mRNA transcript might be differentially spliced, or even both mechanisms might occur, as has been demonstrated for myosin light chains (Periasmy et al., 1984).

Nevertheless, one cannot totally exclude that the different aldolase A mRNAs could be specified by different genes. It has been shown that in man, at least two genes carried by different chromosomes (Hagenauer et al., 1985), and in rat at least five genes (P. Maire, unpublished work) are present. There is no information until now on how many of these genes are transcribed.

In fast twitch fibres, the rise of the aldolase A mRNA lighter species level is parallel to that of other specific muscular protein mRNAs such as glycogen phosphorylase M, creatine kinase M (F. Schweighoffer, unpublished work) \(\alpha\)-actin (Minty et al., 1982) and adult myosin heavy chain (Wild et al., 1984).

In conclusion, the expression of aldolase A mRNAs is qualitatively and quantitatively related to muscle development. The lighter mRNA species is absolutely specific to the differentiated fast twitch muscle fibres, while the heavier species accounts for foetal, ubiquitous aldolase A expression.

\[\text{Expression of brain-specific ID sequence is not restricted to the brain, and a novel complementary cID sequence is found in L-type pyruvate kinase mRNA (a liver-specific messenger)}\]

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We have recently shown that the pyruvate kinase (PK) gene is transcribed in the liver in three distinct translatable mRNA species of 3.2, 2.2 and 2 kb (Simon et al., 1983). These three different pyruvate kinase mRNAs only differ by their 3' untranslated extension (J. Marie, M. P. Simon, Y. C. Lone, M. Cognet & A. Kahn, unpublished work).

In order to study the role of these messengers and the regulation of their expression in the liver, we have sequenced both the whole coding region and the 3' untranslated region of the 3.2 kb PK mRNA.

Abbreviations used: kb, kilobases; PK, pyruvate kinase.

Fig. 1 shows the nucleotide sequence of 3PK cDNA clones (11C6, 12H2, 2B8) which covers the whole 3' non-coding region of the 3.2 kb PK mRNA. We have found that the 3.2 kb mRNA possesses in its 3' non-coding region a sequence complementary to the brain-specific identifier sequence (ID) described by Sutcliffe and co-workers (Sutcliffe et al., 1982, 1984a; B; Milner et al., 1984); however, this sequence which is surrounded by two Alu family elements is absent in the two other PK mRNAs (Fig. 1).

This cID sequence present in the PK mRNA was subcloned in both orientations in M13 single-stranded phage, both strands being used as probes to analysis the expression of transcripts containing ID and cID sequences in various tissues.

Fig. 2 shows the Northern blot and dot blot analysis in various tissues, ID sequence probe hybridized, as expected, with the two small brain-specific RNAs, BC1 and BC2.
Fig. 1. Partial restriction maps and nucleotide sequence of the whole 3' untranslated region of PK-L mRNA

(a) Partial restriction maps of three L-type PK recombinant plasmids which cover the whole 3' untranslated region of PK-L mRNA. The following restriction enzymes are indicated in the cDNA inserts: AvaiI (Av); SalIIA(S); AccI (AC). IIC, insert hybridized with the 3.2 kb, 2.2 kb and 2 kb of L-type PK mRNA, while 2B8 and 12H2 inserts recognized only the 3.2 kb species (1). The TGA stop codon and poly (A) tail are indicated. Restriction fragment spanning the cID sequence is underlined by a solid bar.

(b) The cDNA nucleotide sequence of the whole 3' untranslated region of PK-L mRNA.

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Fig. 2. Expression of transcripts containing ID sequence in various tissues

(a) Northern blot analysis of various tissues with cID probe (A) and ID probe. (B) Two micrograms of polyadenylated cellular RNA from rat liver in (1) muscle in (2) and brain in (3) were hybridized with either ID probe (A) or cID probe (B). (b) Quantification of transcripts containing ID sequence (B) or cID sequence (A) of various tissues by dot-blot analysis. Total cellular RNA from rat liver (3), muscle (2), and brain tissues (1) were dotted on to Gene Screen Plus (New England Nuclear) membrane and hybridized with the ID and cID probes.
(Sutcliffe et al., 1982, 1984a, b; Milner et al., 1984); surprisingly the cID sequence probe hybridized not only with the PK mRNA but also with a 0.6kb RNA specifically expressed in the adult muscle. Furthermore, both strands are also transcribed in heterogenous high molecular weight poly (A+) mRNA in various tissues, especially the adult muscle (Fig. 2b).

