General of Health Services, to disseminate information on various aspects of communicable diseases to medical fraternity and health administrators. The newsletter may be reproduced, in part or whole, for educational purposes.

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