**Discussion**

The results shown here raise the following interesting points:

(i) The ID sequence has been shown to have a stem-loop structure while the cID sequence found in PK-L mRNA is functional role for sequence in a liver-specific mRNA. This possible structure. This structure might contribute to a surrounded by two Alu family elements which can modifyism, responsible for generation of the three PK mRNAs which could be involved in the alternative splicing mechanism, responsible for generation of the three PK mRNAs (J. Marie et al. unpublished work). This is also the first example in which a transcribed ID sequence is present in a functional mRNA.

(ii) Our results indicate that since this particular family of repeated sequences are transcribed in either orientation and are expressed in different types of tissues, the phenomena in which they are involved are not limited to their function as hypothetical brain-specific 'identifier'. The possibility exists, however, that specificity of the control of the expression of such transcripts depends on strand that is transcribed.

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**Wavelength independence of the quantum yield for adenine–thymine photoaddition**

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We have recently demonstrated the formation, in DNA irradiated with u.v. light, of a new type of photoproduct which results from photoaddition between the adjacent adenine and thymine bases in T-A doublets (Bose et al., 1983; Bose & Davies, 1984). The photoreaction was first characterized in the deoxydinucleoside monophosphate d(TpA) and involves addition between the 5,6-double bond of thymine and the six-membered ring of the adenine nucleus (Bose et al., 1984). Hitherto, our studies of this photoreaction have been restricted to the effects of 254 nm radiation. To gain further information concerning the mechanism of the photoreaction and its potential involvement in biological responses to u.v. radiation, we have investigated the wavelength dependence of its quantum yield over the range 254–285 nm which encompasses the low-energy absorption maximum in the u.v. spectrum of d(TpA). In these experiments, the photohydration reaction of 1,3-dimethyluracil (DMU) was chosen as the reference actinometer (Rahn & Sellin, 1979). This system has the advantages that the quantum yield of photohydration (0.014) is effectively independent of wavelength between 240 and 280 nm and there is no interference from wavelengths in the visible region.

Solutions of DMU (0.2–0.5 mM) and d(TpA) (0.08–0.2 mM) in distilled water were irradiated in sealed 1 cm pathlength quartz cuvettes having a capacity of 3.5 ml. Before irradiation, the solutions of d(TpA) were adjusted to pH 7 and saturated with nitrogen. Irradiation at 254 nm was carried out with two 8 W germicidal strip lamps (Sylvania G8T5) mounted in parallel and positioned 8 cm above, and parallel to, a transparent face of the quartz cuvette. For measurements at other wavelengths the cuvette to be irradiated was placed at the exit slit of a 1 m Hilger and Watts Monospek 1000 monochromator (blazed at 300 nm) so that all the emergent light entered the cuvette. The monochromator was illuminated with a 1 kW xenon arc lamp and the spectral bandwidth was 2.5 nm at all wavelengths between 260 and 285 nm.

Identical volumes (3.5 ml) of solutions of d(TpA) and DMU were irradiated (at room temperature) in the same experimental configuration at each wavelength studied. Their concentrations were adjusted to give matched high absorbances (≥ 1.3) at the irradiation wavelength to ensure that essentially the same proportion of the incident radiation was absorbed in each case. The decrease in absorbance of the irradiated solutions was then monitored as a function of time. The measurements for DMU, which permitted direct calculation of the fluence rate at different wavelengths, were made at 266 nm where its molar extinction coefficient (Cantor et al., 1970) to 3500 M⁻¹ cm⁻¹ (Bose & Davies, 1984). From the values of the fluence rate and the rate of production of the photoadduct the quantum yield of the

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Fig. 1. U.v. absorption spectrum of d(TpA) at pH 7 with superimposed quantum yields for adenine–thymine photoadduct formation

Abbreviation used: DMU, 1,3-dimethyluracil.